

AGRICULTURAL DRAINAGE ISSUES IN THE CENTRAL VALLEY, CALIFORNIA

OVERSIGHT HEARING
BEFORE THE
SUBCOMMITTEE ON
OVERSIGHT AND INVESTIGATIONS
OF THE
COMMITTEE ON
NATURAL RESOURCES
HOUSE OF REPRESENTATIVES
ONE HUNDRED THIRD CONGRESS
FIRST SESSION
ON
AGRICULTURAL DRAINAGE ISSUES IN THE CENTRAL VALLEY,
CALIFORNIA

HEARING HELD IN WASHINGTON, DC
OCTOBER 26, 1993

Serial No. 103-54

Printed for the use of the
Committee on Natural Resources



U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1994

77-141

For sale by the U.S. Government Printing Office
Superintendent of Documents, Congressional Sales Office, Washington, DC 20402
ISBN 0-16-044034-3

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AGRICULTURAL DRAINAGE ISSUES IN THE CENTRAL VALLEY, CALIFORNIA

TUESDAY, OCTOBER 26, 1993

HOUSE OF REPRESENTATIVES,
COMMITTEE ON NATURAL RESOURCES,
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS,
Washington, DC.

The subcommittee met, pursuant to call, at 9:45 a.m., in room 1324, Longworth House Office Building, Hon. George Miller (chairman of the subcommittee) presiding.

STATEMENT OF HON. GEORGE MILLER

Mr. MILLER. The Subcommittee on Oversight and Investigations will come to order for the purposes of conducting an oversight hearing on agricultural drainage issues in the Central Valley of California.

This issue is not new to this committee or to any of the interested parties. We have been dealing with the issues of drainage in the Central Valley since the inception of the irrigation systems in the 1930s, trying to sort out the differences between irrigation, flood, flood control, and drainage.

Since that time, back in 1955, the Bureau first looked at a feasibility study for an earth-lined interceptor drain that should be built for this project. In 1960, there was a conclusion that the Secretary of the Interior should build a drain if the State of California did not.

Of course, the State immediately decided that they should not, and that the Federal Government should build this drain. The questions in the mid-1960s started to be about the content of the drainage water, where and how it should be disposed of, and what conditions should be put on that drain. And in the late 1960s, obviously, litigation was begun on both sides for failure to complete the drain by those who were concerned about the drain.

We now find out that in the last several years we have gone through the disaster of the Kesterson Reservoir where the drainage waters are posing a serious threat to migratory birds and other wildlife and to habitat. And over this period of time, hundreds of millions of dollars have been spent to try to define and to set some parameters on the issues of drainage and what we should and should not do. It seems as though every time a solution is proposed, it is rejected by everyone, and we start this cycle over again. But that does not relieve the pressure on the irrigation systems and the drainage systems within the Central Valley. It continues to mount as land continues to be irrigated and the tolerance contin-

ues to be reduced for the lands to accept the irrigation water and not spin off toxic materials as a result of that irrigation.

Within that overall issue, we are also confronted with an issue of whether some adjustment should be made to the manner in which we handle some of the drainwater through the Grassland Water District¹ and whether an alternative or changes in that system ought to be created. That is some of the background.

This is a long and arduous battle here looking for a drainage solution to the Central Valley. We have had blue ribbon commissions and red ribbon commissions and yellow ribbon commissions; we have had it all. We just don't have a solution here that is within the grasp, apparently, of the overall community. And, hopefully, this hearing is the beginning of a process to try to set some direction to that, recognizing that many of the parties have done what the Congress has asked them to do in terms of exploring those alternatives. We simply haven't gotten to the place where we could get some of them implemented and to relieve the pressure on the overall system.

With that, I would like to recognize any Member who may want to make an opening statement.

Mr. Smith.

STATEMENT OF HON. ROBERT F. (BOB) SMITH

Mr. SMITH. Thank you, Mr. Chairman. Thank you for holding these hearings.

This appears to be an intramural struggle, but it surely is not, simply because what happens to reclamation in California, San Joaquin Valley or anyplace else, of course, impacts all of the western States that depend upon reclamation of water. So I have a definite interest in this hearing.

I spent two years on the Public Works Committee and at that time, we were talking about point/nonpoint pollution. We can identify and see point pollution. We haven't done anything about that but I get the impression that somehow the Congress has shifted its interests to nonpoint pollution for one reason or another, which means that you have agriculture production in direct confrontation with these questions of drainage and toxic waste.

It occurs to me we could clear up point pollution if we had the money to do so. We haven't done that. But we have shifted the incidence, it seems, to production agriculture and that really concerns me. So I am going to be very interested in listening carefully to Mr. Langley, Mr. Lehman, Mr. Dooley and Mr. Pombo, in particular, because I know there is a direct impact on production agriculture there. But if they have problems, so do the rest of us in this country.

Thank you.

[Prepared statement of Mr. Smith follows:]

¹ Editor's note.—Witnesses at the hearing often referred to "Grasslands" interchangeably with "Grassland" to refer either to the Grassland Water District or the general area of wetlands in the northern San Joaquin Valley known as the Grasslands.

**STATEMENT OF
THE HONORABLE ROBERT F. (BOB) SMITH
BEFORE THE SUBCOMMITTEE ON OVERSIGHT & INVESTIGATIONS
ON IRRIGATION DRAINAGE
OCTOBER 26, 1993**

Mr. Chairman, I want to thank you for holding this hearing today on this important subject.

Like the irrigators in the San Joaquin Valley, the farmers in my state are very interested in where this Administration wants to take the Federal reclamation program.

We have heard that the days of dam building for the Bureau of Reclamation are over. Knowing that, we hope that this Administration will still allow us to use the projects that we now have for agriculture in the West.

The issue of irrigation drainage is one that we should continue to carefully evaluate. I know that Sports Illustrated did an article on the horrors of irrigation drainage from the Federal reclamation program. Although this is a serious issue, I'm not convinced that a magazine that has a swimsuit edition should be the final word on how we manage the Bureau of Reclamation.

I think what we will find as we explore this issue, is that everyone wants to solve this problem. I know for a fact that irrigation interests have invested considerable resources trying to address the drainage problem.

Mr. Chairman, I know that our colleagues, Mr. Pombo, Mr. Dooley and Mr. Lehman have a particularly keen interest in the hearing today. I trust that you will listen carefully to what these Members have to say on issues impacting their constituents in the San Joaquin Valley.

Thank you, Mr. Chairman.

Mr. MILLER. Mr. Dooley.

STATEMENT OF HON. CALVIN M. DOOLEY

Mr. DOOLEY. Thank you, Mr. Chairman, for holding this hearing. I think you correctly outlined the problem: Some of the solutions that were anticipated to be effective when we first instituted the San Luis Act in 1960, have proven not to be capable of addressing some of the problems that have occurred.

I hope through the course of this hearing that we will not be looking at only some of the problems of the past but hopefully trying to find ways in which we can cooperate with all parties in trying to find a solution.

You know, I think I am privileged to represent some farmers in the westside San Joaquin Valley who have been very progressive in trying to institute some very positive approaches to dealing with drainage water. The Howe Family of Westlake Farms, I think, has been very progressive in trying to take a proactive role in finding an environmentally friendly manner of dealing with this difficult issue.

I also hope as we discuss this issue today that we will also hear from some of the witnesses on some of the other innovative approaches to this critical problem. So I think we all understand that we have to find a way to deal with this and we need to do so in a balanced way, which means that we have to integrate consideration of the economic impacts that any solution might have.

Thank you.

Mr. MILLER. Mr. Pombo.

STATEMENT OF HON. RICHARD W. POMBO

Mr. POMBO. Mr. Chairman, in the interest of time, I would just as soon ask unanimous consent to enter an opening statement into the record.

Thank you.

[Prepared statement of Mr. Pombo follows:]

**STATEMENT BY
THE HON. RICHARD POMBO (CA-11)
BEFORE THE
SUBCOMMITTEE ON OVERSIGHT AND
INVESTIGATIONS
OF THE
HOUSE COMMITTEE ON NATURAL RESOURCES
ON
OCTOBER 26, 1993**

Mr. Chairman:

Thank you for holding this very important hearing today on the problem of agricultural irrigation drainage in the Central Valley of California. As we deliberate on this issue, today and in future hearings, it is my sincere hope that we openly and fairly consider all of the alternatives associated with proper water usage and irrigation drainage in the San Joaquin Valley.

Agricultural production is essential to the economy of the Central Valley region. Producers have come to depend on the area's rich, fertile soil to provide agricultural goods for people all over the world. Lacking a comprehensive plan to handle excess irrigation has created a host of problems in the region which need to be addressed.

We must seek reasonable solutions to these drainage problems, before they mount, to assure long-term agricultural production in the San Joaquin Valley. Recognizing this to be a regional concern, it is essential that these solutions be addressed with local remedies and, considering the current economic climate of the area, must be accomplished in as cost effective a manner as possible. Most importantly, since no group has a greater stake in this issue, we must pay particular attention to the views of the farmers in the Central Valley.

Today's hearing is an important initial step toward formulating a comprehensive plan to solve the drainage problems faced by Central Valley agricultural producers. I look forward to hearing all the views of our distinguished panel, and working with them for a constructive solution. Thank you.

Mr. MILLER. Mr. Lehman.

STATEMENT OF HON. RICHARD H. LEHMAN

Mr. LEHMAN. Thank you, Mr. Chairman.

I guess it was 10 years ago when I was in the State legislature. During my last year there, I chaired a hearing that I originated on drainage problems in the valley, raising the concern that something has got to be done about this, and how we need a long-range solution. That was ten years ago, and the only thing that has happened in the meantime is Kesterson. I remember the meeting we had six years ago in Los Banos, when Mrs. Halleck told us about Kesterson. And, clearly, we still need a long-term solution for drainage in the San Joaquin Valley. No one has ever questioned that.

As Mr. Dooley said, we are going to need a solution, though, at the same time, recognizing the economic concerns in the area. And I think we also have to understand that this now interfaces with all the other things that we have going on as well.

The implementation of H.R. 429 is having profound effects, along with the Bay-Delta water quality standards, and the Endangered Species Act. All are causing problems for agriculture and its financing. I think whatever we do has to be well thought out, but considered in the context of all the other revolutionary changes that are taking place in the San Joaquin Valley. At the same time, as Congressman Dooley said, we must recognize that an awful lot is being done locally to address the problem.

Without a massive drain system, we have gone into ponding and taking marginal lands out of production. We have gone into arrangements with other districts to try to deal with the problem. So we are willing to do our share, but understand there is a tremendous burden on us at the present time dealing with the rest of the regulatory scheme and the legislation that has come down.

I look forward to the hearing, Mr. Chairman.

[Prepared statement of Mr. Lehman follows:]

OPENING STATEMENT
THE HONORABLE RICHARD H. LEHMAN
HEARING ON AGRICULTURAL DRAINAGE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
OCTOBER 26, 1993

Mr. Chairman:

I think we all acknowledge the importance of agriculture to the state, the nation and, especially California's Central Valley. California agriculture provides low cost, high quality food and fiber for the nation and is strategically critical to maintaining a domestic supply of these goods. However, it is becoming more and more difficult to farm in the Central Valley due, at least in part, to the vagaries of weather and the water supply uncertainty due to imposition of congressional mandates to restore the environment without adequately considering economic factors with factors bearing on hundreds of thousands of Californians. No planning can be truly feasible in such a climate of uncertainty.

To maintain a robust agricultural economy in California, the government must assist farmers in balancing the salt load between application of irrigation

water and the salt content of soils. High levels of groundwater laden with salts can ruin crops. Open air evaporation of drain water containing selenium without adequate safeguards causes deformities in waterfowl. We know this to be true and need to design solutions in this context.

The San Joaquin Valley Drainage Program provides numerous examples of projects that the USBR and federal contractors can utilize to help improve source reduction, re-use drain water and develop feasible land retirement schemes. Irrigation districts are already testing and incorporating many of these ideas and could use better assistance from the federal government. But, there will still need to be disposal of some drainage water into water bodies, and as long as these plans meet water quality standards, they should be allowed. A case in point is the pending agreement on by-pass of the Grasslands water district. This proposal should go forward without delay.

Right now, Central Valley water users are being held hostage by a variety of environmental constraints in the Delta. A six year drought wreaked havoc on efforts to plan solutions to the drainage problem and now an institutionalized drought is applying similar pressures. For water users on the

West side to realistically think about integrating many of the proposals put forth by the environmental community, they will need improved certainty about their water supply. I, and my colleague, Mr. Dooley, have asked the President to become involved in this "train wreck" in the Delta, to bring balance to decisionmaking on critical issues of water supply to both agriculture and municipalities.

I don't believe this issue should be forgotten as we begin our discussion on drainage problems in the Valley.

Mr. MILLER. Thank you.

Our first panel will be made up of the Honorable Dan Beard, who is the Commissioner of the Bureau of Reclamation, Department of the Interior. He will be accompanied by Mr. Wayne White, who is the California State Supervisor for Ecological Services, Fish and Wildlife Services. Mr. Carroll Hamon, who is Deputy Director, Department of Water Resources for the State of California.

Welcome to the committee. We will take your testimony in the order in which you have appeared here on the witness list.

Commissioner Beard, let me welcome you to the committee. This is the first time you have testified that I have been present. I am sorry I missed your first testimony before the committee. But I certainly want to welcome you, Dan, and tell you how proud all of us, I think, are on the committee of your selection as Commissioner. And also to tell you how proud I am as I talk to people from the West, including those who don't agree with you, who are numerous, by the way. I'm proud about how open you have been and willing to meet with individuals on some of the thorny problems, and not put people off with respect to some of the issues that confront members of this committee and others within their districts. Time and again, people have explained that in many instances, it is the first time they really had a sit-down with the Commissioner on very intense problems within their districts.

I want to commend you for those efforts. And we look forward to your testimony.

PANEL CONSISTING OF DANIEL P. BEARD, COMMISSIONER, BUREAU OF RECLAMATION, DEPARTMENT OF THE INTERIOR, WASHINGTON, DC, ACCOMPANIED BY ROGER PATTERSON, REGIONAL DIRECTOR, BUREAU OF RECLAMATION, AND WAYNE WHITE, CALIFORNIA STATE SUPERVISOR FOR ECOLOGICAL SERVICES, FISH AND WILDLIFE SERVICE, DEPARTMENT OF THE INTERIOR, SACRAMENTO, CA; AND CARROLL M. HAMON, DEPUTY DIRECTOR, DEPARTMENT OF WATER RESOURCES, STATE OF CALIFORNIA, SACRAMENTO, CA

STATEMENT OF DANIEL P. BEARD

Mr. BEARD. Thank you, Mr. Chairman.

All I can tell you is the view from here is a lot different from the view up there.

Mr. MILLER. I am a little worried about you down there.

Mr. BEARD. Me, too.

With your permission and the permission of the other members of the committee, I would also like to have Roger Patterson, Regional Director of the Bureau of Reclamation sit with me today. He is here to accompany me and help answer any questions. Is it okay?

Mr. MILLER. All right.

Mr. BEARD. Mr. Chairman, let me just say I appreciate the opportunity to testify before the subcommittee. It is particularly timely that the subcommittee has chosen to convene this hearing. Recent court decisions, pending administrative actions, and the challenges posed by the implementation of the Central Valley Project Improvement Act have all worked to highlight the need for review-

ing our objectives regarding agricultural drainage in the San Joaquin Valley.

Mr. Chairman, the problems posed by the lack of drainage service in the San Joaquin Valley are significant. Without adequate drainage, the long-term outlook for agricultural production in the valley's western side is in question, and without adequate agricultural drainage the salt and trace element concentrations in soils and shallow groundwater threaten the crop production.

In addition, agricultural drainage can cause a number of significant off-farm environmental impacts. In the mid-1980s, as you have referred to earlier, reproductive failures and adult mortality were discovered among resident and migratory waterfowl at the Kesterson Reservoir with all the attendant problems that ensued.

When the San Luis Unit of the Central Valley Project was authorized in 1960, the Congress outlined a number of safeguards to ensure that the unit would not be constructed unless there were guarantees the drainage problems would be solved. The legislation relied on the State and Federal Governments to develop and implement a solution. The solution decided upon was to construct the San Luis Drain.

The result of this decision is painfully obvious to all of us today. Construction of the Drain was halted by the Congress after questions were raised about environmental impacts and about its continued completion and operation. The construction and operation of drains serving 42,000 acres of land and the discharge of that drainwater at Kesterson Reservoir proved to be a multimillion dollar disaster.

Since 1985, when the decision was made to close Kesterson Reservoir, \$33 million has been spent to maintain the Kesterson site in an environmentally benign condition.

Following the problems at Kesterson, the Congress agreed to appropriate funds for a joint State-Federal effort designed to study the agricultural drainage problems of the San Joaquin Valley. This effort was the San Joaquin Valley Drainage Study Program and one of the co-directors, Carroll Hamon, is here today. The other co-director on the Federal side was Ed Imhoff who was with the U.S. Geological Survey at the time. The result of their report was a strategy to manage drainage-related issues, focusing on activities that could be done in a short time frame.

This strategy was developed within two overall policy constraints. All of the alternatives proposed in this report first had to meet the water quality objectives viewed as protective of fish and wildlife and in agreement with Federal criteria and State agencies, and second, had to focus on in-valley solutions. These activities were designed to manage the drainage-related issues while long-term solutions to disposal of salts were sought.

Unfortunately, the comprehensive solutions proposed in the drainage study remain not widely embraced. Nonetheless, nine drainage study recommendations were integrated—a comprehensive program of very pragmatic actions that represented a political consensus among the agencies involved, reached only after years of very difficult work. Rather than tailor one solution to the valley, the study recommends a series of solutions for each sub-basin.

Under one of the provisions in the settlement agreement reached in the *Barcellos* case, the United States agreed to prepare a drainage plan for the San Luis Unit. Reclamation applied the San Joaquin Valley Drainage Study Program approach, with some modifications, in a draft report released in December of 1991, which identifies specific alternatives for implementation of San Luis Unit. The recommendations proposed by Reclamation included source controls, monitoring, and technology development.

Once again, Mr. Chairman, the solutions proposed were not accepted. Indeed, the Westlands Water District formally rejected the solution proposed by Reclamation in the draft report, officially notified the court and withdrew funds they had deposited in an escrow account.

The rejection of the proposed solution to the San Luis Drainage Unit problems in the San Luis Unit was followed by enactment of the Central Valley Project Improvement Act. The Act provided means and authorization to implement source controls, land retirement and fish and wildlife habitat improvements.

I think it is important to note, however, that in that legislation, the Congress did not comprehensively address the drainage problems of the valley. Other than encouraging water conservation and authorizing water transfers, and providing limited authority to purchase lands causing drainage problems, the Act was silent on the issue of drainage.

Mr. Chairman, we are at an important juncture in dealing with agricultural drainage problems in the valley. The Bureau of Reclamation has now identified three possible solutions to these problems. Each has been rejected or ignored.

Our first effort, the San Luis Drain, was a failure and no one expects that will ever be completed. Our second effort was to participate in the San Joaquin Valley Drainage Study Program, but the recommendations in that report have not been widely accepted. And finally, Reclamation prepared a plan to address agricultural drainage problems as required by the *Barcellos* judgment. Once again, that solution has been rejected by the local parties.

The solutions identified by the Bureau of Reclamation and the Department of the Interior have not been accepted. In the absence of an agreed-upon framework for reducing the discharge of pollutants from irrigation drainage water, progress on the drainage problem in the valley has stalled.

We believe that it is time for all the various parties to try to seek an agreement on how to approach these problems in the future. The kinds of questions we need to address are the following:

What should be the objective of our agricultural drainage policy in the valley? Are the goals outlined in the San Luis Authorization Act still relevant?

How much should be spent to solve those problems by the Federal Government, the State Government and local interests?

What solution or solutions should be used to solve drainage problems? When should these solutions be implemented, and by whom?

What impacts will various solutions have on production from agricultural lands?

What are the economic and environmental costs and benefits of various solutions?

Absent some explicit agreement by the parties on agricultural drainage problems in the valley, I have no choice but to proceed to administer existing laws in a way that reduces the impacts of drainage on the economy and the environment. We will make active use of our authority to acquire drainage-impacted lands from willing sellers. We will remove roadblocks to water transfers, and rapidly expand our programs in water conservation and irrigation efficiency improvements. And we will work cooperatively with the Congress and other Federal agencies with an interest in water quality in the San Joaquin Valley.

Mr. Chairman, the issues I have identified here today certainly do not represent all of the problems posed in developing a comprehensive agricultural drainage policy for the valley. However, we do believe it is time for all the parties to address this important issue.

I would be happy to answer any questions you may have.

Mr. MILLER. Thank you.

[Prepared statement of Mr. Beard follows:]

Statement of
Daniel P. Beard, Commissioner
Bureau of Reclamation

Oversight Hearing on
Drainage Problems in the San Joaquin Valley
Before the
Subcommittee on Oversight and Investigations
Committee on Natural Resources
U.S. House of Representatives
October 26, 1993

Mr. Chairman, I appreciate the opportunity to testify before the Subcommittee this morning on the problems of drainwater generated by irrigated agricultural lands in California's San Joaquin Valley.

Everyone is well aware of the environmental problems that have been created by agricultural drainage water in the Valley. In the face of selenium poisonings of waterfowl, rising water tables, and salt buildup in the soil, the Department of the Interior has spent tens of millions of dollars on mitigation and monitoring, as well as on development of plans to address these agricultural drainage problems. None of these plans has received widespread acceptance. During this same period, we were unable to achieve consensus on public policy objectives and solutions to this growing problem among the various interests -- including Congress. Today, I am requesting that the Congress work with the Administration and clarify Federal policy on agricultural drainage for the San Joaquin Valley.

Reclamation is at a crossroads in agricultural drainage management.

It is particularly timely that the Subcommittee has chosen to convene this hearing. Recent court decisions, pending administrative actions, and the challenges posed by implementation of the Central Valley Project Improvement Act have all worked to highlight the need for reviewing our objectives regarding agricultural drainage.

Mr. Chairman, the problems posed by a lack of drainage service in the San Joaquin Valley are significant. Without adequate drainage, the long-term outlook for agricultural production on the Valley's west side is in question. During the planning phase of the San Luis Unit, it was recognized that approximately 300,000 acres in the San Joaquin Valley would ultimately require drainage to remain in agricultural production. Of this area, 150,000 acres were in the San Luis Unit of the Central Valley Project.

Drainage problems affect wildlife and agricultural production.

Without adequate drainage, the salt and trace element concentrations in soils and shallow groundwater threaten sustainable crop production. A long-term balance between the salt load in drainage water and the salt load in applied irrigation water is needed to sustain agriculture.

In addition, agricultural drainage can cause a number of significant off-farm environmental impacts. In the mid 1980's, reproductive failures and adult mortality were discovered among resident and migratory waterfowl and marshbirds feeding and nesting at Kesterson Reservoir. This discovery led the California State Department of Health Services to issue "health warnings," advising limited consumption of all duck and fish species harvested from western Merced County, and other drainage-impacted habitats in the San Joaquin Valley. In addition, drainage water contamination has been associated with adverse reproductive effects in birds at evaporation ponds, and has contaminated water supplies for public and private wetlands in the Valley.

San Luis Drain was not the answer.

When the San Luis Unit of the Central Valley Project was authorized in 1960, the Congress outlined a number of safeguards to ensure that the unit would not be constructed unless there were guarantees that the drainage problems would be solved. The legislation relied on the State and Federal governments to develop and implement a "solution." The "solution" decided upon was to construct the San Luis Drain.

The result of this decision is painfully obvious to all of us. Construction of the Drain was halted by the Congress after environmental questions were raised about its completion and operation. The construction and operation of drains serving 42,000 acres and the discharge of that drain water at Kesterson Reservoir proved to be a multi-million dollar disaster. Since 1985, when the decision was made to close Kesterson Reservoir, \$33 million has been spent to maintain the Kesterson site in an environmentally benign condition. (A chart detailing these expenses is attached to my statement.) Although no casualties from selenium toxicosis have been observed at the site since 1988, selenium accumulation in bird eggs remains elevated at levels of concern. Meanwhile, no CVP drainage service for San Luis Unit farms has been provided by the San Luis Drain since 1986.

Joint State-Federal Study set forth a new drainage strategy.

Following the problems at Kesterson, the Congress agreed to appropriate funds for a joint State-Federal effort designed to study the agricultural drainage problems of the San Joaquin Valley. This effort was the San Joaquin Valley Drainage Study Program ("Drainage Study"). The result was a strategy to manage drainage-related issues, focusing on activities that could be done in a short time frame.

The plan recommended in the Drainage Study for management of subsurface drainage and drainage-related problems on the western side of the San Joaquin Valley contained the following major components:

* Source Control. On-farm improvements in the efficiency of application of irrigation water to reduce the source of deep percolation. Such water conservation measures will in turn reduce the amount of problem drainage water.

* Drainage reuse. A planned system of drainage-water reuse on progressively more salt-tolerant plants. This would reduce the volume of drainage water and concentrate salts and trace elements for easier containment and safe disposal.

* Evaporation system. Drainage-water evaporation ponds were recommended for storage and evaporation of drainage water remaining after reuse on salt-tolerant plants. Four types of ponds were included: (a) nontoxic ponds in which selenium in drainage-water inflow is less than 2 parts per billion (ppb); (b) selenium-contaminated ponds (inflow-water containing selenium in the range of 2 to 50 ppb) that must include safeguards for wildlife and an equivalent area of alternative freshwater habitat; (c) small selenium-contaminated ponds designed with facilities to greatly accelerate the rate of evaporation, thereby reducing the pond surface area; and (d) temperature-gradient solar ponds that generate electricity by using water from other ponds containing very high salt and trace-element concentrations.

* Land Retirement. Cessation of irrigation of areas in which underlying shallow groundwater contains elevated levels of selenium (i.e., >50 ppb) and the soils are difficult to drain.

* Groundwater management. Planned pumping from deep within the semi-confined aquifer, in places where near-surface water tables can be lowered and the water pumped is of suitable quality for wildlife habitat.

* Discharge to the San Joaquin River. Controlled and limited discharge of drainage water from the San Joaquin Basin portion of the study area to the San Joaquin River, while meeting water-quality objectives.

* Protection, restoration, and provision of substitute water supplies for fish and wildlife habitat. Provision of freshwater supplies to substitute for drainage-contaminated water previously used on wetlands and to allow protection and restoration of contaminated fisheries and wetland habitat.

* Institutional Changes. Water transfers and marketing, tiered water pricing, improved scheduling of water deliveries, and formation of regional drainage management organizations to aid in implementing other plan components.

This strategy was developed within the constraints of two policies. All alternative plans had to: (1) meet the water quality objectives viewed as protective of fish and wildlife, and in agreement with Federal criteria and State agencies, and (2) focus on in-valley solutions. These activities were designed to manage the drainage-related issues while long-term solutions to the disposal of salts were sought.

Drainage Study recommendations were not embraced.

Unfortunately, the comprehensive solutions proposed in the Drainage Study were not widely embraced. Nonetheless, the Drainage Study recommendations were an

integrated, comprehensive program of pragmatic actions that represented a political consensus reached only after years of difficult work. Rather than tailor one solution for the Valley, the study recommended a series of solutions for each sub-basin. In most cases, the recommendations made in this report were non-structural in nature and they imposed responsibilities on nearly everyone.

Under one of the provisions of the settlement agreement reached in Barcellos and Wolfson v. Westlands Water District, CIV-F-79-106-EDP(EDCal), the United States agreed to prepare a drainage plan for the San Luis Unit. Reclamation applied the San Joaquin Valley Drainage Program approach, with modifications, in a draft report released in December 1991, which identified specific activities for implementation in the San Luis Unit.

Draft report on San Luis Unit Drainage Program included new technologies.

The draft report on the San Luis Unit Drainage Program preferred alternative included source control, monitoring, and technology development. The new technologies described in the December 1991, draft report would be directed toward concentrating drainage water, pursuing research and development of technology to remove potentially toxic minerals, and disposal of salts in environmentally acceptable ways. The new technologies would begin in four areas:

- * Concentration and disposal, including agroforestry, evaporation ponds, solar energy ponds, thermal evaporation (cogeneration) and brine export;
- * Pursue research and development of a treatment technology to remove selenium and other trace elements of concern so that receiving streams would be less affected and netting on evaporation ponds could be avoided;
- * Pumping of groundwater to draw down shallow groundwater tables;
- * Changes in institutional regulations to induce reductions in both applied water and drainage.

Westlands, others reject solutions.

Once again, Mr. Chairman, the long-term commitment to the solutions identified for the drainage problem has not been forthcoming. Indeed, the Westlands Water District formally rejected the solutions proposed by Reclamation in the draft report, officially notified the court, and withdrew funds they had deposited into an escrow account.

The rejection of identified solutions to the drainage problems in the San Luis Unit was followed by enactment of the Central Valley Project Improvement Act (CVPIA). The CVPIA provided means and authorization to implement source control, land retirement, and fish and wildlife habitat improvements. I think it is important to note, however, that in that legislation, the Congress did

not comprehensively address the drainage problems of the Valley. Other than encouraging water conservation, authorizing water transfers and providing limited authority to purchase lands causing drainage problems, the CVPIA was silent on the issue on drainage.

Where do we go from here?

Mr. Chairman, we are at an important juncture in dealing with agricultural drainage problems in the Valley. The Bureau of Reclamation has now identified three possible solutions to solving these problems. Each has been rejected or ignored.

Our first effort, the San Luis Drain, was a failure and no one expects that it will ever be completed. Our second effort was to participate in the San Joaquin Valley Drainage Study Program, but the recommendations in that report have not been widely accepted. Finally, Reclamation prepared a plan to address agricultural drainage problems as required by the Barcellos judgment. Once again, that solution has been rejected by the local parties.

The Bureau of Reclamation and the Department of the Interior have identified solutions which have not been accepted. In the absence of an agreed-upon framework for reducing the discharge of pollutants from irrigation drainage water, progress on the drainage problem in the Valley has stalled.

The questions that need to be addressed by this Administration and the Congress include such items as:

- * What should be the objective of our agricultural drainage policy in the San Joaquin Valley? Are the goals outlined in the San Luis Unit Authorization Act still relevant?
- * How much should be spent to solve these problems by the Federal and State governments? How much by irrigators themselves?
- * What solution or solutions should be used to solve drainage problems? When should these solutions be implemented, and by whom?
- * What impacts will various solutions have on production from agricultural lands?
- * What are the economic and environmental costs and benefits of various solutions?

Absent explicit agreement on solutions by the parties, including Congress on agricultural drainage policy for the Valley, I intend to proceed to administer existing laws in a way that reduces the impacts of drainage on the economy and the environment. We will make active use of our authority to acquire drainage-impacted lands from willing sellers. We will remove roadblocks to water transfers, and rapidly expand our programs for water conservation and irrigation efficiency improvements. And we will work cooperatively with

Congress and the other Federal agencies with an interest in water quality in the San Joaquin Valley.

Mr. Chairman, the issues I have identified here today certainly do not represent the universe of problems posed in developing a comprehensive agricultural drainage policy for the Valley. However, we do believe that it is time for all parties -- the water users, the State, the Congress and the Administration -- to address this important issue.

Mr. Chairman, I'd be happy to answer any questions.

SAN JOAQUIN VALLEY DRAINAGE, FEDERAL COSTS
FY 1961 THROUGH FY 1992

<u>Task</u>	<u>Dollars expended</u>
Construction of the San Luis Drain	40.0 million
San Joaquin Valley Drainage Program	47.0 million
Operating and maintaining Kesterson and the San Luis Drain	3.6 million
Kesterson cleanup and maintenance	30.3 million
Planning studies for the drainage program	6.5 million
Barcellos Judgment Plan	<u>3.4 million</u>
TOTAL	\$133.5 million
Funds budgeted for land retirement and water acquisition in FY 1994:	\$11.141 million

STATEMENT OF CARROLL M. HAMON

Mr. MILLER. Mr. Hamon.

Mr. HAMON. Mr. Chairman, members of the subcommittee. I am Carroll Hamon, Deputy Director of the Department of Water Resources, Sacramento, California. I appreciate the opportunity to present this statement for the Department on the very important topic of irrigation drainage problems in the San Joaquin Valley of California.

The State of California, along with others, recognized the need for drainage when plans were being made to deliver water for irrigation of westside San Joaquin Valley in the 1950s. The California Water Plan, published in 1957, included plans for delivery of water for irrigation to parts of Tulare, Kings, and Kern Counties and also described the need for drainage of those areas proposed for irrigation. Those lands, as well as the San Luis Unit of the Federal Central Valley Project, were provided irrigation water supplies in the late 1960s, but without a drainage facility.

During the following years, both the State and Federal Governments, working with the local water agencies, sought unsuccessfully to authorize and construct a master drain from near the southern end of the San Joaquin Valley to the Sacramento-San Joaquin Delta.

Finally, in the late 1970s, the U.S. Bureau of Reclamation completed 85 miles of the Drain, terminating at Kesterson Reservoir. And we are all painfully aware of the resulting effects on waterfowl and other aquatic birds that used the reservoir.

All the varied interest groups have been working diligently since the mid-1980s to find solutions to the agricultural and environmental dilemma that is posed by the need to drain irrigated land in this area to prevent waterlogging and salinization of the productive soils.

The State joined the Federal Government in a renewed search for a drainage solution in the five-year San Joaquin Valley Drainage Program that ended in the 1990 publication of *A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley*.

The plan proposed a number of actions that, taken together and implemented where practical, would allow the drainage problem to be managed "in-valley" well into the next century. It did not propose a final solution to the problem, but did note that ultimately it may become necessary to remove salt from the valley to achieve a salt balance and to allow a sustainable irrigated agricultural economy.

The Department of Water Resources (DWR) has continued its efforts to support actions recommended in the *Management Plan*, both independently and in cooperation with other State and Federal agencies involved in the San Joaquin Valley Drainage Implementation Program. DWR currently chairs the eight-member management group that is made up of four State and four Federal agencies. And DWR also is the host employing agency for a program-supported drainage coordinator that was hired in August of this year.

The *Management Plan* contained eight major components and those were: source control, drainage reuse, evaporation systems,

land retirement, groundwater management, institutional change, discharge to the San Joaquin River, and protection, restoration, and provision of substitute water supplies for fish and wildlife habitat.

Major efforts of the Department have centered on source control, drainage reuse, evaporation systems, and to a lesser degree, on land retirement and discharge to the San Joaquin River. DWR is also funding, in cooperation with the Bureau of Reclamation, a drainage water treatment demonstration project that is seeking efficient biological removal of selenium from drainage water. The San Joaquin Valley Drainage Relief Act, passed by the California legislature in 1992, authorized the Department of Water Resources to purchase drainage-affected land from willing sellers. It also created the San Joaquin Valley Drainage Relief Fund which would, in effect, be a revolving fund used to purchase land, sell the associated water as land is taken from irrigated production, and to buy more land and then repeat the process.

However, no funds have been provided to initiate the process, which must be self-sustaining. DWR is currently working with the Bureau of Reclamation, which has some funding for retirement of irrigated land through the Central Valley Project Improvement Act (CVPIA), to determine if the two programs may be administered to complement each other and produce a viable State program. The CVPIA coordinating committee has reviewed the progress to date and encourages continuation of this effort.

The *Management Plan* includes a feature to utilize a portion of the San Luis Drain to bypass drainage water around the Grasslands area and through an 8-mile extension of the Drain to the San Joaquin River. Discharge in that plan was proposed only when the San Joaquin River could assimilate drainage water constituents and still meet the established water quality objectives.

A similar proposal is being made by the Grassland Water District and is being discussed here today. DWR supports that proposal with adequate monitoring to meet San Joaquin River water quality objectives.

Both the State and Federal Governments have invested tens of millions of dollars in study, planning, and seeking a solution to agricultural drainage problems on the western side of the San Joaquin Valley. We are at a point where funds are needed to aid the growers and local water districts in taking the actions necessary to manage the problem and continue to seek a permanent solution.

Some funds will be available through the Central Valley Project Improvement Act and will aid in protection, restoration, and provision of water supplies for fish and wildlife habitat. The CVPIA also provides some funds to further source control, for drainage reuse demonstration, and for land retirement. But funds to help growers initiate on-the-ground drainage management actions are not available and appear to be a missing link in implementing a drainage management plan. Possibly this subcommittee could consider ways where help might be provided through existing or new loan or grant programs.

I thank you for this opportunity to bring these thoughts to your subcommittee. You may be assured that the Department of Water Resources intends to continue with others in the quest for equitable

solutions to the agricultural drainage and related problems on the westside San Joaquin Valley.

[Prepared statement of Mr. Hamon follows:]

STATEMENT OF CARROLL M. HAMON, DEPUTY DIRECTOR, CALIFORNIA
DEPARTMENT OF WATER RESOURCES, BEFORE THE HOUSE OF
REPRESENTATIVES COMMITTEE ON NATURAL RESOURCES, SUBCOMMITTEE ON
OVERSIGHT AND INVESTIGATIONS REGARDING IRRIGATION DRAINAGE
PROBLEMS IN THE SAN JOAQUIN VALLEY OF CALIFORNIA

Washington, DC October 26, 1993

I am Carroll Hamon, Deputy Director for the California Department of Water Resources in Sacramento, California. I appreciate the opportunity to present this statement for the Department on the very important topic of irrigation drainage problems in the San Joaquin Valley of California.

The State of California, along with others, recognized the need for drainage when plans were being made to deliver water for irrigation of the westside San Joaquin Valley in the 1950s. The California Water Plan, published in 1957, included plans for delivery of water for irrigation to parts of Tulare, Kings, and Kern Counties and also described the need for drainage of those areas proposed for irrigation. Those lands, as well as the San Luis Unit of the federal Central Valley Project, were provided irrigation water supplies in the late 1960s, but without a drainage facility.

During the following years, both the State and federal governments, working with local water districts, sought unsuccessfully to authorize and construct a master drain from near the southern end of the San Joaquin Valley to the Sacramento-San Joaquin Delta. Finally in the late 1970s, the U.S. Bureau of Reclamation completed 85 miles of the drain,

terminating at Kesterson Reservoir. We are all painfully aware of the resulting effects on waterfowl and other aquatic birds that used the Reservoir. All of the varied interest groups have been working diligently since the mid-1980s to find solutions to the agricultural and environmental dilemma posed by the need to drain irrigated land in this area to prevent waterlogging and salination of the productive soils.

The State joined the federal government in a renewed search for a drainage solution in the five-year San Joaquin Valley Drainage Program that ended in the 1990 publication of "A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley". The Plan proposed a number of actions that, taken together and implemented where practical, would allow the drainage problem to be managed "in-valley" well into the next century. It did not propose a final solution to the problem, but did note that ultimately it may become necessary to remove salt from the Valley to achieve a salt balance and to allow a sustainable irrigated agricultural economy.

The Department of Water Resources has continued its efforts to support actions recommended in the "Management Plan", both independently and in cooperation with other State and federal agencies involved in the San Joaquin Valley Drainage Implementation Program. DWR currently chairs the eight-member

(four State and four federal agencies) Management Group and is the host employment agency for a program-supported Drainage Coordinator that was hired in August 1993.

The Management Plan contained eight major components:

- Source Control
- Discharge to the San Joaquin River
- Drainage Reuse
- Protection, Restoration, and
- Evaporation System
- Provision of Substitute Water
- Land Retirement
- Supplies for Fish and Wildlife
- Ground Water Management
- Habitat
- Institutional Change

Major efforts of DWR have centered on source control, drainage reuse, evaporation systems and, to a lesser degree, on land retirement and discharge to the San Joaquin River. DWR is also funding, in cooperation with USBR, a drainage water treatment demonstration project that is seeking efficient biological removal of selenium from drainage water.

The San Joaquin Valley Drainage Relief Act, passed by the California Legislature in 1992, authorized the Department of Water Resources to purchase drainage affected land from willing sellers. It also created the San Joaquin Valley Drainage Relief Fund which would in effect be a revolving fund used to purchase land, to sell the associated water as land is taken from irrigated production, to buy more land and then repeat the

process. However, no funds have been provided to initiate the process, which must be self-sustaining. DWR is currently working with USBR, which has some funding for retirement of irrigated land through the Central Valley Project Improvement Act, to determine if the two programs may be administered to complement each other and produce a viable State program. The CVPIA Coordinating Committee has reviewed progress to date and encourages continuation of the effort.

The Management Plan includes a feature to utilize a portion of the San Luis drain to bypass drainage water around the Grasslands area and through an 8-mile extension of the drain to the San Joaquin River. Discharge was proposed only when the San Joaquin River could assimilate drainage water constituents and still meet established water quality objectives. A similar proposal is being made by the Grasslands Water District and is being discussed here today. DWR supports that proposal, with adequate monitoring to meet San Joaquin River water quality objectives.

Both the State and federal governments have invested tens of millions of dollars in study, planning, and seeking a solution to agricultural drainage problem on the westside San Joaquin Valley. We are at a point where funds are needed to aid the growers and local water districts in taking the actions necessary to manage the problem and continue to seek a permanent solution. Some

funds will be available through the Central Valley Project Improvement Act and will aid in protection, restoration, and provision of water supplies for fish and wildlife habitat. The CVPIA also provides some funds to further source control, for drainage reuse demonstration, and for land retirement. But, funds to help growers initiate on-the-ground drainage management actions are not available and appear to be a missing link in implementing a drainage management plan. Possibly the Subcommittee could consider ways where help might be provided through existing or new loan or grant programs.

Thank you for the opportunity to bring these thoughts to your Subcommittee. You may be assured that the Department of Water Resources intends to continue, with others, in the quest for equitable solutions to the agricultural drainage and related problems on the westside San Joaquin Valley.

Mr. MILLER. Thank you very much for your testimony.

As I understand the testimony of both of you, you seem to be outlining a situation where we have just come to a halt here. We started this a number of years ago, and as Congressman Lehman pointed out, after all the excitement around Kesterson, there was a lot of activity. We did the drainage study and a lot of other actions. Slowly it appears we just coasted to a stop here in terms of those actions that appear to be necessary to correct the drainage problem on a valley-wide basis, whether you divide it into sub-basins or not.

It appears that this more or less has come to a stop in terms of the actions that are necessary, mainly because the solutions proposed by one or more different groups or studies have been rejected by the participants who would be necessary to make them work. Is that fair?

Mr. BEARD. I am not sure I would characterize it that way. I think the way I would characterize it is we are in a transition phase. You know, 30 years ago the answer seemed very simple: We would build a drain. We have now all come to the conclusion that there has to be in-valley solutions, of some type, during a 50-year period. Now we have finally rejected the silver-bullet theory, I suppose is the best way to put it—that there has got to be one simple solution to this problem.

Well, now we have all agreed that isn't the case; there is no easy answer to this question. We are now in a transition phase of determining what we do next.

The Congress has, in many respects, already spoken. You know, the Congress has directed us to increase our efforts in conservation, irrigation efficiency improvements, purchasing lands, taking land out of production and some other steps. We are going to proceed with those. And the EPA, as their testimony later on will suggest, recommends that approach as well.

But, I think the question before the Congress now is, Is that the way you want us to continue to proceed? And if that is the way we are going to proceed, who are going to be the people who carry the load and carry the costs associated with this type of a solution?

If that is the way we should be proceeding, then I think, as my testimony points out, it is time for all the parties to sit down and determine that if this isn't the way we want to go, then let's figure out another way and look at our overall policy.

What my testimony is trying to get at, Mr. Chairman, is that we need some affirmation that the policy direction on which we are proceeding at the present time is the correct one. Is this the way that Congress wants us to go?

Because any solution is very expensive, and dollars are short. I mean, as Carroll's testimony points out, his recommendation is that we have additional funds created. And as you know, we are just like the State, we are strapped for funds.

Mr. MILLER. Well, a couple points on that answer. I think on page 3 of your statement, at the bottom there, you say the strategy was developed within the constraints of two policies. All the alternative plans had to meet the water quality objectives viewed as protective of fish and wildlife, and in agreement with the Federal criteria and State agencies, and focus on in-valley solutions. And that was from the very beginning. There was the notion that you

were not going to export one region's problems to another, whether it was in the early days that talk of Monterey Bay or going to the greater delta at Antioch. Congressman Coelho, at that time, and others said, this is going to have to be worked out within the valley area.

If you do that, then the drainage plan, as I understand it, and the studies that have been done, on a comprehensive and an individual basis, give you a series of arrows to put into your quiver to start to manage the drainage problem.

I don't know if this is accurate or not, but I think politically it would appear that land retirement is the most restrictive and perhaps the harshest. And then, if you work back into conservation, reuse, cleanup, these various alternatives for draining the shallow subsurface water down deeper, you know, the intensive welling program, all of those are a range of tools that people seem to have agreed upon are the right tools to use. And the mix depends upon what is going on in that basin, what kind of lands are you dealing with in severity of the problem.

I find it hard after all this to suggest that the answer is for the Congress to come in and say this is the way to do it. One, that is not our business, and two, I don't know that we would necessarily do it right.

But the first question I need to ask is whether or not you have the authority, and I am talking to you collectively, State and Federal here, whether or not you have the authority? Second, are there pressure points where this authority can be exercised in terms of getting greater conservation or different land management processes implemented?

Or are the drainers able to simply stonewall this and say simply, we are not going to do this?

Mr. HAMON. Mr. Chairman, I think you have a good comprehension of the drainage plan that was prepared in 1990. It did have a mix of various elements—including source-controlled reuse groundwater management, land retirement—that were proposed as an in-valley management scheme.

That in-valley management scheme was not intended as the ultimate solution, as you just mentioned. The growers in the water districts out there are implementing source control to the degree that is possible. They are making more efficient use of the irrigation water, therefore, cutting down on the amount of drainage coming out.

The Department of Water Resources and the Federal Government are funding demonstration programs on reuse, the concept of using water on salt-sensitive plants, then taking the drainage from that to put on to salt-tolerant plants and from trees, to the eucalyptus trees and others, in order to reduce the volume of drainage water that has to be treated or cared for in some other way.

I think there is quite a lot of activity out there in source control and drainage reuse, and now we are beginning to develop programs whereby willing sellers of drainage-affected lands may be able to take that land out of production in a way that we call "land retirement."

So this is a problem that has developed over a number of years and in-valley solutions are going to take a number of years in order to wrestle with this problem.

The out-of-valley solution I don't think will ever come about until all of the effort that is possibly made in-valley in order to solve the problem has been accomplished. But I do believe that there are a number of actions that are being taken now that, if we could put those together, would get us further down the road toward the salt problem.

Mr. MILLER. What prevents you from pulling those together?

Mr. HAMON. As I see it, the State and Federal Governments have been chartered with the responsibility of supporting the actions of the local water districts and the local growers in those areas. I don't know that we need any additional authority in order to encourage them to continue on the road towards solving the problem.

Mr. MILLER. But I—

Mr. BEARD. I would agree we have the authority as well. But it always gets down to the same issue, and that is: "Who pays?" Now, the San Joaquin Valley Drainage Study Program came up with a series of recommendations. I think we have to look at what they recommended in comprehensive terms. They recognized there are 620,000 acre-feet of problem water that have to be reduced, and a million acres of land that have to be addressed, with yearly costs of \$42 million a year, just in the solutions that they proposed. And it is very important to note, as they also point out in their report, that how we fund solutions was an issue that wasn't addressed or even discussed. Ultimately, that is the issue we get down to. Who is going to pay for this?

There is the presumption on the books, at the present time, that this is a Federal responsibility, especially with respect to the San Luis Unit. And the decision to go with the Drain was a decision on the part of the Federal Government to pursue that particular path. And I think one of the most challenging issues facing us is, first of all, Do we want to proceed with the way that we seem to be proceeding at the present time? There are very decentralized solutions, such as conservation water withdrawals, water transfers, some small investments in technology improvements, to the extent we can get them. The question then becomes, "Who pays?" Is this an entirely Federal responsibility? If it is going to be shared like most costs, we should ensure the local interests are willing to come up with the dollars.

I think, ultimately, it gets down to dollars and responsibility. Those are important issues, and I think we haven't got any consensus on that issue.

Mr. MILLER. If I could just take one moment and then recognize my colleagues.

We have witnessed over the last several weeks in the Congress, the Congress is getting more and more reluctant to pay for a whole series of items. But, obviously, certainly for those of us within the California delegation, the question is, What is it we are buying? You know, I can go around and fund a whole series of decentralized soft solutions, and I won't know until the end whether or not I have got a solution.

I may have allowed a lot of people to extend their time on the land, but I still may be inheriting a rather massive problem. Because when you add up all of the parts, it doesn't add up to solving the drainage problem. And I have spent a lot of money, and now I still have the drainage problem, and I may now have drainers who are in a reduced financial capacity to participate because their lands have not survived that process.

That is fairly difficult, it seems to me, to get the Congress to buy into, to the tune of half a billion dollars, whatever it takes over the decade to do that.

What is it people are willing to sign up to do, and I think that is part of the concern here.

Congressman Smith.

Mr. SMITH. Thank you, Mr. Chairman.

I have a map before me identifying a proposed canal which would drain the Grasslands, I suppose. Is that a part of the overall plan?

Is that something, Mr. Beard, that you endorse?

You don't have the map?

Mr. BEARD. I don't have the map. And you used the word "drain" and asked if I endorse it. And the answer is no.

What is the question?

Mr. SMITH. Let us call it the San Luis Drain; you are familiar with that?

Mr. BEARD. Yes, I am.

Mr. SMITH. That is what I am talking about.

Mr. BEARD. No, I do not support continued construction of the Drain. As Carroll noted, 85 miles were completed to Kesterson and that is going to be the end of it.

Mr. SMITH. What has occurred that has, I guess, stopped the birds from dying at Kesterson?

Mr. BEARD. We have closed Kesterson down; we plugged the drains; we eliminated the drainage water and the inflow into Kesterson; and the birds have stopped dying.

But maybe I would ask Wayne White to mention, too, I think we have also found that some of the problems there haven't exactly gone away.

Mr. WHITE. Yes. The evaporation ponds throughout the valley, some may even be worse than Kesterson. They vary in their toxicity.

Mr. SMITH. Have you found any results of that with other calamities, like Kesterson?

Mr. WHITE. Yes.

Mr. SMITH. In what magnitude?

Mr. WHITE. Well, it varies.

Mr. SMITH. One bird; 1,200?

Mr. WHITE. No. The 4 ponds that were studied, they found toxicity and death in about 1,000 birds. That is 4 of, roughly, 26 ponds. And again, they vary in toxicities, some much worse than others.

Mr. SMITH. For what period of time was that?

Mr. WHITE. That was a two-year study.

Mr. SMITH. Mr. Beard, a little bit off the issue here, I wanted to ask you, you graciously discussed with me the question of penalties for good-faith errors on Reclamation projects. I am interested in

whether or not you are going to promulgate a rule, as we discussed, or do you want us to proceed with legislation?

Mr. BEARD. I don't see any reason for you to proceed with legislation. I have made a commitment to you and to others, that by January 1, we will solve this problem administratively.

Now, whether we take care of 100 percent of the problems is uncertain, but we will certainly take care of most of them. We will not have instances of individuals who fail to fill out a form correctly and get bills for \$26,000, or whatever it is. My recommendation to you would be to wait until you see what we propose and how we propose to forms requirements. If it is not acceptable, there is nothing wrong with the Congress proceeding to address the issue, but I don't think it is necessary now.

Mr. SMITH. I appreciate that.

Thank you.

Mr. MILLER. Mr. Dooley.

Mr. DOOLEY. Mr. Beard, perhaps, I just want to get clarification in terms of what you are asking.

May I interpret by your testimony that you are saying, because of the original San Luis Act, which had the provision that required the construction of a discharge facility for the drainage water, that the Bureau is somewhat precluded from taking actions that most of us accept in a real-world situation are not limited to the export of drainwater? And because of recent court decisions and because of the letter of the law, the Bureau is in a Catch-22, in that technically you are still required to handle up to 100,000 acre-feet of drainage water?

Mr. BEARD. I think that is a fair characterization of the problem we are presented with. I think that the United States doesn't agree with the decision of the court and its interpretation, but that is still a matter before the courts.

Well, what I am really trying to say is that the answer from interests in the valley is always to have the Federal Government solve this problem. We have tried three times to come up with a comprehensive solution, and every time we have struck out. Maybe it is time to move down a different path here. And we have. We are moving forward in a new direction. This new policy is not articulated in a widespread manner, but we are moving increasingly towards conservation, land withdrawal and some modest—

Mr. DOOLEY. I guess—

Mr. BEARD [continuing]. Transfers and some other things.

Mr. DOOLEY. My question is, Are you asking us for legislation to amend the San Luis Act that specifically requires the handling of the discharge of this drainage water?

Mr. BEARD. Not at the present time.

Mr. DOOLEY. You are saying administratively that is not a problem, even in light of what the court decisions have been?

Mr. BEARD. Not at the present time. But I think the Congress and the Administration and the local interests need to sit down and decide how we want to approach this problem. Right now, we have imposed additional O&M expenditures on recipients of irrigation water. There have been very substantial objections to many of these O&M expenditures. Well, the conservation efforts that are being done on-farm right now are either going to be done by local

interests or through some modest federal funds in the form of loans. Right now this is a fairly major burden that is going to fall on local interests.

The question is, Is that an acceptable way to proceed? And my budget is just like the budget of every other Federal agency; it is going down, not up.

Mr. DOOLEY. On the issue of repayment and on the issue of the repayment for the Kesterson cleanup, what is the position of the Bureau on how those costs would be allocated, at this time?

Mr. BEARD. I have had a recommendation from the regional staff, and I am currently reviewing the recommendation with the Solicitor's Office and with the Budget Office and OMB. The issues presented are whether or not the approximately \$110 million we have expended for the Kesterson cleanup in the San Joaquin Valley Cleanup Program is to be repaid, and what portion is to be repaid by water users. As you know, the Congress has spoken already, and appropriated them as construction funds. The question is, Can we now come along ex post facto and say that a portion of these funds were the pursuit of human knowledge or better understanding of processes and, therefore, should not be reimbursable?

Then there is the future issue of who pays for operation and maintenance expenditures for monitoring Kesterson?

Mr. DOOLEY. Did I understand, then, in your last statement, that you basically said the original intent of the appropriations was that they would be nonreimbursable?

Mr. BEARD. No. No. My interpretation is that the issue wasn't addressed by the Congress, but they appropriated them all as construction funds for the San Luis Unit. No comment was made about whether or not they were reimbursable or nonreimbursable. That is usually an administrative matter that is done by Reclamation unless there is a separate account in either the authorization or appropriation.

Mr. DOOLEY. On some of the more progressive things that are happening out in the valley trying to deal with this, in one specific project, some of us are very concerned. We are frustrated because we have spent \$50 million trying to understand how to deal with this problem, and have come up with some excellent recommendations. We see some interesting ideas out there that look like they might be financially viable and could be part of the solution, such as a project by the Firebaugh Water District and the Santana Company. It is a cogeneration type of facility that they are looking at, and they think it would be financially viable.

I guess my question is, What efforts is the Bureau taking to prioritize these types of projects that can receive some cooperation with the Bureau? Further, what have you done on a project such as this, which requires, in order to make it financially feasible, a commitment by the Bureau or WAPA to purchase the power at 7-8 cents a kilowatt hour? What is the interaction there, and what is really the commitment to try to bring some of these projects on line?

Mr. BEARD. May I ask Roger to address the issue?

Mr. PATTERSON. Congressman, earlier this year, the Bureau put out a solicitation for ideas for technology advancement for both water conservation and drainage, and the Santana proposal is in

that category. I think we received 40-some applications for evaluation in the two categories, and an interagency team is looking at those.

I think we are ready to award 11 or 12 of those proposals. We are in direct discussion with WAPA and with that particular project. Our criteria was that we were willing to put up half of the money on a particular technological idea, and to see it advanced. That was the basis upon which we solicited proposals.

Mr. DOOLEY. Thank you.

Mr. MILLER. Mr. Pombo.

Mr. POMBO. Mr. Beard, in your statement a few minutes ago, you talked about the need to remove up to 75,000 acres from production. Has there been a map prepared for that or any idea of where that is going to come from?

Mr. BEARD. I am not aware that I made that statement.

Mr. POMBO. I may be misquoting you, but I thought I heard you say that a few minutes ago.

Mr. BEARD. No, I think the San Joaquin Valley Drainage Study Program made recommendations about how much land would have to eventually be withdrawn from production. But Carroll, I don't know whether they actually had specific maps.

Mr. HAMON. No, there were not specific maps that were published on that. The amount was estimated based upon the selenium concentration in the shallow groundwater supplies and the drainability of the soils. And there was an estimate then made at about 74,000 acres across the whole westside of the San Joaquin Valley, it would probably be more economically feasible to take that out of production and try to provide drainage facilities for that high selenium-type drainage that comes from those areas.

Mr. POMBO. There was no map ever prepared for that; there was just an estimate made?

Mr. HAMON. The estimate was of a regional nature. There were soils maps. Water quality maps that were used in preparing that estimate. But not a detailed map showing landownership or anything like that.

Mr. BEARD. If I could supplement the answer. We currently have authority to purchase lands, and take them out of production. We have a program under way, but we are working with the Department of Agriculture, State DWR and State Fish and Game, as well as the U.S. Fish and Wildlife Service, to make certain that the lands we do purchase—and we can only purchase from willing sellers—are lands that everyone agrees are going to result in some fish and wildlife values as well as solve drainage problems. We are also going to go out for public comment on the criteria that we are going to be using in January, so there will be public hearings on that.

So to allay any fears that there might be some federal land grab, so to speak, these will be willing-seller, willing-buyer purchases after all the various agencies involved review the transaction.

Mr. POMBO. I understand that part of it, but you do not have the money to buy the land, do you?

Mr. BEARD. In our budget this year, we have around \$5.4 million to purchase lands.

Mr. POMBO. Besides removing land from production and conservation efforts, what other solutions are you proposing at this

point to take care of the drainage problems that we have in the valley?

Mr. BEARD. Well, briefly, you heard the talk of the various technological innovations being considered, and we are moving forward to try to award funds to participate in some of those. We do have authority now to transfer water, and that may be of assistance, because land will be fallowed in that case.

Roger, are there some other things you might want to mention?

Mr. PATTERSON. Basically, we are working from the list that was in the San Joaquin drainage program.

We put water conservation criteria out last April. The districts, all the users of CVP water, are required in the next few months to submit plans to Reclamation. We continue to work with the Geological Survey on the idea of groundwater pumping as a management tool. We are considering the whole array of things in the drainage program report.

Mr. POMBO. Are you factoring in the economic viability of doing some of these things? Is that being figured before you go into them, before you start spending money on them?

Mr. PATTERSON. Well, it varies. Let me put it that way. For instance, the basis that we are using for the land retirement program is a willing seller, with a sealed-bid approach. We have been talking at length with the Soil Conservation Service so that the money that we have supposedly offered to a willing seller under sealed bids will represent the value and the economics of that property.

We are trying to design criteria so that under that program we get multiple benefits—reduced drainage, acquire upland habitat and acquire water that can perhaps be transferred—and bring those all together. However we do not have, quote, an economic evaluation of each of these program areas.

Mr. POMBO. On the new technology that all of you have mentioned about ways to do this, is the economic viability figured in after you have already started it to see if you can actually do it?

Mr. PATTERSON. What we are doing on the technology advancement is, I would say, first of all, there is nothing that has been proven either technologically or economically. So we are in the early stages of those with the idea that if something proves out, then the economics will have to be evaluated before you would have any kind of a broad-scale implementation. So that I would say would be in the second phase.

Mr. POMBO. Okay, thank you.

Mr. MILLER. Mr. Smith.

Mr. SMITH. Mr. Beard, or any of you, have there been identifiable human kinds of illnesses that have come directly from any of the toxic waste that has developed?

Mr. BEARD. Everybody down here is pointing this way.

Mr. SMITH. Nobody wants to handle that.

Mr. BEARD. I will defer to Carroll, but what I would say is that Merced County, at the time of Kesterson, did issue public health warnings not to eat the fish or birds that were collected at Kesterson. That warning was in place for several months. I don't know if there are other instances of—

Mr. SMITH. But nobody was poisoned; nobody died.

Mr. HAMON. No, no, no.

Mr. BEARD. Not that we know of.

Mr. SMITH. How do you tell a duck that is on Kesterson or on another—

Mr. MILLER. They have two heads in Kesterson.

Mr. SMITH. Like the Potomac fish, you light up at night.

Mr. BEARD. Well, Mr. Smith, I think the problem is a little more difficult than that. The problem is that that is a criminal violation of law. Under the Migratory Bird Treaty Act, we cannot take migratory waterfowl and construct a drainage pond which contaminates and kills birds. That is a criminal statute. So it is a little like dealers in Reclamation where we have the one penalty, to either shoot you or hang you. So it is a very difficult kind of penalty associated with that law. It is a real challenge.

Mr. SMITH. There are no dead criminals either.

Mr. BEARD. No.

Mr. MILLER. The map that Congressman Smith was referring to, I think, may have been misinterpreted. Well, it depends on your interpretation of continuation of the Drain; however, he was talking about the proposal, I think, to skirt the Grasslands area and to take some of the wastewater out of the area between the San Luis Project and Grasslands and move it into the San Joaquin River.

My understanding is that to do that raises some problems with EPA in terms of the water standards, with Mud Slough. And what is the other receiving body, Salt Slough? Is that correct?

Mr. BEARD. Yes.

Mr. MILLER. How would we deal with that discharge?

Mr. BEARD. The State, the Regional Water Quality Board, will either have to give an extension of the time for compliance or implementation of the standard or take some other action. Without affirmative action on the regional board's part, the proposal cannot go forward. It is as simple as that.

Mr. MILLER. If you open this route that now skirts Grasslands and theoretically mitigates and insulates the damage to Grasslands of running some of this drainage water through there, their lands now, which in some cases leaves the ditches and is used to flood some of the wetlands, if you have now provided that installation, how long is it before you will get additional requests to use that facility by people further down the valley with what may be or, in fact, are much hotter lands with respect to selenium?

Mr. BEARD. To date, we have not had any.

Mr. MILLER. I know you have not had any but the highway is not open.

Mr. BEARD. Well, you know, the issue here is we have the facility and this plan has been proposed for, I think, close to six years. The Bureau has been examining this issue as well as the Fish and Wildlife Service throughout that period of time. We have made what we think is a good-faith effort to try to answer every question we can. We have also tried to put into place procedures by which we can terminate this effort should problems be presented.

Now, have we answered every question? Probably not. But there are some real advantages to proceeding with this trial balloon, if you will. I think the advantages particularly to migratory waterfowl are important for us to try to take care of.

First of all, the regional board has to act, and if it does not act affirmatively, then we just do not proceed. But we will have a monitoring program in place. We will monitor the results, and if we have contamination, then we will have to bring it to an end.

I would defer to Wayne if you have any additional comments about this.

Mr. WHITE. Mr. Chairman, this is a situation where I used to be neutral. I didn't have an opinion. But that has changed. As you look more at this issue, the contamination of the wetlands is happening. This action will simply move the current level and actually do a little more than that, because we set up an oversight committee that will deal with unacceptable impacts and developing mitigation measures that would impact that.

We do not have that at this time. We need to wait to see what the board will do in implementation of the standard. If they have a phased implementation strategy, the position is still that this action has to meet standards. If it does not, then you do not have the action.

Mr. MILLER. Well, as I read the memorandum from the Central Valley Regional Water Quality Board, they say—this is July 1, 1993—they say “there is no need to extend the basin plan compliance dates of October 1, 1993, which is no longer applicable because they provide for a compliance schedule of up to ten years for the adoption of numerical objectives for point source discharge and compliance schedules for a time to be determined by the regional board for nonpoint source discharges.”

My concern is, if you go forward and you approve this action, where does that leave us with respect to getting these standards met? Is this another ten years? Overall, groups have been looking at this for six years, as you say. This plan has been put forward, and in that six years we have used up all the time, and now we find we are at a deadline and we are told the deadline is not applicable and we can really have up to ten more years for what is rapidly becoming a point source solution, the manner in which it is gathered and channeled. It starts to look a lot more like a point source solution than this notion of uncontrollable runoffs out there that are too expensive for any one group to fix up and they contribute to the problem. What happens here?

Understand that you are also taking that pollution of the wetlands and you are moving it into the San Joaquin River and you are moving it eventually either into the pumps to go south or into San Francisco Bay. So this in-valley solution is starting to look a little bit more ephemeral than what we talked about before. And understanding even with it going through Grasslands, it is a different issue now because this becomes ideally an isolated facility, does it not?

Grassland has to contend with the pollution because the water is not isolated from their lands as it moves through there.

Mr. BEARD. First of all, the question is whether or not the runoff at the present time meets the standards. Then there is the issue of whether or not we approve the plan and we discharge into Mud Slough. If we do not approve the plan and we discontinue to operate as we are right now, the issue of just charge and the standards

is still an issue which EPA, the State board, and the regional board will each have to deal with.

The question for the Bureau of Reclamation was, Is this an advantageous proposal for us to proceed with? And the answer was, yes, from the fish and wildlife standpoint it does make sense and we should proceed with it.

Mr. MILLER. Assuming the standards are in place.

Mr. WHITE. And no increased loading to the river.

Mr. MILLER. Right. But all that is to be determined after you have approved the plan. The plan is approved contingent upon an implementation plan being approved to meet the standards so there is no loading of the river. That is everybody's sort of, "yes, yes, yes, we will get to that," but what they want is the short authority and the permit to move the water now. There is a distinction between those two. Right?

Mr. PATTERSON. Right.

Mr. MILLER. I will tell you why I raised the issue, it probably has not made your day yet, but the *San Francisco Examiner* just started a five-day series on San Francisco Bay on the theory that some of these issues politically come around again.

They are making it very clear to the inhabitants of the Bay and Delta they are not an isolated facility—that there are a number of actions that take place in municipalities and private industry on the farming community by the Bureau of Reclamation and others that impact that Bay.

I have constituents, mainly in the major oil refineries in this county, spending millions of dollars to clean up the selenium that they discharge into the Bay through the refining process. That is because they are point source pollution. Now I am being told we have a plan here that allows selenium into the Bay with the hopes of some action being taken within the next decade.

What is the equity of those two positions?

Mr. PATTERSON. Well, our view and the criteria that we have to apply is that, with and without this permit, we are in the same place as far as the loading on the San Joaquin River.

Mr. MILLER. Except there is a constituent in the valley under the current system that is not interested in that process continuing. That is Grassland and the environmental community. But somehow this is different? Why? It appears the difference is they believe that oil companies have deep pockets so they can meet everything right now and somehow once we have collected all this wastewater together, we can still go through a fix that it is a nonpoint source introduction of wastewater into the operation at least for the next decade.

Mr. BEARD. The question whether it is a point source or a nonpoint source is a matter of law under the Clean Water Act.

Mr. MILLER. I understand that. But as I say, if you put it in a pipe and you ran it out of a refinery, there would be no issue what it is. You put this in the river, although you have gathered it now through the Drain, you have gathered it from all these sources and made it a major source of introduction, and you admit that it is going to have to comply with EPA standards, but we are going to go through the process to allow it prior to a hard-and-fast plan for the implementation of meeting those standards.

I just don't know why we would allow this to go forward without some assurances by the drainers and Grassland and others that in fact they will comply with the plan of implementation.

You give the permit, they will be back here saying they cannot do this, they cannot do that, they cannot do this or that.

Mr. BEARD. The presumption is that we have created an oversight committee to make sure they do comply with the plan. If they do not, then the permit is going to be jerked.

I think compliance is an easy condition to impose on the agreement in order to proceed with this action. But I think you raise a larger issue, which is the issue of should agricultural drainage water be covered under the Clean Water Act.

Point source and nonpoint source pollution are major issues which I think the Congress is going to have to address when they reauthorize the Clean Water Act.

Mr. MILLER. Whether you address it as a point source or nonpoint source, as I understand it, what Wayne is suggesting is that in fact you cannot allow for the loading of the river.

Mr. WHITE. Yes.

Mr. MILLER. That is what the standards address.

Mr. WHITE. Your frustration is also felt by other people up here on the panel. The fact is we have a situation that is somewhat out of our control. We have a Regional Water Quality Control Board trying to deal with standards that EPA has set. We do not necessarily have control over that. We can comment on it and we have quite strongly, but under—

Mr. MILLER. No, but my problem is this, that we are reacting to the politics of one group of people who cut across a number of different political circles and the environmental community decided they are going to solve their particular problem but they are not going to solve the overall problem. Your monitoring group sounds to me a lot like sending the boys out to round up the cows after they have left the corral, and you know in this community, that is tough politics down there.

Once that water starts flowing in an isolated facility, you are going to have hell to pay to put it back on somebody's lands, wetlands or what have you, because you will be charged with loading a toxic back on to Grassland or somewhere else. They will not be so nice to you as they are to Grassland now when they think they can move it off of the Grassland.

So I am just worried that one of the points here where we can bring the Water Quality Control Board and you and the Bureau and the drainers and Grassland together on a plan of implementation, we ought not to give that away, especially when I say what will start happening up north, and that is we went through it in the 1960s, we went through it in the late 1970s, and now we are back in the 1990s on the questions and the impacts on San Francisco Bay. You are going to start telling people or you, the Federal agencies, are going to start telling people what they have to do and not do. Yet we will have a major source and a growing source of pollution out of the San Joaquin River if it does not meet these standards.

Mr. WHITE. I agree with what you say. The regional board did not even accept the provisions identified in the Rainbow Report, as we affectionately refer to it.

Mr. MILLER. I understand that.

Mr. WHITE. If the Fish and Wildlife Service could put blinders on, in effect, we would say our refuge is in trouble, San Luis complex is in trouble because of water problems.

Mr. MILLER. If the ocean liner had not sunk, you guys would not all be in the lifeboat together. We understand that. I am just trying to determine what the interests are here. There is no question, if one of you thought you could get out by throwing the other over, you would in a minute. That tells me there are problems with this when the permit comes first and the action comes second.

And I think it is a disservice to the people who are genuinely concerned and the impacts of the overall solution to the drainage problem. It is obviously a disservice to a lot of people who have been spending millions of their own dollars to try to remove selenium and other pollutants from the waters of the Bay and Delta system. And we are giving this kind of latitude to say, "Well, go ahead, get your discharge permit and we will get back to you in the next decade."

Mr. BEARD. Far be it from me to jump in here once more and argue with the Chairman, but the question here is do we proceed with the proposal that we have before us. It is a five-year permit with review after two years and Grassland has to comply with all the conditions imposed by the regional board. Whatever those conditions are, those are the ones with which drainers will have to comply.

In addition to that, the drainers will establish drainage and constituent load reduction and goals. In other words, by moving forward with the proposal, we bring the drainers into the solution and together we are working toward a solution. Do we get it before we even start? Probably not. Are we going to get it within a short period of time? Presumably yes. If not, then the proposal comes to an end. There is a two-year window of review plus constant monitoring.

We must decide whether or not we proceed with this proposal, or whether it is better to just do nothing and wait to get all the parties to somehow come together. We have been ignoring the central problem here, Mr. Chairman, which really is the question of the original loading of the drainage constituents. That is the larger issue which we have not addressed here.

Mr. MILLER. That is my point. But if that loading is compared to standards so that it is not loaded to the river, people have to contemplate a different set of actions because that is really the test we want to do. We have all pledged ourselves, even with our diverse interests, that we would not move this solution from the Central Valley to the shores of the Delta or into San Francisco Bay or westward into Monterey Bay.

So now we are creeping our way north here, and I suggest that after five years what would you do with the water if the standards were not met? You are not going to put it back on to Grassland. Are you going to stop the irrigators from irrigating? That looks like a long-term litigation.

My concern is that the tools are out of sync here. The burdens and the benefits here are a little out of sync because, you are right, the loading continues down the valley. Yet we have kind of indirectly constructed the San Luis Drain, and if these actions turn out to be too expensive, there will be requests from the San Luis Unit and others to start using that facility. After all, that is a facility they say they were promised. Just looks different.

Any further questions? Mr. Dooley.

Mr. DOOLEY. The Chairman made a point that he saw this facility as contributing to a growing source of selenium to the Bay. As I understand the proposal, that is not accurate; it is not going to increase the amount of selenium but in fact, it is going to control its flow and should be able to control it in a manner which, contemplating the flows of the San Joaquin River, should actually provide a reduced environmental impact on the Delta and the Bay.

Mr. BEARD. Well, I think the point the Chairman was making was that, as it presently works, selenium is filtered out, if you will, through Grasslands before it reaches Mud Slough, or as it reaches Mud Slough. And under this proposal, it would be concentrated more directly. I think that is what he was saying.

Mr. DOOLEY. Are you saying, then, it is in fact going to have a greater impact on the Delta in terms of the selenium?

Mr. BEARD. I don't think so.

Mr. PATTERSON. We do not think it will have a substantially greater impact on the Delta. As we view it, this is one of the pieces of the drainage program that dealt with controlled and limited discharge to the river while meeting water quality standards. That is the goal we want to get in a managed way. The agencies are working with the drainers and Grassland to try to put a plan together annually to get us closer to that. Does it solve a bigger picture? No, it is simply a management technique to try to deal with a kind of localized problem.

Mr. DOOLEY. Dan, you had some budget numbers in your testimony. The bottom line is funds budgeted for land retirement and water acquisitions in 1994 of \$11.1 million. Are those funds, then, specifically allocated to deal with land retirement within the drainage areas and land acquisition? What are these numbers?

Mr. PATTERSON. The \$11.1 million may not be correct, Mr. Dooley. We will see what comes in our final appropriations bill. Nevertheless, these would be funds used by Reclamation in this partnership with the State of California where we would solicit from willing sellers requiring that problem drainage areas would be a very prominent criteria for acquisition.

So we would develop that and then solicit proposals from those areas. So it would be for land retirement focused largely in the problem drainage areas.

Mr. DOOLEY. In terms of any financial support or incentives for some of the new technologies, such as the Santana process, is that budgeted within that amount or is that out of another budget area?

Mr. PATTERSON. That is outside of our regular appropriation. This is contained within the Central Valley Project Restoration Fund, for which, for the first time, we hope to receive an appropriation in 1994. Demonstration projects are actually funded separately in the water and energy appropriation.

Mr. DOOLEY. Mr. White, again getting back to the discharge of the Grassland project, which we will be discussing here in such a short while, with the discharge, the salinity standard and the amounts going to be discharged into Mud Slough, what standard does that meet; or that is, what is in excess of the quality standard?

Mr. WHITE. The position on the FONSI, and our position, Interior, Fish and Wildlife and Reclamation, is they have to have standards. As the Chairman points out, we have to wait to see what the standards are. EPA has set a standard and the regional board has to figure out how to implement it. So the position is whatever that standard is, if it is 5 ppb, it has to be met.

Mr. DOOLEY. What is the current standard?

Mr. WHITE. It is 5 ppb.

Mr. DOOLEY. And we are meeting those standards now?

Mr. WHITE. No. And I would offer probably in neither point, either Mud Slough or Salt Slough, at this time.

Mr. DOOLEY. So with this facility, then, where are we going from status quo to with this facility in terms of—

Mr. WHITE. We have simply directed the problem water into the Drain so that you can get fresh water to the wetlands. Right now you are limited because of a Regional Water Quality Board condition of 2 parts per billion for selenium. You cannot do that with a mix of water because you cannot control the fresh water from the drainwater.

Mr. DOOLEY. So the beneficial impact on this is primarily in the Grasslands and the increase in the water quality.

Mr. WHITE. For wetlands.

Mr. DOOLEY. For migratory birds. And the FONSI basically was a finding that stated that the impacts on the Delta and the Bay-Delta water quality were not significant.

Mr. WHITE. Well, the position is that there will be no increased loading. We have already been doing monitoring. We are going into the second year worth of monitoring.

The other benefit to this is that, in fact, as a condition of the permission to reuse the Drain, we would have set up an oversight committee that would deal with unacceptable impacts to migratory birds and endangered species. And if there were, we would identify mitigation measures that would be implemented. Right now we do not even have that.

Mr. DOOLEY. Okay. Thank you.

Mr. MILLER. Mr. Smith.

Mr. SMITH. Thank you, Mr. Chairman. I am quoting from a letter of July 12 sent to the Corps of Engineers from the Defenders of Wildlife. One sentence near the end of the letter reads: "We understand that the mass loading of selenium, boron, and other trace elements into the San Joaquin River would remain similar to the current situation."

Now, evidently somebody has made an estimate that additions because of the Drain would not increase the loading on the San Joaquin River. Do you agree with that?

Mr. PATTERSON. We do. We think that that is generally the case. However getting back a little to Mr. Dooley's question, you are transferring a load that is now going essentially in two routes to

primarily one, which for six miles of this one slough, called Mud Slough, the concentrations will go up. There are roughly 70 miles of channels through the Grasslands area and another slough called Salt Slough where water quality will improve to be less than the 2 parts per billion.

Mr. SMITH. Therefore, you have answered the Chairman's question. There will be no increase in loading in the San Joaquin River; therefore, no problem downstream in the Bay.

Mr. MILLER. Now, you know it is not that simple.

Mr. SMITH. It is your ball.

Mr. MILLER. Wayne, do we not get some benefit. Whether it is a benefit we like or not, we get some benefit of the current system because some of the selenium is taken up within the Grasslands area?

Mr. WHITE. That is probably true. It is spread over two areas instead of one.

Mr. MILLER. But when it finally gets to the San Joaquin River, you get some benefit of the take-up of the vegetation within Grasslands; is that not correct?

Mr. WHITE. In the sense of selenium, yes.

Mr. MILLER. Yes. This system, you would not have that benefit. I don't know what that is worth.

Mr. WHITE. I don't know if we can quantitatively identify it, either. It is a real tough question. We could speculate for a long time. And the monitoring we are doing, starting on the refuge and on Grasslands, is beginning to give us some of the answers to that.

I don't know what these values mean in terms of the increases in selenium in Mud Slough, but we will get back to you on that.

Mr. MILLER. Any further questions?

Thank you very much for your testimony and we are going to have a further discussion, I believe, of the Grasslands proposal and we would like to get back to you after that. Thank you.

The next panel will be made up of Dan Nelson, the executive director of San Luis and Delta-Mendota Water Authority, from Los Banos; and Ms. Karen Garrison, Natural Resources Defense Council in San Francisco; and Catherine E. Kuhlman, Chief, Water Quality Branch, Water Management Division from the EPA in San Francisco.

Welcome to the committee. Your statements will be put in the record in their entirety. To the extent that you can summarize, we would appreciate it so we will have time for questions.

I guess my colleagues have abandoned me, but we will have time for questions from me, which is the most fun anyway.

Mr. Nelson, we will begin with you.

PANEL CONSISTING OF DANIEL NELSON, EXECUTIVE DIRECTOR, SAN LUIS AND DELTA-MENDOTA WATER AUTHORITY; KAREN GARRISON, NATURAL RESOURCES DEFENSE COUNCIL; CATHERINE E. KUHLMAN, CHIEF, WATER QUALITY BRANCH, WATER MANAGEMENT DIVISION REGION 9, U.S. ENVIRONMENTAL PROTECTION AGENCY

STATEMENT OF DANIEL NELSON

Mr. NELSON. Thank you, Mr. Chairman. Thank you for the opportunity to be here. I will say that I am going to speak from an outline today that we have submitted to you; however, we have also submitted lengthy supporting documents and will also be submitting a more thorough statement as well.

[Editor's note.—The documents can be found in the appendix.]

Mr. MILLER. If there is no objection, we will include that in the record of the hearings. Thank you.

Mr. NELSON. Thank you very much.

Mr. Chairman, the San Luis and Delta-Mendota Water Authority is composed of 39 water districts. It has joint powers authority. It is on the westside San Joaquin Valley, and actually covers over into the San Felipe unit of the San Benito County water districts. The bond between the 39 water districts is that they all have contracts with the Federal Government, taking water delivery through the Tracy Pumping Plant of the CVP.

So, essentially, we represent all the federal Delta exporters in our authority. That representation is fairly diverse, as I said. We not only include the Santa Clara Water Agency, which serves about a half million urban folks, we have a couple of different types of agricultural contracts, including what we call our service ag. or Reclamation contracts, exchange contracts. We also represent the Grassland Water District and the wetlands on the western side of the valley.

I agree with Congressman Lehman's comments earlier, and they were confirmed by Commissioner Beard, that the area is in a period of transition and uncertainty. I don't think we can understate that. Water supply-wise, right now, they are caught with the Endangered Species Act and are restricted from their pumping from the Delta through the listing of the delta smelt and the winter-run salmon. This is on top of the implementation of Public Law 102-575, which replaced 800,000 acre-feet of water supply to areas and other uses, and also the doubling of the anadromous fish down the road. About how much water that might take, there is some uncertainty involved.

I think it is worthwhile to note this last year when the entire rest of the State was finally made whole by good precipitation which we were blessed with in California, that 32 out of 39 of our member agencies were straddled, burdened with a 50 percent water supply this year. And, again, these are directly attributable to the implementation of the Endangered Species Act and implementation of Public Law 102-575.

Since that time, we have been taking a close look at what we can anticipate in future years. We have come to the realization that this is pretty much it. Even in years like this, we may under special circumstances be able to get up to 60-65 percent supply. How-

ever, once we get below-average years, we do not have the margin of error we used to, and we get down to zero supply real quick. So we are reeling and adjusting to the future scenario for ongoing water supply for the westside San Joaquin Valley.

The other thing that leads to the uncertainty is our rising cost. Some of the factors for the rising cost—generally our O&M cost through the Bureau, and even local districts, is fixed, and when you have fixed costs and reduced units to spread those around in, generally you have higher cost per unit. And, again, a 50-percent supply generally means twice the price that you normally pay for that water.

Also under Public Law 102-575, we have tiered-pricing provisions and the restoration fund costs that increase our cost. Likewise, as was testified to a little bit earlier, we really have an uncertainty about how the federal drainage costs are going to be allocated. And by the way, I have submitted for the record a fairly thorough position paper by the water users on that, which I think will clarify what the water users' positions are.

What all this leads to is just a tremendous amount of uncertainty. And as a result of this uncertainty, essentially we are handcuffed when we try to take a look at the long-term plans. And specifically, with drainage, we are at a time when we really do not know what agriculture is going to look like on the western side of the Valley in 10-15 years. But on the other hand, we are being asked to make long-term commitments. Even if we could make those long-term commitments, the financing for those long-term commitments is essentially unavailable.

Obviously, we are a very, very high-risk area, and right now financial institutions are backing away. This is on top of losing a lot of the equity as a result of uncertainty in water supplies. Land values, without exaggerating, could have peaked out at \$3,500-\$4,000 an acre; there was an auction a few months ago and a lot of the land was between \$300 to \$1,700 an acre. So we have lost a tremendous amount of equity.

And this all points out that, again, we are in a period of transition, and there needs to be a more comprehensive master plan on both water supply and drainage completed for the next step.

Having said all this, this is not to say that the local districts have been sitting back. A lot of our attention, granted, has been focused on water supply issues, but I think if you look at the record, it is incredible what the local districts have been doing. I would like to take a moment just to summarize some of the things, and by the way, I have, again, introduced this into the record.

The Panoche Water District, as an example, has done at least five demonstration projects on looking into different types of treatment and essentially trying to find a treatment or a black box that can be used to purify the water so it can be reusable and regained as a resource and also solve and separate the mineral and the salt problem. At this point I would say they are making a lot of progress; however, we have not found something that is economically feasible. However, those efforts continue.

The Firebaugh Water District and the Santana process were mentioned. The Westlands Water District has had a couple of different treatment plants. The local water users have not given up on the

notion of treatment and they continue doing demonstration projects.

I will say a lot of these projects are cooperative and participate in funding through the Bureau and the State agencies as well. So there has been good cooperation on the treatment front with local and State agencies and Federal agencies.

As far as source control and water conservation, we agree this should be the initial focus of the area, and once again, I would point you to the record. I sincerely do not think you will find anyplace in the world that uses water in a more conservation-minded and higher tech way than the westside San Joaquin Valley.

Westlands Water District is a model for water conservation plans. The exchange contractor, Central California Irrigation District, has implemented tiered pricing and the extra revenue that has been provided they have used to line canals. Mr. Swearingen will talk in more detail about that.

The Broadview Water District is being used as a model for implementing tiered water pricing concepts district-wide. These are very progressive districts and they are not sitting on their hands. They are moving forward and implementing drainage techniques that help them to survive.

You need to understand, where the Federal and the State Governments have this overall umbrella problem, these districts on a daily basis are now managing and operating drainage water. They do not have the luxury of being able to sit back and say, gosh, we cannot figure this out; we do not know what to do. These folks on a daily basis are dealing with the drainage problem and dealing with it progressively.

Again, Westlands Water District has a model water conservation program. I would refer you to the submittal that I put in for the record.

Other things are being done out in the area. A lot of the water is recirculated and blended, testing essentially tolerances for salinity.

Land retirement. I would like to take a moment to talk about land retirement because it is not something that is being rejected by the local users and, in fact, policies are being generated out in the valley now that would take land out of production.

There are a couple fundamental things that I would need to talk about on land retirement. The water that is taken off the land that is retired is going to need to stay local and applied to other lands in the communities that do not contribute to drainage problems. The second fundamental notion regarding land retirement is that the local communities through their districts must be the ones that develop the criteria for the land going out of production.

I say *must* be the ones. They need to be taken into consideration for they best know which lands can most efficiently be taken out of production. They know the ones that are the most productive, the least productive, and the ones that are not allowing them to meet quality guidelines. And also, they are doing regulated release of salts.

After I made this list of the individual districts' efforts, what the individual districts were doing, in preparation for today's testimony, I started looking through the management plan or the San

Joaquin Valley drainage program. Generally what I found is source control, drainage reuse, evaporation system, which we so far in our area have rejected. We have not gotten into evaporation since Kesterson. We have been leery of getting involved in that, although the Bureau recommended that through their San Luis drainage program and also through the San Joaquin Valley drainage program. We have been leery to get back into the evaporation system—

Mr. MILLER. I will have to ask you to summarize.

Mr. NELSON. In summary, if you go through the implementation recommendation, the local districts have been implementing the San Joaquin Valley drainage plan. Everything that has been recommended in this plan is being worked on by the local districts and a lot of the things have been accomplished. I would also remind you that the San Joaquin Valley drainage program also recommends the use of export through the San Joaquin River in the extension of the Drain.

Thank you very much and sorry to go over my time.

Mr. MILLER. Thank you.

[Prepared outline statement of Mr. Nelson follows:]



**Outline Statement of Daniel Nelson
Executive Director
San Luis & Delta-Mendota Water Authority
before the
Committee on Natural Resources
Subcommittee on Oversight and Investigations
Hearing on Agricultural Drainage Issues in the Central Valley, California
October 26, 1993**

Introduction

- Overview of the San Luis & Delta-Mendota Water Authority
 - 39 Member Agencies
 - All with contracts with the Federal Govt./CVP
 - Receive water through Federal Tracy Pumping Plant & Delta-Mendota Canal
 - Provide O&M Services for Federal Facilities south of the delta

- Period of Transition/Uncertainty
 - Water Supply
 - Endangered Species Act
 - Listing of Winter Run Salmon
 - Listing of Delta Smelt
 - Proposed listing of other fish
 - PL102-575
 - 800,000 AF
 - Doubling of Anadromous Fish
 - EPA Delta Standard Setting Process
 - Water/Drainage Costs
 - Fixed O&M, Costs per unit rises with a decreased supply
 - Supplemental Water Costs
 - PL102-575
 - Tiered Pricing Provisions
 - Restoration Fund
 - Federal Drainage Costs, Repayment Obligations
 - USBR Report
 - Settlement Process

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Outline Statement of Daniel Nelson
Executive Director
San Luis & Delta-Mendota Water Authority
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- Difficulties of Long term planning
 - Financial
 - Loss of Equity & Investment Capital
 - Availability of Funds, Financial Community hesitant to loan money
 - Water supply/cost uncertainty

Current Local & Regional Efforts/Cooperation

- Regional Efforts
 - Drainage Committee, SLDMWA
 - Forum for Federal Contracting Districts to address drainage issues
 - City & County of San Francisco, Reclaimed Water Reuse Program
 - Grassland Task Force
 - Management & Operation of drainage water within Grassland Basin
- Individual District Efforts
 - Source Control/Water Conservation
 - On Farm
 - District Tiered Pricing
 - Treatment Development
 - Reuse
 - Land Retirement
 - Regulated Release of Salts

Long Term Goals

- Need comprehensive approach to water supply and drainage issues
 - Multi Federal Agency Approach, folding in State Agencies
- In the interim, continue maintenance of salt balance within regulatory/statutory framework

Mr. MILLER. Ms. Garrison.

STATEMENT OF KAREN GARRISON

Ms. GARRISON. Good morning, Mr. Chairman, and members of the subcommittee. I represent the Natural Resources Defense Council. We appreciate the opportunity to be here today.

Despite some recent progress towards managing drainage more effectively, irrigation drainage clearly remains one of the most in-transigent problems associated with agriculture in the valley. I refer you to my written statement rather than review the impacts in detail here.

In short, the extent, persistence, and urgency of those impacts, coupled with the fact they affect areas off-farm and even outside the valley, underscore the need for a comprehensive, aggressive approach to drainage management.

Fortunately, a comprehensive drainage management plan already exists. In the mid-1980s, Congress authorized the San Joaquin Valley drainage program, about which you have heard quite a bit today. As a result, we now have a *Management Plan* for sub-surface drainage endorsed by the California Department of Water Resources and the Bureau of Reclamation a couple of years ago.

The plan does not pretend to be on target in every detail. It incorporates experimentation and leaves room for mid-course correction. But the strategies at the core of that plan are sound ones supported by countless studies and field tests. They include, as you have heard from Dan, source control, primarily through more efficient water use, retirement of lands unsuitable for irrigation, and restoration of habitat damaged by drainage pollution.

I would differ with your characterization of its support for evaporation systems. The drainage program really recommended limiting evaporation systems rather than using them as an additional technology.

The program implicitly recognized that export of the drainage problem was not an economically or politically feasible pollution as long as source control options had not been exhausted.

The program did not set out to retire lands or reduce agricultural water use. Those results are incidental effects of an approach that aims to keep land in production. Nonetheless, implementation of the plan could make water available for other uses—an important benefit in a water-short State. That potential creates a valuable funding mechanism for land retirement.

Congressman Dooley and others have noted the need to look at the economics, costs of a solution. I agree with that, but we have to measure those costs against the expense of doing nothing. The alternative to the hard work of managing water more efficiently and retiring certain lands over the next 50 years is quite simply far more extensive losses of productive farmland, high economic costs, and a continued threat of toxic contamination of wetlands and streams. The drainage program estimated the continuation of the status quo would result in economic costs of over half a billion dollars yearly and loss of about half a million acres of land.

After expending many millions of dollars to come up with this plan, NRDC believes it is time to make it work, using all the tools available. That will not happen if the government plays only a

weak support role for drainage management. To be successful, State and Federal agencies have to integrate the provisions of the plan into ongoing regulatory and incentive programs and new projects.

Agricultural interests have to provide leadership and take the initiative to follow the plan. So far, however, as Mr. Beard noted, some irrigation districts have rejected the plan and State agencies, in particular, have shown little interest in putting the plan into practice.

For example, the State Water Resources Control Board ignored the plan when it adopted the Inland Surface Waters Plan, which is a set of water quality regulations for the State's rivers, streams, and canals. That plan imposed no requirements for source control by irrigators draining into those waterways.

The Central Valley Regional Water Board gave short shrift to the drainage plan when it issued permits this summer for evaporation ponds in the Tulare Basin.

The State made no effort to identify specific lands for retirement or match landowners with potential purchasers.

Finally, the State imposes no drainage source control requirements on recipients of State Water Project supplies. Negotiations between growers and environmental groups to develop water conservation best management practices now hang by a thread and never fully integrated the drainage program recommendations for source control.

In view of this record, we question whether the State made more than a paper commitment when it endorsed the plan. However, California now faces a number of new opportunities to demonstrate a serious intent. A court recently invalidated the Inland Waters Surface Plan, giving the State board, or the EPA, a chance to revisit earlier decisions. The evaporation pond permits have been appealed to the State board, and the State legislature passed a law encouraging the retirement of lands with contaminated groundwater.

The subcommittee may want to learn more about what the State intends to do with the drainage program plan in each of those instances.

There is some good news about implementation. The CVP Improvement Act gave statutory authority to the *Management Plan's* recommendations for source control and land retirement, an important step toward implementation of the plan by federal water contractors.

The Bureau has now completed the criteria for water conservation best management practices, in compliance with the CVP Improvement Act, and it appears to be embarking on efforts to explore options for land retirement. Although both those efforts are now on track, it would certainly benefit from periodic review from this subcommittee.

I also take polite exception to Mr. Hamon's assertion source control is being pursued to the extent possible. I think the drought offered some relief to the problem of high water tables but that reprieve could end with the return of normal water years.

There are also some promising signs, as Congressman Dooley has said, of initiative by growers and cooperation by growers and other

entities aimed at carrying out the intent of the drainage program plan. In the Tulare basin, pond operators are working with agencies and environmental groups to develop management practices that are consistent with the plan. The restoration fund created by the CVPIA offers an opportunity for cooperation on projects central to the plan. Proposals to remove drainage from Grasslands' canals via the San Luis Drain could provide an opportunity, if linked with a solid program of drainage source control. The State and the Bureau should promote such efforts and use them as models for broader programs.

The drainage program plan can't be implemented fully without a strong commitment to the plan on the part of both the Federal Government and the State, in close cooperation between the two. I believe Congress already gave the approach a resounding endorsement when it incorporated it into the Central Valley Project Improvement Act, and I will encourage the subcommittee to promote implementation of the drainage program plan in any way that it can.

A first step might be to review the 1991 implementation plan prepared by the drainage program staff, to determine whether it integrates the *Management Plan* squarely into regulatory and incentive programs of the agency participants. It should also make sure that any proposal to use the San Luis Drain is coupled with the plan to ratchet down on discharge or drainage and retire the lands that contribute heavily to selenium production in that area.

Mr. MILLER. Thank you.

[Prepared statement of Ms. Garrison follows:]



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TESTIMONY
OF THE NATURAL RESOURCES DEFENSE COUNCIL
ON SAN JOAQUIN VALLEY IRRIGATION DRAINAGE ISSUES

Submitted by Karen Garrison
To the House Subcommittee on Oversight and Investigations

October 26, 1993

My name is Karen Garrison. I represent the Natural Resources Defense Council (NRDC), a nonprofit environmental organization with a national membership of 170,000. More of our members live in California than in any other state. NRDC has worked for over a decade to promote western water policy reform and protection of the aquatic ecosystems so vital to California's environment. We appreciate this opportunity to testify today before the Subcommittee on Oversight and Investigations.

I'd like to begin by thanking the Chairman and other members of the Committee on Natural Resources for your tireless efforts to set the Central Valley Project (CVP) on a more environmentally sound course. Due largely to your success at that undertaking, I come to this hearing with a much greater sense of optimism about the prospects for managing the San Joaquin Valley drainage problem than would have been possible even two years ago. One can point, now, to tangible progress such as the Bureau of Reclamation's incorporation of drainage management objectives into its criteria for conservation plans in the CVP. The Bureau deserves credit for completing a first step that could yield a significant future payoff.

The Problem

Despite some important advances, however, irrigation drainage remains one of the most intransigent problems associated with agriculture in the Valley. As early as the 1890s, cultivated lands in the Valley were forced out of production by poor drainage and salt accumulation. What's different a century later is the magnitude and urgency of the problem.

For example, reports prepared by the San Joaquin Valley Drainage Program indicate that if current conditions continue, the spreading saturation of the shallow groundwater table could force over half a million acres of cropland out of production by 2040. The temporary relief brought by the drought would not prevent eventual economic losses of well over half a billion dollars yearly. The discharge to the San Joaquin River of drainage laden with selenium and pesticides causes acute toxicity

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in many miles of the river, quietly eliminating food web organisms and dependent fish species. And volumes of data reveal higher rates of embryo deformities in water birds at the Tulare Basin evaporation ponds than found at Kesterson in the mid-1980s. The extent and persistence of these impacts underscore the need for a comprehensive, aggressive approach to drainage management.

The Principles of Sound Drainage Management Are Well Known

Fortunately, a comprehensive drainage management plan already exists. In the mid-1980s, Congress authorized the San Joaquin Valley Drainage Program. This \$50 million state-federal effort addressed the causes of the drainage problem systematically, aiming to avoid repetitions of environmental disasters like the contamination of Kesterson Wildlife Refuge. Based on extensive research, the Drainage Program prepared a Management Plan for Subsurface Drainage. The California Department of Water Resources and the Bureau of Reclamation endorsed that Plan a couple of years ago.

The strategies at the core of that Plan are sound ones, supported by countless studies and field tests. They include source control (primarily through more efficient water use), retirement of lands unsuitable for irrigation, restoration of habitat damaged by drainage pollution, and a monitoring program to track the problem and management activities. The Drainage Program management committee started with the premise that export of drainage pollution to other areas was not an option as long as source control efforts had not been exhausted.

The Program did not set out to retire land or reduce agricultural water use; those results are incidental effects of an approach that aims to keep land in production. Nonetheless, implementation of its Plan could make water available for other purposes, an important benefit in a water-short state. That potential also creates a valuable funding mechanism for land retirement.

The Program confirmed that there is no silver bullet that will solve the drainage problem once and for all. The alternative to the hard work of implementing the Plan is, quite simply, extensive losses of productive farmland, high economic costs, and a continued threat of toxic contamination of wetlands and streams.

Implementation: Some Progress, Many Missed Opportunities

Those losses cannot be avoided if the government plays only a weak support role for drainage management, and irrigators resist the Plan at every step. State and federal agencies must integrate the provisions of the Plan into ongoing regulatory and

incentive programs and new projects. Irrigators must take initiative to follow the Plan.

So far, however, the State of California in particular has shown little interest in putting the Plan into practice. For example:

- o The State Water Resources Control Board ignored the Plan when it adopted the Inland Surface Waters Plan, a set of water quality regulations for the state's rivers, streams, and canals. It chose to impose no requirements for source control by irrigators draining into those waterways.
- o The Central Valley Regional Water Quality Control Board ignored the Drainage Program Plan when it issued permits this summer for evaporation ponds in the Tulare Basin, despite pressure from numerous federal agencies and public interest groups to take the Plan into account. Specifically, it failed to require source control in its permits, reduce overall pond acreage sufficiently, or require at least an acre of clean wetland habitat for each acre of toxic pond.
- o The State has made no effort we know of to identify specific lands for retirement or match landowners with potential purchasers.
- o The State imposes no source-control requirements on recipients of State Water Project supplies. Negotiations between growers and environmental groups to develop water conservation BMPs have fallen apart, and never fully integrated the Drainage Program recommendations for source control.

In view of this record, we question whether the State made more than a paper commitment when it endorsed the Drainage Program Plan. However, it now faces a number of new opportunities to demonstrate its serious interest. A court recently invalidated the Inland Surface Waters Plan, giving the State Board (or the EPA) a chance to revisit its earlier decision. The evaporation pond permits have been appealed to the State Board. And the state legislature has passed a law encouraging the retirement of lands with contaminated groundwater. The Subcommittee may want to learn more about how the State intends to use the Drainage Program Plan in each of these instances.

The Bureau shares responsibility with the State for setting up a coordinated monitoring program that would track the impacts of drainage on groundwater, surface water, and plants and animals. Such a program provides a crucial means of measuring progress and adapting management strategies to changing

conditions. We suggest the Subcommittee request a progress report from DWR and the Bureau on the status of the monitoring program and efforts to link it to practical drainage management initiatives.

The Bureau and the State also share responsibility for developing pilot projects that would test certain Drainage Program recommendations. The Committee may also want to know the status of pilot projects.

There is certainly some good news about implementation. The CVP Improvement Act (CVPIA) gave statutory authority to the Management Plan's recommendations for source control and land retirement -- an important step toward implementation of the Plan by recipients of federal water supplies. The Bureau has now completed the criteria for water conservation best management practices (BMPs), in compliance with the CVPIA. To ensure follow-through, the agency must insist those criteria be met when approving conservation plans, renewing contracts, and making grants or loans. It must also explore options for and promote land retirement through the programmatic environmental impact statement (EIS) and in decisions that follow it. Although both these efforts are now on track, they would benefit from periodic review by this Subcommittee.

There are also some promising signs of cooperative efforts between growers and agencies or environmental groups aimed at carrying out the intent of the Drainage Program Plan. In the Tulare Basin, some pond operators are working with agencies and environmental groups to develop management and mitigation practices consistent with the Plan. The restoration fund created by the CVPIA offers an opportunity for cooperation on projects central to the Plan. Proposals to remove drainage from Grasslands' canals via the San Luis Drain could also provide such an opportunity, if linked with a solid program of drainage source control. The State and the Bureau should promote such efforts and, where possible, use them as models for broader programs.

Conclusion

The Drainage Program Plan cannot be implemented fully without a strong commitment to the Plan on the part of the federal government and the State, and close cooperation between the two. Many opportunities to implement the Plan have already been passed over, particularly by the State. We urge this Subcommittee to encourage implementation in any way it can. A first step might be to review a 1991 implementation plan prepared by Drainage Program staff to determine whether it integrates the Management Plan squarely into government regulatory and incentive programs.

STATEMENT OF CATHERINE E. KUHLMAN

Mr. MILLER. Ms. Kuhlman.

Ms. KUHLMAN. Mr. Chairman, committee members, you have my testimony which has been entered into the record. I would just like to make a few brief remarks.

EPA has been involved in this project trying to deal with the drainage and the issues related to drainage for many years and recognizes the difficulty here in balancing between the environment and the economics of the situation.

I think we all share the goal of continuing lands in production with environmental protection. As you heard much discussion this morning, our concern has been the need for long-term commitments that will assure reductions to achieve water quality goals. The trade-off between clean water for wetlands and increased loadings of selenium and other salts and metals into Mud Slough could be a good short-term solution. But as the Chair noted, it may also remove some of the incentive to reduce drainage loadings.

I would like to give you a little bit of feel for what is the environmental impact. The environmental assessment notes that loadings in Mud Slough from the proposed project will go up to as high as 57 parts per billion. The current standard from EPA is 5.

Current research shows that 10 parts per billion causes chronic toxicity in aquatic life; 20-30 parts per billion causes toxicity in aquatic life; 1-2 parts per billion is needed to protect wildlife, particularly migratory birds.

So we have a range from 1 to 2 to 30—and at 30, you are having toxicity in the stream—and a proposal that will increase loadings up to around 57 parts per billion.

We believe that the 5-parts-per-billion standard that is in place is a reasonable one to shoot for to achieve over time. The regional water board in the 1980s adopted a plan of implementation to ratchet down loadings from where we were existing in the environment right now, down to the goal of 10 ppb that they have set.

This summer, they brushed aside that implementation plan in favor of going to the Inland Surface Water Plan that was adopted on a statewide basis. As Karen noted, we have a tentative order out now from the State Superior Court voiding out the State Inland Plan. That leaves us at this point in time, with no plan of implementation on how to go from where we are to some reasonable goal to protect the environment.

And at this point in time, that goal is 5 ppb.

So where do we go from here? I think it is important, given the recent court action, that EPA needs to work with the State Water Resources Control Board and the drainers to establish how soon we can get a plan of implementation in place that could take us from 57 parts per billion down to something closer to 5.

I would also suggest that perhaps it might be valuable for the oversight committee to discuss the benefits of a coordinated approach to project funding. Right now, I think each agency is basically funding projects based on its own set of criteria. There might be some benefit in looking at a coordinated approach; to pool our money, if you will, to assist in monitoring, research, as well as working with the State in making available to farmers loan money that is available through the Clean Water Act.

So I think the State needs to put together an implementation plan, and I think that realistically it is going to take them at least a year, if they started on it now.

And I think the Feds and the State and the drainers need to work together to come up with some kind of plan that will take us from where we are right now into the future, because it feels pretty disorganized at this point in time. That concludes my remarks.

[Prepared statement of Ms. Kuhlman follows:]

**TESTIMONY OF
CATHERINE KUHLMAN
CHIEF, WATER QUALITY BRANCH
WATER MANAGEMENT DIVISION REGION 9
U. S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
OF THE
COMMITTEE ON NATURAL RESOURCES
U.S. HOUSE OF REPRESENTATIVES**

October 26, 1993

Good morning Mr. Chairman and members of the Subcommittee. It is a pleasure to be here today to discuss the issues related to the use of the San Luis Drain for conveying agricultural drainwater around the Grasslands Water District in California.

The U.S. Environmental Protection Agency (EPA) Region 9 has been involved with drainage issues in the San Joaquin River for fifteen years. The issues are extremely complex, and solutions that satisfy environmental and public health concerns while allowing for the continued productivity of the agricultural lands have been very hard to find.

EPA recognizes that a tradeoff between clean water for wetlands and increased levels of selenium in Mud Slough exists, and that a compromise may be the best short-term solution that is available at this time. However, we continue to be concerned that the environmental impact analysis for the current project did not develop and explore alternatives that did more than simply move the contamination from the wetlands to Mud Slough.

- 2 -

As currently designed, the project:

- ▶ will result in acute toxicity to aquatic life in Mud Slough;
- ▶ will result in violation of the federal water quality standards for selenium;
- ▶ will result in violation of the water quality control plan of implementation; and,
- ▶ may not lead to further reductions of pollutant loadings to the San Joaquin River.

These problems are significant, but can be solved or mitigated. Everyone here is familiar with the toxic effects of agricultural damage at Kesterson National Wildlife Refuge (including wildfowl deformities causing chicks to die when hatched); this is but one dramatic example of a widespread problem.

It is EPA's position that the solution to the drainage problem is drainage reduction. Reductions in drainage throughout California are being achieved through conservation and tailwater recovery. Further reductions may be achieved through more aggressive implementation of the proposals presented in the San Joaquin Drainage Program Plan such as land retirement. We believe innovative market solutions and financial incentives can also play an important role, such as a pollutant trading scheme that has been proposed for a portion of the San Joaquin Valley.

EPA remains available to help work through the myriad of difficult environmental and legal issues surrounding reopening of the San Luis Drain.

Thank you Mr. Chairman; I would now be happy to answer any questions you or other members of the Subcommittee may have.

Mr. MILLER. Thank you.

Mr. Nelson, with all the actions that you have described to the committee, how do you quantify the reduction in the problem water that has taken place?

Mr. NELSON. I think when you look at the process that we are involved in that will ultimately lead to the quantification, we are generally under regulatory mode. What that means is as the San Joaquin Valley drainage program recommended, there are going to be continued discharges to the San Joaquin River regulated—maybe not—regulated accordingly. As our discharges become restricted, we are addressing that in minimizing and trying to meet the standards through, again, initially source control, and when we still can't meet that, reuse—

Mr. MILLER. What does your plan tell you about your ability to reduce the flows by your plans for source control?

Mr. NELSON. I will defer to Joe McGahan who does a lot of the technical work and the monitoring for the local agencies to meet the regulations in the San Joaquin River.

Mr. MILLER. We will get that for the record.

Mr. NELSON. Yes, sir.

Mr. MILLER. Ms. Kuhlman, given your statement and issues that EPA has raised to date, and I guess coupled with the overturning of the—what is the technical term?

Ms. KUHLMAN. The Inland Water Surface Plan?

Mr. MILLER. The water plan that was done at what level—in Superior Court?

Ms. KUHLMAN. It was Superior Court, and I don't know what the decision is on appeal. We are in the period from issuance to finalization of the order.

Mr. MILLER. I assume from your remarks that my earlier interpretation is correct, that if we were to give the permit today to use the Drain around Grasslands, that we would not have in place any process for meeting these standards?

Ms. KUHLMAN. I think there is a process in place for trying to meet the standards. What I think isn't in place is assurance that process will deliver results.

Mr. MILLER. I stand corrected.

So now that we have a process, you are telling me that we don't have assurances that the purposes of the process will be met?

Ms. KUHLMAN. I don't see anything in the construction of the oversight committee that leads me to conclude that if standards continue to not be met, or to put it more accurately, if loadings out in the environment still continue to be high enough to cause toxicity, that there would be some action that would really result in change, increased source reduction. I don't see a cause and effect.

Mr. MILLER. Ms. Garrison, in your discussions here, my concerns with the—what is this, the Central Valley Water Quality Control Board here?

Ms. GARRISON. Yes.

Mr. MILLER. That their role over the years continues to cause me concern as to whether they are serious about using their authority to see if we can bring these parties together. They consistently seem to be the escape valve by which the solution gets away from us.

Each time we think we have got people in a room to meet their obligations, somehow they are released once again through the Water Quality Control Board's treatment of this issue.

Ms. GARRISON. I would say that is accurate; they certainly haven't exerted very much leadership in this area.

Mr. MILLER. I guess it just haunts me that there is a political process in place here that suggests you can continue to put this problem off, and put this problem off. Eventually we will be back here, as we were when we came under the Migratory Bird Treaty, and maybe some other mechanism or some other part of the law or political situation, we will be back here on a crisis basis. And I think that we have tried to work on this drainage problem with the idea that we should try to work on it so that, as I think you pointed out and others pointed out, we can minimize the adverse impacts to go around. But that was going to take an awful lot of cooperation and a steady marching toward the goals, and this process to date just hasn't done that. And I would be very interested in the technical papers from the drainers as to what they have effectively done or not done to date.

I know what they are saying they want to do and the goals and the aspirations, but we are still sitting here with three-quarters of a million acre-feet of water that pose a serious problem to the long-term viability, both of the irrigators and the environmental stability of this region, and perhaps even the Bay and Delta region. You know, almost the entire time I have been in this Congress, what usually happens is we come along on a crisis basis. Almost all of the answers become more severe because you have run out of time. You are put up against some additional guideline, principle, law or edict that takes away the maneuvering room for adapting these solutions, given the various circumstances—in this case, mainly of the drainers. I just worry that we are running out of room here.

Ms. GARRISON. I think that is right. Ironically, the State board is now a participant in this drainage program team, I am not sure what they call it, but the group of agencies that is charged with implementing the plan to the extent that implementation is happening. But the implementation plan they prepared is a very *laissez faire* one that simply lets the agencies go about their business, more than really trying to come up with a coordinated approach where everybody is pulling in harness, and I would suggest that is one place to look.

I would also agree with Dan that there are some progressive districts that he represents who have done quite a bit. We aren't at ground zero. We have moved along the spectrum.

In that area in the Grasslands, though, there are some lands that are very hot and as long as they keep pumping selenium into this nonpoint source discharge, you are going to have a lot of problems. Certain lands are going to undercut the progress made by other people through source control as long as they are still in production.

We need to move more quickly towards setting priorities for retiring some of those lands. I think that is the way you are going to see a major difference quickly between what we would discharge under the status quo and what we would discharge with some work in line with the drainage program.

Mr. MILLER. Mr. Dooley.

Mr. DOOLEY. Just one comment is that, in terms of us being at another crisis point and having our options eliminated and a lack of flexibility, I think that one has to understand that the people who are most at risk here are the drainers and the users. They are the ones that are seeing the prospect of losing the economic utility of their land—and no one has a more vested interest in solving this problem, especially in light of the restrictions now and the acknowledgment that we will never have a drain that goes out. We have some people, as Ms. Garrison has said, that have been extremely progressive in this area. They are trying to do some things to really provide the certainty I think a lot of us are concerned that this agreement doesn't necessarily mandate; namely, that we will continue to meet the standards down the road. I don't think anyone disagrees with that.

But I get a little frustrated because I think there is a lack of acknowledgment of the good-faith effort of a lot of folks out here to try to deal responsibly with the problem. I would like perhaps, Dan, for you to comment from your estimation looking at today and the status quo versus ten years ago, the commitment of your district and other water districts that deal with this problem. From my perspective there has been a real awakening that we can't walk away from this.

Mr. NELSON. Since the realization of the problems associated with the drainage water that are exemplified by Kesterson, there have been a tremendous amount of examples, and good examples, of cooperative efforts, and I think some of the best cooperative efforts are represented here today with the Grassland basin drainers and the Grassland Water District. The initial thing that we had to look at in the Grasslands basin was, are the things that are happening in Kesterson where you have an evaporation-type pond, are they happening in the Grasslands area? And there were, indeed, some signs that there were definite problems in the wildlife so what we have done through various cooperative efforts is to try to take a look at the initial problem. And I think one of the solutions to that initial problem is being presented here today but that is as an example.

We wouldn't have thought of doing treatment demonstrations, you are right, ten years ago. We wouldn't have thought, frankly, that taking land out of production was a viable option. We are developing criteria locally right now to take land out of production, so, yes, we have learned a lot in the last ten years.

It has been painful. There has been a lot of people hurt. There is as high as 40 percent unemployment on the westside not attributable to drainage but water supply. Things are moving ahead.

Mr. DOOLEY. Ms. Garrison, if I understand, one of your concerns about some of the permits that were granted was that the proposals did not include a plan or a mandate for some level of source reduction.

Ms. GARRISON. Right.

Mr. DOOLEY. And that means applied water?

Ms. GARRISON. Yes.

Mr. DOOLEY. You know, from my perspective, though, isn't that basically an absolute? If you are an individual who is having to set

aside land for ponds, isn't that a natural or economic incentive to reduce the source so you will have a reduced supply?

Why does it necessarily require an arbitrary reduction and then the inevitable result from economic and financial incentives to reduce the amount of drainage water that you have?

Ms. GARRISON. The short answer is that it has to do with comprehensive planning. What the drainage program tried to do was take a look at the whole and say how much do we have to reduce our drainage by to get to a certain goal. They came up with an amount of reduction in drainage that was desirable to reach that goal. Any independent person may have some economic incentives to reduce their drainage but they don't—there is a certain tragedy of the common problem that happens where nobody can see how their actions fit into the whole and so they will pursue their own interests.

The drainage program came up with a standard, as it were, of drainage reduction that they thought would accomplish the goals they were aiming for. And some pond operators agreed that made sense and actually adopted them or proposed them as part of their permits. The regional board in a classic example of the attitude that the Chairman just described, refused to put that in the permits, even of the person who proposed to have it in his permit, much less use it as a model for other permits, which would have been the sensible approach.

Mr. DOOLEY. Ms. Kuhlman, you talked about exceeding the salinity standards in Mud Slough. Basically, I understand that was a trade-off we felt was merited because we consolidated what was excessive salinity levels in 70 miles of channel to basically that 6 miles, and we felt that was appropriate policy at this time.

Your concern is about the lack of a process which ensures that we are going to deal with the source reduction so that we are not eventually faced with the EPA coming in subsequently after this five-year period and saying that we are not meeting the salinity standard, so there has to be more done?

Ms. KUHLMAN. Under the Clean Water Act, EPA cannot enforce water quality standards directly. We have no mechanism to enforce against nonpoint source polluters. That is something that is left under the Clean Water Act to the prerogative of the States. So the answer to your question is, no. EPA is only in a position, at this point in time, of saying there will be impacts on the environment when your levels are as high as they are going to be in Mud Slough, so let's look for practical alternatives.

Mr. DOOLEY. Thank you, Mr. Chairman.

Mr. MILLER. Thank you.

Just one point. We pointed out in the very beginning of this process many years ago, there were irrigators that immediately came to the forefront and invested substantial amounts of money looking for solutions, many of which did not pan out.

It is not a question of acknowledging those efforts. The question is whether or not you can achieve those purposes because you have some lands that are just so hot. Can you dilute this to the point where you can get down to 5 ppb or not? I think it is the old problem—if everybody has got to get through the keyhole then we are probably not going to get there. And that means that then you

have to start to look at these other alternatives, which may include water exchange; that is, provide some reimbursement or provide some incentive for those farmers to move that water to some other use so that the rest of the farmers can meet those standards.

But I think this process to a great extent has been driven by the worst case rather than the best case. I am not sure the best cases are being allowed to show the way. They are being held back in terms of the potential success by the worst-case lands, in this case, because right now we don't seem to have the ability to get there without getting the Mud Slough with less than 57 parts per billion or 30 parts per billion. That is unacceptable.

And it seems to me that demands a hard-and-fast process to get to where the standard of 5 ppb is upheld. At some point down the road, those irrigators and others are going to have to make some tough decisions. Right now, the proposal is to continue to keep in the air enough balls to suggest that decisions are being made when, in fact, the tough decisions aren't being made and eventually you are going to drop all the balls. I just think that is what is going to happen here. Because some of these lands are so hot that your ability to mitigate on the rest of the lands to make up for that doesn't look terribly feasible at this point. Maybe it will 20 years from now or some other time, but at the moment, it doesn't look terribly feasible.

Well, thank you for your testimony and for your help on this issue.

The next panel will be made up of Don Marciochi who is the general manager of the Grassland Water District and Resource Conservation District, Ms. Chelsea Congdon, who is resource analyst for the Environmental Defense Fund, Joseph McGahan who is representing Summers Engineering, and Mr. Dee Swearingen who is the executive director of the San Joaquin River Exchange Contractors Water Authority in Los Banos. Somebody here is going to be accompanied by Dr. Young.

Mr. Marciochi, we will start with you.

Welcome to the committee and your full statement will be put into the record in its entirety, and to the extent you can summarize, would be appreciated.

PANEL CONSISTING OF DON MARCIOCHI, GENERAL MANAGER, GRASSLAND WATER DISTRICT AND GRASSLAND RESOURCE CONSERVATION DISTRICT, LOS BANOS, CA; CHELSEA H. CONGDON, RESOURCE ANALYST, ENVIRONMENTAL DEFENSE FUND, OAKLAND, CA, ACCOMPANIED BY TERRY F. YOUNG, PH.D., SENIOR CONSULTING SCIENTIST, ENVIRONMENTAL DEFENSE FUND, OAKLAND, CA; JOSEPH C. MCGAHAN, SUMMERS ENGINEERING, INC., REPRESENTING THE GRASSLAND BASIN DRAINERS, HANFORD, CA; AND DEE E. SWEARINGEN, EXECUTIVE DIRECTOR, SAN JOAQUIN RIVER EXCHANGE CONTRACTORS WATER AUTHORITY, LOS BANOS, CA

STATEMENT OF DON MARCIOCHI

Mr. MARCIOCHI. Thank you, Mr. Chairman, it is a pleasure to be here to brief you on this issue. I will summarize my statements.

In fact, I think if I can ask the Chairman's permission, to utilize this map, come forward with that map to help clarify some of the issues that were discussed earlier as to the management of water in our area.

Mr. MILLER. Whatever is convenient for you.

Mr. MARCIOCHI. Let me lead off by saying I think it is only with a great deal of reluctance that the Grassland Water District finds itself in the position of being the lead agency on the San Luis Drain Project. We feel that while there are other agencies with more resources and a greater ability to implement this project, we as the recipients of the drainwater in that area have found it necessary to begin this process to remove that water from our canal systems.

If I may come forward now.

Mr. MILLER. Hold on a moment.

You know the area?

Mr. DOOLEY. I have seen it.

Mr. MARCIOCHI. Perhaps.

Mr. MILLER. Do you want to refer to it now.

Mr. MARCIOCHI. I think there are a couple points of clarification that need to happen.

First of all, let me describe this area in green is the Grassland Water District. The red line that you see here is the San Luis Drain. The proposed point of interception is at this point. The exit from the Drain into Mud Slough is at this point.

One of the things that was discussed was Grassland's interest in this process in that it removes the drainwater from our system. It does to a degree. This current proposal takes the drainwater out of the north Grasslands system, out of the system that services 20,000-some acres of State and Federal lands as well. The south Grasslands canal system will still be impacted.

We have put into place facilities over the last ten years to be able to alternate drainwater flows and fresh water flows throughout the south Grasslands. That creates a timing problem for us.

It isn't a question of us having this water go out upon the land, out upon the wetlands, it is more a scheduling problem. These conveyance systems throughout the district serve a dual function. First is a supply system for CVPIA, water supplies, and second is a conveyance system for drainage, so the district itself will not find itself in a position, if this project is implemented, of having not to deal with that drainwater. We still have that problem.

The other point that was made earlier that I think needs some clarification is regarding the standards that are or are not in place. There was concern expressed about transferring this problem downstream throughout the river system and into the Bay and the Delta.

There is a five-part standard on the San Joaquin River. That standard has been in place for probably at least two years. That is part of the Regional Water Quality Board's Basin Plan amendments. It is a five-part standard. It has to be met.

It will be met as a part of this project. It has been met during the last few years. So while we talk about the impacts, there are some impacts that may occur in Mud Slough. Reference was made to the increased concentrations that might occur in Mud Slough.

There is a standard in place already on the river that has to be met, so I sense the concern that we were merely taking this out of our system, transferring it throughout the river system and on downstream. That isn't the case.

The other point that I think that needs to be made——

Mr. MILLER. Well, what are you saying?

Mr. MARCIOCHI. The concern had been expressed that there was no standard or that there was a standard that may be put into place once this project goes into place. That reference was made to a standard on Mud Slough.

Mr. MILLER. That standard is not currently enforced against this proposal.

Mr. MARCIOCHI. That is correct, but there is a standard on the San Joaquin River which is immediately downstream.

Mr. MILLER. But it is not enforced against this proposal.

Mr. MARCIOCHI. Yes, it is.

Mr. MILLER. Well, which is it, is it or isn't it.

Mr. MARCIOCHI. The standard on the San Joaquin River is enforced.

Mr. DOOLEY. Outside of Mud Slough.

Mr. MARCIOCHI. The water is discharged at this point into Mud Slough. It goes 6 miles down Mud Slough to the San Joaquin River. There is a standard in place on the San Joaquin River. And it——

Mr. MILLER. How can you take 57 parts per billion and dump it into Mud Slough and get it to——

Mr. MARCIOCHI. That is up to the drainers to achieve. If it doesn't happen, the project stops and that is our position in this as the operator of the project. We physically move the water through the Drain through our system into the Drain to the discharge point. The responsibility and liabilities for meeting that standard or standards on Mud Slough rest with the draining entities, will rest with the draining entities as a result of any service agreements.

Mr. MILLER. That is a disclaimer of liability.

Okay. Go ahead.

Mr. MARCIOCHI. And in fact, Mr. Chairman, this project cannot proceed until the drainage service agreements are in place. Those are still another step that has to be taken.

I believe that is all at this time. I would be glad to answer any questions.

Mr. MILLER. All right.

Thank you.

Mr. MARCIOCHI. Thank you.

[Prepared statement of Mr. Marciochi follows.]

GRASSLAND WATER DISTRICT
AND
GRASSLAND RESOURCE CONSERVATION DISTRICT
TESTIMONY BEFORE THE
SUB-COMMITTEE ON OVERSIGHT AND INVESTIGATION
RELATING TO THE PROPOSED USE OF
THE SAN LUIS DRAIN

OCTOBER 26, 1993

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U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON NATURAL RESOURCES
SUB-COMMITTEE ON OVERSIGHT AND INVESTIGATION
HEARING ON THE PROPOSED USE OF
THE SAN LUIS DRAIN*

Mr. Chairman and members of the Committee, as general manager of the Grassland Water District and Resource Conservation District, I appreciate the opportunity to brief you today on the Grassland Wetlands and the proposed use of the San Luis Drain.

I. HISTORY AND DESCRIPTION OF THE GRASSLAND WETLANDS

Situated along both sides of the San Joaquin River in the Central Valley of California, the Grassland Wetlands encompass an area approximately 30 miles long and 25 miles wide. This ecosystem, commonly referred to as the Grassland Wetlands Complex, consists of Federal, State and privately managed wetlands, riparian corridors and native grasslands. Although wetland systems once covered more than 4 million acres within the Central Valley--90% of California's original wetland acreage--only 300,000 acres now remain. Of this, the 160,000 acre Grassland Wetland Complex represents the largest organized wetland complex in the United States and is perhaps the most critical link in the Pacific Flyway which stretches from Alaska and Canada to Mexico and Central and South America. This wetland system, of which the Grassland Water District and Resource Conservation District are the largest part, is recognized by the U.S. Fish and Wildlife Service as the most important wintering area for waterfowl in the nation and has been designated as one of only 15 international reserves for wintering and migrant shorebirds in the world.

* Presentation by Don Marciochi, General Manager of Grassland Water District and Resource Conservation District.

II. WATER SUPPLY

Faced with the prospect of an uncertain water supply following the construction of the Central Valley Project (CVP), land owners within the Grasslands joined together and formed the Grassland Mutual Water Association in 1944, the same year the Friant Dam was completed. Attempts at negotiating a reliable water supply for the Grasslands were unsuccessful, and by 1950 the Bureau of Reclamation served notice on the Grassland owners that water would be available only on interim basis until 1953. At that time, the CVP would come into full operation and water would be diverted south to meet agricultural needs.

To protect the Grasslands, the land owners filed a class action lawsuit against the federal government. The matter was resolved during settlement negotiations, resulting in a reauthorization of the CVP to include water for fish and wildlife purposes. As a direct result of this action, the Grassland Water District was formed, and by 1956 the new district had entered into a contract with the federal government for the delivery of 50,000 acre feet of CVP water each year.

From the early 1950's to 1985, the Grasslands--based on recommendations made by federal and state wildlife agencies and the Bureau of Reclamation--came to rely on the use of agricultural drain water to supplement its contract supply. At times, this drain water accounted for as much as two-thirds of Grassland's water supply.

However, in 1983, selenium contamination caused by the ponding of agricultural drain water was discovered at Kesterson Reservoir within Kesterson National Wildlife Refuge, resulting in reproductive failure in birds. This led to the recognition of a similar problem within adjacent private wetlands of the Grasslands and the enactment of

policy prohibiting the use of contaminated drainwater for wetland management.

With implementation of CVPIA, Grasslands will receive an historic firm water supply. This additional water will provide the District the opportunity to better manage, and improve, critical wetland habitat important not only to wintering waterfowl, but also to a multitude of other forms of wildlife that reside within this sensitive ecosystem.

Unfortunately, the limitless benefits offered by a sufficient and quality water supply can never be fully realized without the resolution of one of our most pressing issues--removing agricultural drain water from the District's conveyance systems. This must happen in order to allow the Grasslands to fully utilize the water provided us by a long-awaited and much appreciated act of Congress.

III. DRAINAGE PROBLEM

Although one of the objectives of Congress in enacting the CVPIA was to provide a sufficient and safe water supply to ecosystems like Grasslands, we are now confronted with a serious dilemma in not being able to deliver this water to state, federal and private wetlands when it is needed. This logistical problem arises in having to share conveyance systems with upslope agricultural drainers. With sufficient water now available, more intensive management of wetlands is needed throughout the year. However, this water can do little good if the ability to physically deliver it to wetland areas is restricted due to matters of plumbing.

Agricultural drain water from the drainage area shown on the map is and has been discharged--from some areas for more than a century--through canal conveyance systems in the Grassland Water District and adjacent areas to the San Joaquin River. These channels must now

serve as supply systems to deliver water provided by CVPIA for wetland management. All too often we are restricted from delivering this water when it is needed because our canals are being used for drainage water conveyance.

Currently, drainwater is being managed by routing it through makeshift facilities and channels on the Los Banos Wildlife Area operated by the California Department of Fish and Game. The Department has formally notified the District that it will not allow use of its facilities for this purpose in the future. As the Kesterson debacle testified, comingling of fresh water deliveries to wetlands and agricultural drainage water must be avoided in order to prevent environmental damage to wetland systems. Obviously, this situation represents a scheduling nightmare in trying to supply water to federal, state and private refuges within the Grasslands and only serves to restrict our ability in providing water to wetlands as mandated by the provisions of the CVPIA.

IV. DESCRIPTION OF SAN LUIS DRAIN PROJECT

The most immediate answer to the drainage problem, as it relates to Grassland Water District, is a reliable and manageable transfer system through the District and adjacent wetlands for the conveyance of agricultural drainage waters to the San Joaquin River. The proposal to utilize the San Luis Drain for this purpose provides the District with an immediate, albeit short-term solution which gives us the flexibility in delivering water to wetland habitat as well as lessening the potential impacts of agricultural drainage water mixing with District water supplies.

Simply stated, the proposed project entails removing the drainwater from the North Grasslands systems and conveying it in the San Luis Drain for a distance of 18 miles to Mud Slough and then 6

miles to the San Joaquin River. The project has met CEQA and NEPA requirements with a Finding of No Significant Impact. The FONSI includes many mitigation measures, including the formation of an Oversight Committee and Technical Advisory Committee which will continuously review the project for any potential environmental impacts and have authority to terminate the project--at any time--should problems arise. The proposal to use the Drain is limited to a maximum of 5 years and an extensive monitoring program has been implemented and the necessary permits required for the project have been secured. Although the Grassland Water District will serve as managing entity, liability and responsibility for ensuring water quality and environmental objectives will be passed on to the agricultural drainers via drainage service agreements.

V. BENEFITS OF PROJECT

The implementation of the San Luis Drain project will result in the removal of drainage waters from approximately 70 miles of channels within the Grassland Water District and state and federal wildlife areas. The potential for direct impacts from agricultural drainwater to nearly 30,000 acres of federal, state and private wetlands as well as other sensitive habitats in the area, including the District's conveyance systems themselves, will be immediately removed. The project also represents a first step toward resolving the drainage issue in the long-term. As stated, agricultural drain water currently weaves its way downslope, meandering through a maze of conveyance channels. Needless to say, the ability to closely measure, monitor and control this drainage through the Grasslands has been difficult. However, by placing drainage waters collectively into one system, the task of regulating and enforcing drainage requirements will be greatly improved. This factor alone should be a part of any and all

discussions relating to the benefits of proceeding with this project.

VI. CONCLUSIONS

Only with great reluctance and serious trepidation has Grassland Water District agreed to take on the responsibility as lead agency on this important, yet politically sensitive project. However, possessing the responsibility for protecting the interests of the private wetland landowner within California's largest wetland complex is something we take very seriously. Although the Grassland Water District may not compare in size and stature to the many associated agencies involved in this project, we find the burden upon our shoulders simply because no other agency has been either willing or able to take the immediate steps necessary to resolve this serious problem. After fifty years of struggling for a firm water supply and proclaiming the values of wetlands long before it was fashionable, we now have been given proper recognition and the water supply we need. Yet, it does us little good to pat ourselves on the back if we are unable to deliver this water to the private and public wetlands within the Grasslands because of physical constraints inherent in having to continue to transport agricultural drain water through our wetland service canals.

It is important for the Committee to know that a plethora of options have been explored over the last decade relating to this issue, at an incredible expense of time and energy by federal, state and local agencies. \$50 million of taxpayer money was spent in the development of just one of the many studies which examined drainage in the San Joaquin Valley. Yet, we have made little progress in implementing an acceptable solution. It is our opinion that of the many options explored, only a handful can be seriously considered. If we agree that stopping agriculture altogether on the westside of the

San Joaquin Valley does not offer a realistic or desirable option, then we have only the following alternatives to consider:

- 1) Pollute the private and public wetlands of the Grasslands; or
- 2) Implement the San Luis Drain Project with the safeguards that have been built into the proposal.

Mr. Chairman, Grassland Water District has no ambitions to get into the drainage business or desire to police our agricultural neighbors. Our absolute first priority is to the protection and preservation of the Grassland Wetlands. Although moving ahead with this project will greatly benefit the Grasslands, our future is constantly in the balance, regardless of the progress we have made in maintaining what little of this resource remains. With the Central Valley now being considered the "last frontier" by California's building industry, we are experiencing a constant barrage of threats associated with urban development. Facing such an ominous path, we must do all that we can to ensure full management and protection of this precious resource. Removing agricultural drain water from our systems is an important step in reaching this goal and must be accomplished in order to ready us for the many threats we have yet to face, but will undoubtedly come.

Mr. Chairman, the Grassland Water District appreciates the opportunity to provide these comments. We would also like to take this opportunity to invite you and the other members of the Committee to visit the Grasslands in order to better understand what we have discussed here today and the many other issues which we face.

STATEMENT OF CHELSEA H. CONGDON

Mr. MILLER. Ms. Congdon.

Ms. CONGDON. Thank you, Mr. Chairman, and members of the subcommittee. My name is Chelsea Congdon, I am representing the Environmental Defense Fund, a nonprofit conservation organization that with over 200,000 members nationwide. The staff of the Environmental Defense Fund have been working on issues related to water and drainage management in California for over 15 years. The testimony I will present today I present on behalf of myself and Dr. Terry Young who has joined me here today, who is a specialist in water quality and habitat protection issues, and is a co-author and principal investigator on a study on the potential for using economic incentives to regulate agricultural nonpoint source pollution.

First, let me thank you for the invitation to participate in these hearings on agricultural drainage issues generally in the San Joaquin River and on the proposed reopening of San Luis Drain.

With the recent passage of the Central Valley Improvement Act, Congress signaled a new era in Federal water policy with increased emphasis on environmental restoration and protection and the use of innovative approaches to achieve improved water management objectives. However, progress in controlling and reducing agricultural drainage pollution has been minimal at best.

This committee's attention to drainage pollution problems and the opportunities for solving them provides a real hope that implementation of a comprehensive long-term program will be possible. I refer you to our prepared testimony and to selected comments that we have submitted for the record of this hearing.

One topic to be addressed in these hearings is the status of irrigation drainage on westside. Much of that has been summarized today. In short, the Federal Government responded in 1985 to the disaster at Kesterson Reservoir by taking actions to protect the Kesterson Wildlife Refuge in closing down the San Luis Drain.

However, the San Joaquin River and the nearby Grasslands wetlands complex were still receiving 7 times the volume of drainwater that had been flowing into Kesterson. Moreover, in the Tulare region to the south, similarly hazardous drainwater was being stored in expansive evaporation ponds which also attracted and poisoned birds. In 1985, drainwater that had been delivered to the Grasslands was rerouted to the San Joaquin River by way of various channels and tributaries and sloughs. But for that adjustment, as of October 1993, little has changed in the way that drainage in the San Joaquin Valley is handled.

The reasons for inaction on the part of Federal resource managers and State regulators in implementing and enforcing drainage reduction measures are varied. However, they do not include a lack of information on physical or technological elements of this problem nor can inaction be attributed to the lack of a carefully formulated long-term plan for drainage management.

Interestingly, the State of California developed the first comprehensive evaluation and set of recommendations for solving the drainage problem in a plan that was issued in 1987.

The findings of that two-year, eight-volume report were confirmed and supplemented in 1990 with the recommendations of the

San Joaquin Valley drainage program. The drainage program presented an in-depth plan for solving the drainage problem based on the same fundamental principle endorsed by the State: Namely, first decrease the amount of drainage generated by improving irrigation efficiency, water management, and selectively retiring highly contaminated farmland; and then second, employ available technological fixes as necessary to ameliorate the remaining problem.

The emphasis on farm-level water management is further endorsed in provisions of the recently adopted Central Valley Project Improvement Act which requires the Secretary of the Interior to utilize the recommendations of the San Joaquin Valley drainage program in developing water management and conservation practices.

The Act further requires Federal water contracting districts that receive Central Valley Project water to comply with water quality standards through their drainage discharges.

Unfortunately, the San Joaquin Valley drainage plan is gathering dust on the shelves of all of the affected agencies. Its successor committee chaired by the State Department of Water Resources has taken no discernible action to implement its various recommendations. Another underlying reason why steps toward drainage management have not been taken is that the responsible State and Federal institutions have not been willing to hold farmers who generate the pollution directly responsible for their appropriate share of the responsibility in cleaning it up, which isn't to say that the drainers must bear all of the costs of solving the drainage problem because there are lots of strategies that can be worked out for cost-sharing in coming to a long-term solution.

The proposal to reopen the San Luis Drain for an interim five-year period, as Don Marciochi just discussed, as well as longer-term proposals to construct an interceptive drain and bypass to the southern Grasslands, represent an ominous environmental prospect in light of the Kesterson disaster and in light of the continuing waterfowl poisoning in the Tulare basin. For the Federal Government, the proposal to reopen the Drain presents a clear-cut choice: Will the use of the Drain be tied to solving the pollution, or will it simply serve to move pollution from one place to another?

EDF believes that the Bureau of Reclamation and other agencies with the support of this committee should pursue the former approach. Specifically, we recommend the following preconditions for reopening the Drain:

First, permission to use the Drain should be conditioned on specific commitments to decrease environmental damage and comply with Federal and State laws; second, the contract for the use of the Drain must be signed by an entity or entities legally capable of enforcing those commitments; and third, the use of the Drain should enhance rather than interfere with other environmental restoration projects that Congress has approved for the San Joaquin Valley and should not divert fundings set aside for other restoration purposes for those needs.

With regard to our first recommendation, any agreement for use of the Drain should specify that water quality standards in the San Joaquin River and in Mud Slough must be met when the Drain is in use. There is, in fact, an indication in some of the documentation

that was prepared for the environmental assessment on the use of the Drain that without reduction in drainage from current levels or baseline levels, that the loads of selenium discharged in the San Joaquin River would in fact increase with the use of the Drain.

Moreover, no specific enforceable limits have been placed on drainage discharges. The Drain should not be reopened until those limits are established.

The use of the San Luis Drain should only be permitted, if at all, as an integral component of a comprehensive long-term plan to address the drainage problem such as that outlined by the drainage program. Financial incentives provide potentially cost-effective and efficient means for implementing such a plan and for meeting pollution reduction requirements.

We have at various times proposed a performance bond and effluent fees tied to the use of the Drain in order to provide further incentives for drainage production as well as to provide a financial reserve to cover future mitigation or restoration costs. Those recommendations are set forth in comments that have been provided to this committee for the hearing record.

With regard to our second recommendation, we would note that any requirements tied to the use of the Drain will only be meaningful if some entity is accountable when a problem arises from the Drain's use or when requirements for the use of the Drain are not met. The fundamental problem with the currently proposed use agreement for the Drain and for all of its previous continuing relations is that the signing parties do not ultimately control the drainage or they do not control all of it.

The crux of the problem is that the districts producing the drainage have not reached an agreement on how to allocate responsibility for drainage reduction among themselves nor are the contributing districts necessarily united in their commitment to assume responsibility for any liabilities associated with the drainage disposal.

Lacking this level of agreement among the dischargers, some entity must become the drainage cop. However, none of the Federal or State agencies currently is willing to take on the role of drainage cop and the Grassland Water District, the signing entity for the agreement, has already indicated a reluctance in having to be in the situation of being lead agency. Given the Federal Government's interest in and potential liability with the Drain, clear lines of accountability need to be established before the Drain is reopened.

Third and finally, we recommend that the use of the Drain should not interfere with or detract from other environmental restoration efforts. Specifically, water that has been set aside for restoring fish and wildlife survival should not be used as dilution water for drainage and money that has been set aside in environmental restoration under the Central Valley Project Improvement Act restoration fund should be targeted for real habitat restoration and not be used to pay for plumbing systems that only serve to move drainage from one place to another.

In conclusion, it is not without irony that Secretary of the Interior Babbitt is now faced with a decision of whether to reopen the same San Luis Drain that brought us the Kesterson disaster, and as a result, was closed in 1985 by then Secretary Donald Hodel.

The decision is obviously a difficult one, especially since little has been done since 1985 to address the drainage problems in the San Joaquin Valley.

The proposed use of the San Luis Drain, like the continued operation of evaporation ponds in the Tulare Basin, is only a stopgap measure. The long-term resolution of drainage issues requires a comprehensive approach that relies primarily on changes in farm-level practices. Use of the San Luis Drain, if allowed, should provide meaningful progress toward that long-term solution.

I am happy to expand on these comments or answer any questions, as is my colleague, Dr. Young, and I thank you for your attention.

Mr. MILLER. Thank you.

[Prepared joint statement of Dr. Young and Ms. Congdon follows:]



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BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES

COMMITTEE ON NATURAL RESOURCES

SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS

TESTIMONY OF

TERRY F. YOUNG, PH.D., SENIOR CONSULTING SCIENTIST

and

CHELSEA H. CONGDON, RESOURCE ANALYST

ENVIRONMENTAL DEFENSE FUND

Washington D.C.

October 26, 1993

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BEFORE THE UNITED STATES HOUSE OF REPRESENTATIVES
COMMITTEE ON NATURAL RESOURCES
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS

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TERRY F. YOUNG, Ph.D., SENIOR CONSULTING SCIENTIST

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ENVIRONMENTAL DEFENSE FUND

Washington, D.C.

October 26, 1993

CONGRESSMAN MILLER AND MEMBERS OF THE SUBCOMMITTEE:

Thank you for the invitation to participate in these hearings on agricultural drainage problems in the San Joaquin Valley and the proposed re-opening of the San Luis Drain. The timing of these hearings is critical: with recent passage of the Central Valley Project Improvement Act (P.L.102-575), Congress signalled a new era in federal water policy, with increased emphasis on environmental restoration and protection, and the use of innovative approaches to achieve improved water management objectives. However, progress on controlling and reducing one of California's most intractable environmental problems -- agricultural drainage pollution -- has been minimal, at best. This Committee's attention to drainage pollution problems and the opportunities for solving

them, provides real hope that implementation of an effective, comprehensive drainage management program will at last be possible.

The Environmental Defense Fund (EDF) is a non-profit conservation organization that employs scientists, economists, attorneys, computer modelers, and other environmental professionals who seek innovative solutions to a wide array of environmental problems. EDF played an instrumental role in securing a nationwide ban of DDT, winning a 90% reduction of lead additives in gasoline, and reducing acid rain by half through the recent reauthorization of the Clean Air Act. EDF worked with McDonald's (fast food) Corporation to create a waste reduction program that included a phaseout of the polystyrene "clamshell" package and increased use of recycled materials. EDF works to protect endangered species and wildlife, conserve water and energy resources, control toxic chemicals, improve air quality, encourage recycling, and address international environmental issues. EDF has over 200,000 members nationwide.

The staff of EDF's California office have been actively engaged in efforts to work with public agencies, agricultural water users, and resource managers to develop and implement cost-effective and efficient measures to solve drainage problems on the westside of the San Joaquin Valley for more than a decade. In particular, EDF's experience in drainage-related issues includes: participation in the State Water Resources Control Board's 1987 report on regulation of agricultural drainage and the citizen's oversight committee for the San Joaquin Valley Drainage Program; efforts to establish water quality standards for the San

Joaquin River and the Delta; and technical input to water management reforms set forth in the Central Valley Project Improvement Act. We have recently joined with other organizations in an appeal to the State Water Resources Control Board to ensure adequate mitigation and operational requirements for drainage evaporation ponds in the Tulare Basin, and will soon release a detailed study on the potential for using economic incentives to regulate agricultural pollution.

INTRODUCTION

Over a decade ago, the discovery of dead and deformed birds at Kesterson Reservoir signalled the need for action to keep toxic farm drainage out of wetlands, rivers, and artificial ponds in California's San Joaquin Valley. In the intervening years, exhaustive studies -- including the \$50 million joint federal-state San Joaquin Valley Drainage Program -- determined that clean-up of farm drainage is practical, affordable, and could be started immediately. Specifically, these studies all conclude that improved water management, drainage reduction, and selective land retirement are the key to solving the drainage problem on the westside. However, despite broad-based recognition that there are cost-effective strategies for addressing the drainage problem, toxic agricultural drainage continues to damage fish and wildlife and their habitats to this day, and no enforceable pollution discharge limits have been imposed.

Today's hearing provides the opportunity for Congress to help break this logjam of inaction by assuring that federal involvement in San Joaquin Valley drainage issues meets one simple test: federal agencies and

programs must actively advance the solution, rather than simply rearranging the status quo. For no single federal action is this test more important than the proposed re-opening of the San Luis Drain.

In particular, the emphasis on source reduction at the farm-level and other recommendations of the federal-state program should be the primary focus of a comprehensive program to reduce drainage discharges to meet environmental standards. The Central Valley Project Improvement Act further endorses this approach in requiring the Secretary of Interior to utilize the recommendations of the San Joaquin Valley Drainage Program to develop water management practices to increase conservation and reduce drainage, and requiring water districts to manage drainage discharges so as to comply with water quality standards. These recommendations should not be side-tracked in favor of "solutions" that simply move pollution from one environment to another. Similarly, federal actions, including federal expenditures relating to drainage which do not advance the primary solution to the drainage problem, should not come at the expense of water or money already targeted by Congress for other environmental improvements.

The substantial influence of federal laws and institutions can speed the implementation of a comprehensive, long-term program for environmentally sound agricultural drainage management: first, by linking federal support for drainage disposal programs and projects to specific drainage reduction and land retirement targets; and second, by encouraging the use of flexible financial incentives to implement the required changes in both water management and drainage disposal.

THE BIG PICTURE

The decimation of fish and bird populations (and incidentally nearby land values) at Kesterson Reservoir in 1983 demonstrated the toxic effects of agricultural drainwater. In 1985, the federal government responded, and took action to protect the Kesterson Wildlife Refuge by closing the San Luis Drain. However, it was evident that the drainwater was not limited to Kesterson. Nearby, the San Joaquin River and Grasslands wetlands complex were receiving seven times the volume of drainwater that had been flowing into Kesterson Reservoir, and the potential for similar ecological destruction in these sensitive areas was apparent. Moreover, in the Tulare region to the south, similarly hazardous drainwater was being stored in expansive evaporation ponds, which were attracting and poisoning birds. In 1985, drainwater that had been delivered to the Grasslands wetlands was re-routed to the San Joaquin River by way of various channels and tributary sloughs. But for that adjustment, as of October 1993, little has changed in the way drainage in the San Joaquin Valley is handled.

The reasons for inaction on the part of federal resource managers and state regulators in implementing and enforcing drainage reduction measures are varied, but they do not include a lack of information on the physical or technological elements of the problem. Nor can inaction be attributed to the lack of a carefully formulated, long-term plan for drainage management. Interestingly, the first comprehensive evaluation and set of recommendations for solving drainage problems was developed by the State of California. That plan, issued in 1987, identified the primary, most cost-

effective, method for addressing drainage-related problems -- source reduction at the farm level. The findings of that two-year, eight volume report¹ were confirmed and supplemented in 1990 with the recommendations of the \$50 million federal-state San Joaquin Valley Drainage Program (SJVDP). The SJVDP presented an in-depth plan for solving the drainage problem based on the same fundamental principle: first, decrease the amount of drainage generated by improving irrigation efficiency and selectively retiring highly contaminated farmland; and second, employ available technological "fixes" as necessary to ameliorate the remaining problem.

Unfortunately, the SJVDP plan is gathering dust on the shelves of all of the affected agencies. In fact, its successor committee, chaired by the state Department of Water Resources, has taken no discernible action to implement its recommendations. There is another underlying reason why steps toward drainage management have not been taken, however. It is that none of the responsible state or federal institutions is willing to hold the farmers who generate the pollution directly accountable for cleaning it up. While the Bureau of Reclamation clearly has a role to play in developing and implementing a long-term drainage management program, the ultimate responsibility for drainage reduction rests with the farmers.²

¹ Regulation of Agricultural Drainage to the San Joaquin River, California State Water Resources Control Board, 1987. EDF comments on this report, which demonstrated that on-farm source reduction measures can be used to meet water quality standards, are available upon request.

² Proposals formulated by the Bureau as recently as last year impede progress towards making farmers accountable for their drainage. See the Comments of the Environmental Defense Fund on the San Luis Unit Drainage Program Draft Environmental Impact Statement, March 25, 1992, submitted to this committee with the written testimony presented at this hearing.

RE-OPENING THE SAN LUIS DRAIN

The proposal to re-open the San Luis Drain for an interim five-year period, as well as longer-term proposals to construct an interceptor drain and by-pass for the southern Grasslands and to extend the Drain to the San Joaquin River, represent an ominous environmental prospect in light of the Kesterson disaster and continuing waterfowl poisoning in the Tulare Basin evaporation ponds. For the federal government, the proposal to re-open the Drain presents a clear-cut choice: will use of the Drain be tied to solving the pollution problem, or will it simply serve to move pollution from one place to another? EDF believes that the Bureau of Reclamation and other responsible agencies, with the support of this Committee, should pursue the former approach. Specifically, EDF recommends the following preconditions for re-opening the Drain:

- (1) Permission to use the Drain should be conditioned on specific commitments to decrease environmental damage and comply with federal and state law;
- (2) The contract for use of the Drain must be signed by an entity (or entities) legally capable of enforcing these commitments; and
- (3) Use of the Drain should enhance, rather than interfere with, other environmental restoration projects Congress has approved for the San Joaquin Valley, and should not divert funding set aside for other restoration purposes from those

needs, including specifically funding set aside by the Central Valley Project Improvement Act for environmental restoration.

With regard to the first recommendation, any agreement for use of the Drain should specify that water quality standards in the San Joaquin River must be met whenever the Drain is in use. Moreover, since the San Luis Drain was closed in 1985, no specific, enforceable limits have been placed on drainage discharges. The Drain should not be re-opened until such limits are established.

The use of the San Luis Drain should only be permitted, if at all, as an integral component of a comprehensive, long-term plan to address the drainage problem, such as that outlined by the SJVDP. Financial incentives can provide a potentially effective means for implementing such a plan and for meeting specific pollution reduction targets. Any agreement for use of the Drain should incorporate such incentives. We have, at various times, proposed a performance bond and effluent fees tied to use of the Drain in order to provide further incentives for drainage reduction, as well as to provide a financial reserve to cover future mitigation or restoration costs.³ In the near future, EDF will publish a study which describes the economic and environmental advantages of using other economic incentives (including tradable discharge permits and tiered water pricing) to reduce

³ Copies of EDF Comments (for the period December, 1990 to September, 1991) detailing proposals for the use of financial incentives to implement drainage management measures in conjunction with the re-opening of the San Luis Drain are submitted to this Committee with the written testimony presented to at this hearing.

drainage and achieve environmental objectives. The study will include a proposal for implementing an incentive-based program for regulating agricultural drainage in the Grasslands region. These economic incentives, applied to meet specific environmental goals, can assure that the drainage problem is addressed in a manner that is both effective and efficient.

With regard to the second recommendation, we note that any requirements tied to the use of the Drain will be meaningful only if some entity is accountable when a problem arises from the Drain's use or when requirements for the use of the Drain are not met. The fundamental problem with the currently-proposed Use Agreement for the Drain, and all of its previous iterations, is that the signing parties ultimately do not control the drainage (or at least not all of it). The crux of the problem is that the districts producing the drainage have not reached agreement on how to allocate responsibility for drainage reduction. Nor are the contributing districts united in their commitment to assume responsibility for any liabilities associated with drainage disposal. Lacking any agreement among the dischargers, some other entity must become the drainage "cop". However, none of the federal or state agencies currently is willing to take on this role, and the Grasslands Water District, the signing entity for the agreement, has no enforcement authority over other districts. Given the federal government's interest in and potential liability with the Drain, clear lines of accountability need to be established before the Drain is opened and the pollution starts flowing through the federal aqueduct into the San Joaquin River.

EDF supports the proposition that farmers should decide among themselves how to allocate the allowable pollution load in the Drain. For this reason, we recommend that use of the Drain be contingent upon the formation of a Regional Drainage District, controlled by farmers in the region, which would be responsible for meeting the region's total pollution load limits. In this way, both the Bureau of Reclamation and the Regional Water Quality Control Board, public agencies with differing authorities over drainage, could deal with a single, accountable entity responsible for meeting environmental and other legal requirements.

Third, and finally, we recommend that the use of the Drain should not interfere with or detract from other environmental restoration efforts. Specifically, water that has been set aside for restoring fish and wildlife survival should not be used as dilution water for drainage, and money that has been set aside for environmental restoration under the Central Valley Project Improvement Act Restoration Fund should be targeted for real habitat restoration and not be used to pay for plumbing systems that only serve to move drainage from one place to another.

On the contrary, conditions for use of the Drain should be consistent with the direction Congress took in the Central Valley Project Improvement Act in requiring improved water management. Increasing irrigation efficiency and selectively taking some of the most polluted land out of production will not only dramatically reduce toxic drainage discharges, but also will save water which can be used to restore fish and wildlife habitats elsewhere. Conversely, as water prices begin to reflect the value

of water in competing uses, drainage reduction becomes increasingly affordable.⁴

CONCLUSION

It is not without irony that Secretary of Interior Babbitt is faced with the decision of whether to re-open the same San Luis Drain that brought us the Kesterson disaster and, as a result, was closed in 1985 by then-Secretary Donald Hodel. The decision is obviously a difficult one, especially since little has been done since 1985 to address the drainage problems in the San Joaquin Valley. The proposed use of the San Luis Drain, like the continued operation of evaporation ponds in the Tulare Basin, is only a stop-gap measure. The long-term resolution of drainage issues requires a comprehensive approach that relies primarily on changes in farm-level practices. Use of the San Luis Drain, if allowed, should provide meaningful progress towards this long-term solution, so that agricultural drainage does not continue to be the kind of "train wreck" this administration seeks to avoid.

⁴ EDF recently prepared an analysis of the interrelationships between drainage reduction and water supply benefits. This material was submitted to the California State Water Resources Control Board in July 1992 during Hearings in Consideration of Interim Water Rights Actions. This information is available from the state as a matter of public record and from EDF upon request.

STATEMENT OF JOSEPH C. McGAHAN

Mr. MILLER. Mr. McGahan.

Mr. MCGAHAN. Yes, Mr. Chairman.

I thank you for the opportunity to come here today and brief you on our proposed use of the San Luis Drain. I do represent the Grassland Basin Drainers, specifically that is Panoche Water District, Broadview Water District, Pacheco Water District and a portion of the San Luis Water District. This area encompasses 60,000 acres, of which approximately 31,000 acres have subsurface tile drainage systems.

Historically, the drainage from these areas were discharged into the Grasslands and—just a comment on the changing conditions that we are faced with—prior to 1985, this drainage water was a desired commodity by Grassland and they wanted to receive the water and would have complained if it would have been shut off. Historically, waters that were not used by Grassland, or when they were finished with it, were discharged to the San Joaquin River. So these waters have always gone in that direction. None of the drainage waters from these lands were ever used in the San Luis Drain or were ever discharged in the Kesterson Reservoir.

You have heard quite a few summaries of the proposed project, and I won't go into detail on that now, but the basic benefit as we see it—and we realize there is a detriment to Mud Slough—is to utilize a 6-mile portion of Mud Slough to the advantage of some 70 miles within the Grasslands area that will not have drainage water in them and that can be utilized for delivery of fresh water, and in fact utilization of some waters that are within the limits necessary.

Our proposed project is basically in the implementation phase. The project has been approved by the oversight committee that was set forth in the funds to receive for the project.

The technical advisory committee meets monthly and is doing detail work to monitor the program. A monitoring program has been set forth, the costs are approximately \$250,000 per year over the life of the project. That will be over a million dollars that will be spent on monitoring. It is a very significant effort to make sure and, if any problems develop, to find those early on.

I feel that the Grassland Basin Drainers have made significant efforts to reduce drainage and comply with water quality objectives. One of the most significant conservation measures that has occurred in the area is the conservation of tail water.

Historically, the subsurface drainage waters which are high in selenium and salt and the other constituents, were mixed with surface tailwaters which are basically of good quality. One of the things that has happened, primarily because of reduced water supplies, is that the surface tailwaters are conserved and are reused on the farm and not discharged.

Other efforts have been made. As they have already been mentioned, I will just quickly go over them: conservation practices on farms, including irrigation scheduling to better irrigation application so as not to produce drainage, the efficient application through practices such as shorter water runs, and use of the efficient irrigation systems such as sprinkler pipe and gated irrigation pipe.

In addition, there is a continuing program to recycle subsurface drainage water where possible onto the farmlands. All districts either have in place or have had aggressive programs to recycle this water.

Of course, this has to be done when there is irrigation going on and when the water quality of that recycled water will meet standards for irrigation. One of the keys that we have used for our premise all along here is there has to be a salt balance in order to maintain agricultural production. If, in fact, that is our goal, we have to have some sort of discharge of salts.

The districts have also investigated methods to treat drainage water. They have had an aggressive approach. As you mentioned, the refineries in your district have spent a lot of money to try to reduce the selenium to try to meet the requirements in the Bay. So have the agricultural drainers.

Although not under the point source regulations, they have also spent millions of dollars on pilot plants and these systems to try to reduce their drainage quantity in order to meet the objectives and the limitations that are set.

One of the things that I think is important—and I would like to request that some direction be given to the Bureau and other agencies in the State that are involved in this—is that we have a valuable commodity in our drainage water. The only problem with the drainage water is it has some selenium and some salts in it that make it undesirable.

If we could, and this applies throughout the whole San Joaquin Valley, all we have to do is find a method to take those things out of the water, and then we would have a supply that can be used either for irrigation or for M&I supplies. It would reduce or eliminate quality impacts downstream.

Although we don't have that treatment method in place now, I think that is really what we need to key in on. The use of this project, hopefully, gives us some time to find that solution.

This use of the San Luis Drain is an interim step. We know it is not the final step that is necessary. But it is necessary in order to move us along down the line toward a solution.

I appreciate the time and would answer any comments.

Thank you.

Mr. MILLER. Thank you.

[Prepared statement of Mr. McGahan follows:]

**U.S. House of Representatives
Committee on Natural Resources
Sub-Committee on Oversight and Investigation
Oversight Hearing on Drainage Problems in
the San Joaquin Valley and the Proposed Use
of the San Luis Drain***

Mr. Chairman and members of the Committee, I appreciate the opportunity to brief you today on the proposed use of the San Luis Drain. I am here today representing the Grassland Basin Drainers who are proposing to participate in utilizing an 18 mile stretch of the San Luis Drain in order to allow more efficient water deliveries into the Grassland Water District and other wetland areas and to better manage drainage water. The attached map shows the proposed location of the project and other salient features. The Grassland Basin Drainers are comprised of Panoche Drainage District (encompassing Panoche Water District), Broadview Water District, Pacheco Water District, and Charleston Drainage District (a portion of San Luis Water District). The area encompasses approximately 60,000 acres of which approximately 31,000 acres have subsurface tile drainage systems.

Historically, these drainage waters were beneficially used by lands within Grassland Water District and wetland areas. Subsequent to 1985 when selenium problems were discovered at Kesterson Reservoir, it was determined that these drainage waters were no longer useable on the wetlands and since that time various efforts have been

* Presented by Joseph C. McGahan, Summers Engineering, Inc., representing Grassland Basin Drainers, October 26, 1993.

implemented to manage the drainage water. It should be noted that the areas within these federal districts to date have never utilized the San Luis Drain and did not discharge waters to Kesterson Reservoir. Historically the waters have always been used either in the wetlands or discharged through natural channels (Mud and Salt Slough) into the San Joaquin River. It is proposed to utilize the San Luis Drain from a point approximately 1.3 miles south of Highway 152 to the northerly end of the San Luis Drain near Kesterson Reservoir, a length of approximately 18 miles. Drainage water would continue to be conveyed in limited channels in the south grassland to the connection point to the San Luis Drain. It would continue 18 miles to Mud Slough and thence a distance of approximately 6 miles before it enters the San Joaquin River. Water quality standards would be met in all channels except Mud Slough which would require a delay during the life of the project.

Utilizing this project would mean the removal of drainage waters from approximately 70 miles of other channels within Grassland Water District and state and federal wildlife areas (shown on the attached map). These other channels then would be available for delivery of fresh water supplies to the Grassland Water District and other wetland areas. The wetland areas include existing federal and state wildlife areas as well as proposed areas from the San Joaquin Basin Action Plan/Kesterson Mitigation Plan.

The proposed use of the Drain is currently in the implementation phase. It has been

approved by the Oversight Committee formed as a part of the mitigation and environmental process and the Technical Advisory Committee. An extensive monitoring program has been approved and is being implemented. Various permits required for the project have either been issued or will soon be received. One pending item is the signing of the agreement between the Bureau of Reclamation and the Grassland Water District for use of the Drain. The drainage area identified in the agreement is the same drainage area that is shown on the map. The drainage area includes federal contractors as well as the San Joaquin River exchange contractors, and private lands.

Significant efforts have been made by the Grassland Basin Drainers to reduce drainage and comply with water quality objectives. As a part of the Basin Plan Amendment adopted by the State Water Resources Control Board in 1989, water quality objectives were set in the San Joaquin River and in Mud and Salt Slough as well as requirements for the drainage entities to provide annual drainage operation plans to indicate what they were doing to meet water quality objectives. As you well know, due to the recent drought and as a result of the Central Valley Project Improvement Act, there have been significant reductions of water delivered to the federal contractors. This aspect along with conservation practices have resulted in reduced drainage.

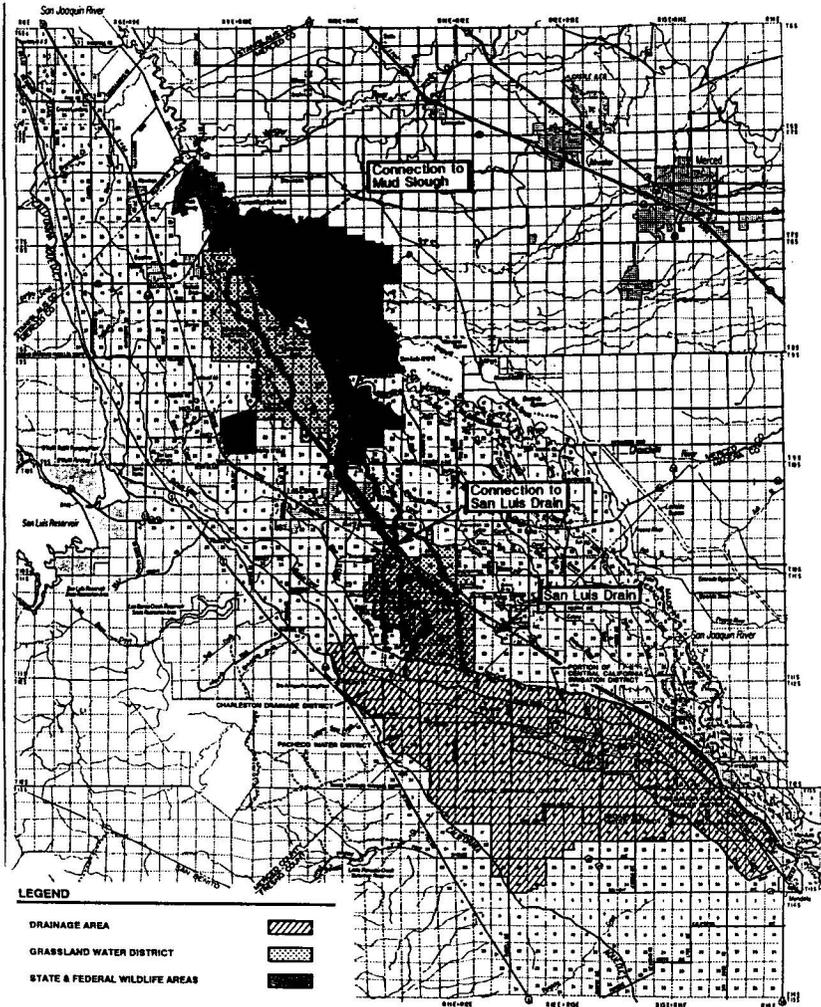
One of the most significant conservation efforts has been the separation of the

subsurface tile water which is high in selenium, salts and other constituents of concern and the surface tail water. The surface tail water is being reused on-farm and not discharged. Conservation practices on farm have included better irrigation management through irrigation scheduling, more efficient application of water such as through shorter water runs and purchase of more efficient application systems i.e. sprinkler irrigation equipment and gated pipe. In addition, there is continuing efforts to recycle drainage water into the water supply were it is possible and still maintain water of acceptable quality for application to irrigation crops. In order to maintain the salt balance on the lands, however, there must be disposal of the salts.

The Districts are also investigating methods to treat drainage water for reduction of elements of concern such as selenium. Efforts have included iron filing filters, ion exchange systems, co-generation facilities and bacteriological treatment. To date these projects have not proven feasible for on farm application. The Districts, however, continue to search for solutions. If the drainage water could be cleaned up it could become a beneficial use and valuable water source south of the Delta.

This proposed use of the San Luis Drain is one interim step that is necessary in order to manage the drainage problem along the westside. It is a vital step, however, to allow time so that a long term solution can be implemented.

Mr. Chairman, thank you for the opportunity to provide these comments.



LEGEND

- DRAINAGE AREA**
- GRASSLAND WATER DISTRICT**
- STATE & FEDERAL WILDLIFE AREAS**

LEGEND

- County Line
- Grain Boundary
- River
- Creek, Slough, Canal, Ditch (as noted)
- Drain
- Interstate Highway
- State Highway
- County High Road
- Major County Road or City Street
- Other Road
- Roadbed
- City, Town

LEGEND

- Water
- Normal Wildlife Refuge
- Wildlife Management Area
- Canal
- Slough
- Drain
- Ditch
- Grassland
- CC
- County
- Southern Pacific Railway
- Western Pacific and Southern Railway

Proposed Action :

- Channels that will no longer have unusable drain water.
- Channels with drain water.
- Conveyance of drain water in San Luis Drain.

BERNARDINI ENGINEERING, INC.
 CONSULTING ENGINEERS
 CALIFORNIA
 DECEMBER 1988

STATEMENT OF DEE E. SWEARINGEN

Mr. MILLER. Mr. Swearingen.

Mr. SWEARINGEN. Thank you, Mr. Chairman, members of the committee.

My name is Dee Swearingen, I am the executive director of San Joaquin Exchange Contractors Water Authority which is a joint powers authority representing the Central California Irrigation District, San Luis Canal Company, Firebaugh Water District, and the Columbia Water Canal District, what are referred to in most cases as the "four entities."

As a brief overview of where they lie, it is about 240,000 acres of prime agricultural land in Fresno, Merced, and Stanislaus counties. It lies between the cities of Mendota and Patterson between Interstate 5 and the San Joaquin River, with about 16,000 acres on the east side.

Our growers produce over 33 different crops from apples to zucchini. In deference to the Administration, we have also got broccoli and peas included in that.

The Exchange Contractors' water rights go back to pre-1914, back into the 1800s, when Henry Miller and others were developing the Miller and Lux cattle empire. When the Friant Division of the Central Valley Project was planned, it became clear that no extensive development could occur on the east side of the San Joaquin Valley, between Modesto and Bakersfield, unless water could be diverted from the San Joaquin River to be spread north and south.

The plan for constructing the Friant Project included the exchange of San Joaquin River water for Sacramento River water via the canal to be built spanning from the Sacramento Delta to the city of Mendota. Mendota is the location where the Exchange Contractors presently and previously diverted their water, hence the name the Delta-Mendota Canal.

The landowners of lands now comprising the four Exchange Contractors were asked by the United States Bureau of Reclamation to first quantify their water rights and then agree to exchange these waters. In 1939, the predecessors of existing landowners entered into an agreement with the Bureau to do so.

The exchange contract guarantees that the quality of water will meet specific quality standards, promises explicitly that if the water is not delivered from the Delta-Mendota Canal, we would return to delivery of the water.

When Miller and Lux sold the landholdings, Henry Miller made sure that all the deeds reserved the right for all land tracts to use the sloughs, canals, and waterways for irrigation and drainage. These tracts of land also currently make up the Exchange Contractors and Grassland Water District, thereby granting the Exchange Contractors the right to drain the water to the San Joaquin River. Of the 240,000 acres in the Exchange Contractors' service area, there are less than 30,000 areas that have some water quality problems.

Through conservation loan programs, tiered water pricing, monitoring, and education, the entities have been able to reduce the quantity and improve the quality of their drainwater.

The entities are also working on blending tile drainwater recovery systems, reuse, voluntary water transfers to meet the required standards. The drainage problem areas which occur in the Exchange Contractor's service area are primarily limited to the Central California Irrigation District and the Firebaugh Canal Water District.

We are exploring the possibility of new technologies that are designed to treat subsurface drainwater and remove the salts and other natural minerals. One of these technologies, known as the Santina process, looks very promising. We are working with the Bureau of Reclamation to bring a Santina plant on-line that could treat all of the tile drainwater that is causing problems in the four entities. We believe that the Bureau could in turn use this as part of their level for refuge water that they are needing.

We are also voluntarily executing a water conservation plan using the Bureau's guidelines which we believe will help in long-range planning.

In conclusion, the San Joaquin River Exchange Contractors are engaging in many technologies and practices which we believe will enable us to make successful long-term plans. It is important to remember, though, that the drainage we are dealing with is coming from naturally occurring minerals in the soil and not manmade chemicals.

I would gladly answer any questions, or if I can't, I will try to research them for you.

Mr. MILLER. Thank you.

[Prepared statement of Mr. Swearingen follows:]

SAN JOAQUIN RIVER EXCHANGE CONTRACTORS WATER AUTHORITY

Consisting of 240,000 acres on the Westside of the San Joaquin Valley

JAMES E. O'BANION
Chairman

JOHN B. BRITTON
Vice Chairman

DEE E. SWEARINGEN
Executive Director

NOWA C. TRIOLO
Administrative Assistant

JEFF BRYANT
Watermaster

**Central California
Irrigation District**

JAMES E. O'BANION
President

MIKE PORTER
General Manager

San Luis Canal Company

JACK THRELKELD
President

ROBERT E. CAPEHART
General Manager

**Firebaugh Canal
Water District**

JOHN B. BRITTON
President

STEVE CHEDESTER
General Manager

**Columbia Canal
Company**

DARRELL VINCENT
President

DAVID WOOLLEY
General Manager

P. O. Box 2115
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Testimony of Dee E. Swearingen
SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
COMMITTEE ON NATURAL RESOURCES
U.S. House of Representatives
Washington, D.C. 20515

Mr. Chairman and Members of the Committee:

My name is Dee E. Swearingen. I am the Executive Director of the San Joaquin River Exchange Contractors Water Authority with a Joint Powers Agreement representing Central California Irrigation District, San Luis Canal Company, Firebaugh Canal Water District, and Columbia Canal Company.

As a brief overview, the San Joaquin River Exchange Contractors Water Authority is comprised of approximately 240,000 acres of prime agricultural land in Fresno, Merced and Stanislaus counties from Mendota to Patterson, positioned between I-5 and the San Joaquin River, with approximately 16,000 acres of land east of the San Joaquin River. (See Exhibit 1, attached.) Our growers produce over 33 different crops, from apples to zucchini, from row crops to tree crops.

The Exchange Contractors' water rights are pre-1914 dating back to the 1800's when they were developed by Henry Miller as part of the Miller and Lux cattle empire. When the Friant division of the Central Valley Project was planned, it became clear that no extensive development could occur on the east side of the San Joaquin Valley, between Modesto and Bakersfield, unless water could be diverted from the San Joaquin River to the north and south.

The plan for constructing the Friant project included the exchange of San Joaquin River water for Sacramento River water via a canal to be built spanning from the Sacramento Delta to down to Mendota. Mendota is the location where the Exchange Contractors presently divert their San Joaquin River water; hence the name, "Delta-Mendota Canal."

The landowners of the lands that now comprise the four Exchange Contractors entities were asked by the United States Bureau of Reclamation to first quantify their water rights and then agree to an exchange of waters under specified conditions. In 1939 these entities, or their

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predecessors, entered into a contract with the Bureau of Reclamation for exchange of San Joaquin River water from the Delta-Mendota Canal.

The Exchange Contract guarantees that the quality of water will meet specific quality standards, promises explicitly that if water is not delivered from the Delta-Mendota Canal, we will return to delivery of water from the San Joaquin River.

When Miller and Lux's land holdings started to be broken up and sold, Henry Miller made sure that all of the deeds reserved the right for all land tracts to use the sloughs, canals and water ways for irrigation and drainage. These tracts of land make up the current lands of the Exchange Contractors and Grassland Water District, thereby granting the Exchange Contractors the right to drain to the San Joaquin River. Of the 240,000 acres in the Exchange Contractors' service area, less than 30,000 acres have water quality problems with sub-surface drainage.

Through water conservation loan programs, tiered water pricing, monitoring and education, the entities have been able to reduce the quantity and improve the quality of their drain water.

The entities are working on blending tile water recovery, re-use, and voluntary water transfers to meet the required standards. The drainage problem areas which occur in the Exchange Contractors' service area are within the boundaries of two of our entities: Central California Irrigation District and Firebaugh Canal Water District. Those two entities have approximately 30,000 drainage impacted acres.

We are exploring the possibility of new technologies that are designed to treat sub-surface drain water and remove the salts and other natural minerals. One of these technologies, known as the Santina process, looks very promising. We are working with the Bureau of Reclamation to bring a Santina plant on line that could treat all of the tile drain water and make it usable as Level IV refuge water.

We are also in the process of voluntarily executing a Water Conservation Plan using the Bureau of Reclamation's Guidelines, which we believe will help in long range planning.

SUBCOMMITTEE ON OVERSIGHT AND INVESTIGATIONS
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In conclusion, the San Joaquin River Exchange Contractors are engaging in many technologies and practices which we believe will enable us to make successful long-term plans. It is important to remember that when it comes to drainage, we are dealing with naturally occurring minerals in the soil, not man-made chemicals.

I will gladly answer any questions you may have; if I do not have the answer, I would be pleased to provide it to you as soon as I can research it.

Thank you.

Mr. MILLER. Ms. Congdon, let me take you to page 9 of your statement where I think it may get to, as you say, the crux of the problem. And that is if we were to go forward with the agreement as it is currently structured, who do we have an agreement with?

Ms. CONGDON. Mr. Chairman, that is not exactly clear. I think that you may have an agreement that works perfectly. There is a use agreement with Grassland which references drainage service agreements that Grassland intends to execute with some or all of the drainers who put drainage in the Drain.

There is a FONSI with environmental commitments by reference. The environmental commitments refer primarily to actions that need to be taken by the drainers subject to mandates that need to be established by the regional board.

If all of those things go as planned, you probably got exactly what you asked for. The question is, Will it go as planned? And I think that our concern and the concern that is reflected in our comments is that the Bureau of Reclamation is essentially signing a contract to allow another party or a number of parties to use the Drain without knowing exactly how it will turn out or what will happen in the future.

For example, the Bureau of Reclamation does not necessarily have influence or control, as the representative from Interior stated earlier, over the setting or enforcement of water quality standards or setting or enforcement of drainage reduction objectives.

Mr. MILLER. Let me ask you—

Ms. CONGDON. Second, which I think is the rest of your question, primarily addresses even if the Bureau knew the answer to those questions, it is very difficult to predict how the relationships will work out between the discharging entities themselves.

If past experience is an indication, not all of the contributing drainers may hang together if in fact that problem does arise with the use of the Drain. And if that is the case, or if only some of the drainers sign on to the contract, then it is not clear that all of the drainage will be in the Drain, which is one of the primary objectives for this project.

Mr. MILLER. Mr. Marciochi, let me ask you a question. You now take this drainwater because you signed a contract to take it; is that correct?

Mr. MARCIOCHI. That is correct. Those contracts were signed beginning in the late 1950s through the early 1970s?

Mr. MILLER. And they terminate when?

Mr. MARCIOCHI. The contracts that we have in place now terminate within the next couple of years, I believe. There have been amendments to those contracts which have been entered into based on the use of the Drain project. And those contracts would be in place for the life of this project, the five-year life of this project.

Mr. MILLER. What do those contracts say, the amendments?

Mr. MARCIOCHI. Basically that the district will continue to accept drainwater through the south end of the district. It provides for a fee paid to the district. And again they are tied to the use of the Drain itself—without being able to recall all the provisions, that is my recollection, but it is tied to the use of the Drain.

Mr. MILLER. So if this project is approved, you are going to extend those contracts?

Mr. MARCIOCHI. Essentially, that is what that does.

Mr. MILLER. And if the project is not approved?

Mr. MARCIOCHI. Those contracts again will terminate within the next couple of years based on water service contracts that have been in place.

Mr. MILLER. What would the drainers do then?

Mr. MARCIOCHI. That is a good question. I assume that they would attempt to continue the extension of the contract. There really aren't many options out there other than the management of the salinity that is in place right now.

Mr. MILLER. If you can get fresh water for the north Grasslands; right?

Mr. MARCIOCHI. That is correct.

Mr. MILLER. If you can get fresh water—apparently getting that is why you wanted to move some of this off-site—if you can get fresh water for the north Grasslands, why would you take basically contaminated water and continue to deal with it?

Mr. MARCIOCHI. I am not saying that those contracts would be extended beyond that period of time unless there were some provisions for meeting the water quality standards and unless there was—

Mr. MILLER. Coming on to your lands.

Mr. MARCIOCHI. Coming on to our land or meeting the water quality standards as a part of the Drain project.

Mr. MILLER. So you probably want the same kind of agreements that I would like to have when it comes on to our land in the San Joaquin River, so to speak?

Mr. MARCIOCHI. Yes.

Mr. MILLER. Well my constituents always ask me why don't I run the government like a business. Because if I was a private landowner that is what I would want. I would want assurances that I am not inheriting somebody else's headache.

Mr. MARCIOCHI. Exactly.

Mr. MILLER. Well, all we have now is a contract between you and the Bureau to move the headache north.

Mr. MARCIOCHI. Well, again, there are standards that have to be met in the river.

Mr. MILLER. But this contract doesn't deal with them. You simply become a common carrier at this point. You basically are taking everybody's drainwater and moving it through for a fee and that takes care of the overhead. That is a good business arrangement.

Mr. MARCIOCHI. It has also an impact. It doesn't pay in the long run, because we are being impacted by the movement of that drainwater through our system.

Mr. MILLER. That is why you want out.

Mr. MARCIOCHI. That is why the—

Mr. MILLER. There is nothing wrong with all those motives. I am trying to get them straight and find out where they are coming from.

Mr. MARCIOCHI. That has why the Drain project is an important project for us.

Mr. MILLER. Then our San Joaquin River is just picking up the slack as it has been doing for 30 years.

Mr. MARCIOCHI. Mr. Chairman, may I?

Mr. MILLER. Yes.

Mr. MARCIOCHI. In expounding a bit on those drainage contracts, we have had cause to research some of the drainage rights, some of the historic rights that exist in that area with regard to drainage, and it is our impression, at least at this time, that even if those contracts were not in place, we would have a difficult time based on rights that have been developed over the course of time in stopping drainage water from coming into our channels.

Mr. MILLER. Well, that is what court cases are made of; right? You guys are the best in the world at suing one another. But in one instance, it could be argued that maybe what we, quote, the Federal Government, should do is nothing and let you people sort out the circumstances here. It seems to me we are providing a piecemeal basis to deal with this problem, but nobody is telling us that they are willing to commit to the solution. We can't get an agreement. Apparently to date we have not been able to get an agreement with the drainers about how they will or will not meet that standard that everybody says is in effect at the head of Mud Slough.

They all agree it is there, but the State Water Quality Board and others have created some legal room so nobody is interested in committing themselves to this because why should we commit ourselves to taking this water in an isolated facility north? Why should we do that?

Mr. MARCIOCHI. It offers the management capability that is needed.

Mr. MILLER. It offers you management capability. It doesn't offer me any management capabilities.

Mr. MARCIOCHI. But at the same time, it offers that management capability not only for Grassland but for the Federal and State refuges as well, and the mandate that came along with the CVPIA and all the good that has been done with that putting water out on Federal, State and private wetlands is not possible as long as you got drainwater coursing throughout the system.

Mr. MILLER. I can't get drainwater on to the refuges because it can't meet 2 parts per billion so, therefore, I have to take 57-parts-per-billion water and worry tomorrow about what to do with it.

Mr. MARCIOCHI. In Mud Slough. At the same time, remember that there are standards on the San Joaquin River.

Mr. MILLER. I got your mantra here, okay. I understand there are standards. It is just that nobody has agreed to meet them as of yet, because you are not responsible for that because you are only conveying the water. Your contract says you are not responsible for that.

Mr. MARCIOCHI. Exactly.

Mr. MILLER. Well, I don't know what else there is to say except this sounds like a horrible deal. And I just don't know why the Federal Government would enter into this.

At this time, I appreciate the pressure on the refuges and I appreciate all of the people who have contacted me about this, but I just don't understand why we would get involved in this one at this point when we are not getting assurance from anyone up front where this is going to lead us. And we have a real weak link here

in the regulatory process with the Water Quality Control Board not providing any direction.

Where are the assurances for the public interest here? I mean, we are going to move some cleaner water on the refuge which is certainly in the public interest, but we are going to screw up Mud Slough and maybe or maybe not the San Joaquin River, and we don't know the timetable in which that will or will not occur. Sometime over, perhaps, the next ten years.

What happens to you if the Congress changes its mind this next year on clean water and decides it is going to regulate these. There is probably a fair chance that could happen. What is your situation then?

Are you a discharger in these areas? Do you take these waters on to your land? You currently are putting them into Salt Slough under the current scheme, not under the proposed scheme but under the current one?

Mr. MARCIOCHI. Exactly.

Mr. MILLER. What is your obligation?

Mr. MARCIOCHI. As far as the water that we are currently receiving from the drainers?

Mr. MILLER. Eventually, you discharge into Mud Slough and Salt Slough.

Mr. MARCIOCHI. That water originating from the draining entity you are referring to?

Mr. MILLER. Who is the discharger at that point?

Mr. MARCIOCHI. They are. They are. We don't take title to the water. The contracts reference that.

Mr. MILLER. No joint and several liability there?

Mr. MARCIOCHI. No.

Mr. MILLER. You guys are good. I don't want to pretend that I agree with that announcement because I don't know how contractually you can avoid your obligations, whatever they might be, under the Clean Water Act. You have every right to attempt to do that. I don't know if it holds up.

Well, I asked both the members of the first panel to be available to answer questions that the rest of the other witnesses have raised. I think clearly this committee has to look at the proposed use of the Drain. I just don't think that the equities are fair in this one in terms of public resources versus the continued underwriting of this proposal. We have all these other tools that everybody says they are willing to use but they don't. Instead, the facilities are being used in the best interest of the drainers, and we have some very hot lands in the middle of the drainers. I don't know why we would provide a mechanism for that to continue when we have an opportunity to try to bring people in the room. Apparently these negotiations were going forth at one time.

Isn't that right, Chelsea; weren't there?

Ms. CONGDON. Negotiations for the use of Drain.

Mr. MILLER. And the conditions under which this could be used from the drainers?

Ms. CONGDON. Maybe, Terry, you should elaborate because you were involved in those negotiations.

Ms. YOUNG. We were involved for a long period. There were sets of meetings that you might loosely characterize as negotiations.

Mr. MILLER. Why did they stop?

Ms. YOUNG. They stopped when the FONSI came out. Shortly after the FONSI came out, we got a new director for the Bureau of Reclamation who stated his intention to try to go ahead with a use agreement that is similar to the one that is sitting before you, although at that time, the Bureau was contracting directly with the drainers which seems to us to be an improvement. Short answer to the question is the process stalled out.

Mr. MILLER. If I might, Mr. McGahan, am I correct when I characterize this? What you are trying to design here is an isolated facility from Grassland so they can meet these requirements of being able to put fresh water on to the refuge; is that correct?

Mr. MCGAHAN. That is correct, but I think one characterization that needs to be emphasized is that, without this project, this drainage water goes to the San Joaquin River. And what happens is it probably stays in Mud Slough and Salt Slough, notwithstanding the legal problems with the contracts and keeping it going, and if the standard is 5 parts per billion in Mud Slough and Salt Slough then we do our best job to meet 5 parts per billion in Mud Slough and Salt Slough.

With this project, we do not meet and we cannot meet a 5 parts per billion in Mud Slough, but we have said all along there had to be a delay in the implementation in this five-year period. But we can meet deliverable water quality standards of 2 parts per billion in Salt Slough and the other channels, and we think that is a benefit of the project.

I failed to answer one of your earlier questions as to what the drainers are doing and what they have done. Since 1986 and 1988, the reduction in selenium load that has gone to the river has been reduced approximately 50 percent. Now, this is due partly to the drought and the reduced water supplies that are going to the federal areas, but it is also due to conservation practices. And the reduced water supplies are probably a way of life. We will never go back to the 1986-1988 levels of federal water supply. They have developed some groundwater wells and are using some of those sources which are a part of the drainage program to utilize groundwater to help, and the thinking is that will help the drainage problem.

So there have been reductions. Granted, if water supplies come back more than they are, there probably will be an increase in load of selenium but the conservation practices would also keep it down. And the commitment is, and I think the facts show, that the discharge of drainage is less now than it was before or would be before the project.

Mr. MILLER. But, still, I don't have a guarantee there. I don't have assurances that that will be reflected in the future. I mean, as you say, if you get increased water supplies the load may increase, but conservation may hold it down. We don't even have any assurances of what those relationships will or will not be.

Mr. MCGAHAN. Mr. Chairman, we talk about assurances. I think if you look at waste discharge requirements that point source dischargers have, they have limits; they have standards they have to make; they have limits on how much they can discharge. But as far as assurances, you do not have assurances there either. You

have the authority and the regional board will have the authority in this case to terminate discharge, but there are no assurances on the other kinds of discharges either, as I see it.

Mr. MILLER. Well, correct me if I am wrong, but as I look at the engineering plans at a number of the facilities that ring San Francisco Bay, they are designed with the intent of meeting those standards.

Mr. MCGAHAN. That is correct.

Mr. MILLER. And if they do not, they can have a cease and desist, whatever, down the road. We do not yet even have the design of the system to meet those standards.

Mr. MCGAHAN. Mr. Chairman, I think we do, and let me clarify that. We are shooting at a moving target. Prior to EPA's rejection of the State board basin plan amendment, the standard for selenium was 5 parts per billion into the river but was relaxed to 8 parts per billion in the critical years; and also was a 10 parts per billion standard in Mud Slough and Salt Slough. EPA rejected those standards and now it is 5 parts per billion in the river at all times, including critical years, and it is 5 parts per billion in Mud Slough and Salt Slough.

At some point in time it would be nice to know what the rules of the game are so that we can shoot for them. I think our plan and the reductions that can be done on-farm are enough to meet the 5 parts per billion standard in the San Joaquin River. The one exception is during the interim five years of the project, we cannot meet the standard in Mud Slough. However, it can be met in the other 70-some miles within Grasslands, including Salt Slough, which is a source of water for the federal refuge.

Mr. MILLER. Having said that, all I need is an agreement with the drainers that it will happen, and to date, I don't have it. That is not your problem because you are not here to speak for the drainers, but the fact is we do not have that part of the—

Mr. MCGAHAN. Respectfully, we have it in the mitigation measures in the FONSI. You have to realize the drainers are going into this project that will cost over a million dollars to make the connections to the project. They are going into it with the possibility that after two years, if they do not form a regional drainage entity which is what is desired here to manage it locally, if they do not meet water quality standards in the river, not in Mud Slough, if they do not conform to some drainage reduction milestones, then it will be shut off after two years.

That is a very serious threat that the drainers have going into it. They can spend all this money now, and in two years it will be wasted.

Mr. MILLER. Well, my experience has told me not to get yourself in that position with this group of people. I would rather have it up front. I would rather have it up front than go two years from now and go through that political hassle.

Mr. MCGAHAN. The process is up front. It is part of what is being done.

Mr. MILLER. I don't have any of the responsible parties signed on to that.

Mr. MCGAHAN. You will have the Grassland Water District and you will have the subagreements with the drainers, which Mr.

Marciochi has said have to be in place to do the project. So you will have a sign-on.

Mr. MILLER. Well, that remains to be seen, but so far we do not have that.

Let me thank you very much for your testimony. I have some additional materials presented by EDF that we will make part of the record of this hearing, and thank you very much for your help and your assistance in this hearing.

[Whereupon, at 12:50 p.m., the subcommittee was adjourned.]

APPENDIX

OCTOBER 26, 1993

ADDITIONAL MATERIAL SUBMITTED FOR THE HEARING RECORD

SUBMITTED BY DAN NELSON

PANOCHÉ DRAINAGE DISTRICT

BOARD OF DIRECTORS

MIKE LINNEMAN
PRESIDENT

EDWARD KODA
VICE-PRESIDENT
F.E. REDFERN

JOHN E. WILLIAMS
MICHAEL STEARNS

52027 WEST ALTHEA • FIREBAUGH, CA 93822
TELEPHONE (209) 364-6136
FAX (209) 364-6122

PANOCHÉ DRAINAGE DISTRICT



Drain Discharge
Chronology of Events

- Pre 1985 Subsurface drainage and surface tailwater was discharged from Panoche Drainage District to the Grasslands and used by the wetlands areas.
- 1985 Selenium was discovered at Kesterson Reservoir and it was also determined that selenium was present in the discharge from Panoche Drainage District. Selenium levels from Panoche Drainage District were determined by the U.S. Fish and Wildlife Service to be harmful to wildlife.
- 1985 The Bureau of Reclamation closed Kesterson Reservoir and stopped discharge of drainage waters from Westlands Water District. Although this did not directly impact Panoche Drainage District, it had significant side effects.
- 1985 Panoche Drainage District, Grassland Water District, and other districts banded together to construct an interim facility to discharge drainage water through the Grasslands. The permit for this facility has since expired.
- 1988 The Regional Water Quality Control Board adopted water quality standards in Mud and Salt Sloughs and the San Joaquin River which severely restricted the ability to discharge drainage waters from Panoche Drainage District and other drainage areas.
- 1989-92 Because of water conservation practices by some landowners within the District and the severe drought, the amount of selenium in the drainage water and the quantity of drainage water has significantly reduced.
- 1989-93 Panoche Drainage District and other districts have sought out a alternative method of discharge to the Grasslands utilizing a portion of the San Luis Drain. It appears that this project will be operational in the fall of 1993. This use of the San Luis Drain, however, is still governed by the water quality objectives which requires a

significant reduction in drainage flows from Panoche Drainage District. This project and related obligations will be at a cost of approximately \$10/acre.

Attached is a graph that shows the reduction in loading of selenium in the drainage water from 1985 to present. This reduction in drainage water must continue and actually must be increased to meet water quality objectives.

It is imperative that continued water conservation practices be in place to meet this reduced discharge in order for any discharge to continue and maintain a salt balance in the lands within the District.

11/19/91

Use of San Luis Drain
Estimate of Cost

	<u>Capital Cost</u>	<u>Annual Cost</u>
1. Connection at S. End	\$110,000.	45,000. ^{1/}
2. Discharge Structure at N. End	450,000.	117,000. ^{1/}
3. Repair to San Luis Drain	100,000.	22,000. ^{1/}
4. New Channel in Dept of Fish & Game China Island Unit	50,000.	12,000. ^{2/}
5. Monitoring Program		150,000.
6. Newman Gun Club Pumping		8,000.
7. Contingencies		100,000.
	<hr/> \$710,000.	<hr/> \$454,000.

^{1/} 5 years at 4% plus maintenance

^{2/} 5 years at 8%

300,000

Fundamental Aspects of Selenium Removal by Harza Process



Prepared for the
**SAN JOAQUIN VALLEY
DRAINAGE PROGRAM**

Under contract with the
U.S. BUREAU OF RECLAMATION

DRAFT

HES HARZA
ENVIRONMENTAL SERVICES, INC.

in Association with
**Dr. Marc A. Anderson and
University of Wisconsin, Madison**

March 1989

Executive Summary

In 1986 Harza Engineering Company received a U.S. patent for a process that removes toxic heavy metals from wastewaters. That year this process was applied in a pilot plant study to the drainage water of the Panoche Drainage District and the results were promising, with over 90% removal of selenium.

This study was undertaken to determine the mechanism by which selenium is removed and the specie formed on the iron surface to effect this removal. The process involves passing the wastewater through an activated bed of iron filings at a controlled rate.

The investigators believe, to the best of their ability to determine, that selenium is removed by chemical adsorption on iron oxyhydroxide surfaces at an orange-brown layer of iron filings where the drainage water enters the column. Prior to the formation of the oxyhydroxide layer, selenium can be removed throughout the iron filing bed by physical adsorption.

Several analytical techniques to determine the surface specie on the iron filings were unsuccessful. These techniques included Diffuse Reflectance - and Cylindrical Internal Reflectance - Fourier Transform Infrared spectroscopy and Raman spectroscopy.

EXHIBIT E - LOAN REPAYMENT SCHEDULE
AGRICULTURAL DRAINAGE WATER MANAGEMENT LOAN PROGRAM
PANOCHÉ DRAINAGE DISTRICT - IRON FILINGS PROJECT
STATE WATER RESOURCES CONTROL BOARD - CONTRACT NO. 6-811-550-0

Date: 10/03/91

Effective date of loan contract: 06/15/87
 Date of first disbursement: 05/17/89
 Date of first loan repayment: 10/31/91
 Interest rate: 3.438%

Subject to revision

NO/DY/YR	(1) BALANCE OWED AFTER LAST PAYMENT	(2) INTEREST DURING PERIOD	(3) CURRENT BALANCE (1) + (2)	(4) <DISBURSEMENT> REPAYMENT	(5) APPLIED TO INTEREST	(6) APPLIED TO PRINCIPAL	(7) PRINCIPAL BALANCE AFTER PAYMENT
05/17/1989				< \$100,000.00 >			\$100,000.00
05/17/1990	\$100,000.00	\$3,438.00	\$103,438.00				\$100,000.00
05/17/1991	\$103,438.00	\$3,556.20	\$106,994.20				\$100,000.00
08/16/1991	\$106,994.20	\$917.10	\$107,911.30	\$5,664.86		\$5,664.86	\$94,338.14
10/31/1991	\$102,246.44	\$731.84	\$102,978.28	\$8,803.47	\$8,643.24	\$160.23	\$84,174.91
10/31/1992	\$94,174.91	\$3,246.60	\$97,421.51	\$8,803.47	\$3,246.60	\$5,556.87	\$88,618.04
10/31/1993	\$88,618.04	\$3,046.69	\$91,664.73	\$8,803.47	\$3,046.69	\$5,756.78	\$82,861.26
10/31/1994	\$82,861.26	\$2,846.77	\$85,710.03	\$8,803.47	\$2,846.77	\$5,956.70	\$76,906.56
10/31/1995	\$76,906.56	\$2,644.05	\$79,550.61	\$8,803.47	\$2,644.05	\$6,159.42	\$70,747.14
10/31/1996	\$70,747.14	\$2,438.93	\$73,186.09	\$8,803.47	\$2,438.93	\$6,364.52	\$64,382.62
10/31/1997	\$64,382.62	\$2,233.47	\$66,596.09	\$8,803.47	\$2,233.47	\$6,590.00	\$57,782.62
10/31/1998	\$57,782.62	\$1,986.91	\$59,779.53	\$8,803.47	\$1,986.91	\$6,816.56	\$50,976.06
10/31/1999	\$50,976.06	\$1,752.56	\$52,728.62	\$8,803.47	\$1,752.56	\$7,050.91	\$43,925.15
10/31/2000	\$43,925.15	\$1,510.15	\$45,435.30	\$8,803.47	\$1,510.15	\$7,293.32	\$36,631.83
10/31/2001	\$36,631.83	\$1,259.40	\$37,891.23	\$8,803.47	\$1,259.40	\$7,544.07	\$29,097.76
10/31/2002	\$29,097.76	\$1,000.04	\$30,097.80	\$8,803.47	\$1,000.04	\$7,803.43	\$21,284.33
10/31/2003	\$21,284.33	\$731.76	\$22,016.09	\$8,803.47	\$731.76	\$8,071.71	\$13,212.62
10/31/2004	\$13,212.62	\$454.23	\$13,666.87	\$8,803.47	\$454.23	\$8,349.22	\$4,862.40
05/17/2005	\$4,862.40	\$90.70	\$4,954.10	\$4,954.10	\$90.70	\$4,863.40	\$0.00
		\$33,867.56		\$133,867.34	\$33,867.54	\$100,000.00	

Panoche Water and Drainage District
52027 W. Althea Ave.
Firebaugh, CA 93622

Waste Water Management Int'l Inc.
124 W. Robinson
Fresno, CA 93705

AND

R. J. Anderson
2479 W. San Ramon
Fresno, CA 93711

July 29, 1991,

Dear Sirs:

Following our conversations over the past 30 days, and our perusal of the materials and information provided to us by Panoche Water and Drainage District, we are providing this letter and the enclosed system description and a quotation for the equipment that we feel will best address the Selenium problem being encountered by you.

OBSERVATIONS:

As we understand it, there are multiple wells feeding the distribution piping and the sample identified as DP 25 is the expected average water quality to be addressed by the selected system. The results shown as DP 35 are the worst conditions encountered from the multiple wells. The total volume of water to treated through the treatment process is 210 USGPM.

PROPOSAL:

We have chosen an MMRV System to address your problem. The MMRV system has the advantage of a dual filtration system and high flow rates, and effects a reduction of Selenium in water by 96%.

RATIONALE:

There are clear **advantages** to selecting the duplex, continuous operation MMRV set for the treatment of **Selenium** and other metals under these circumstances. The **HIGH FLOW RATES** attainable per square foot surface area through the MMRV media vessels coupled with the exceedingly **LOW BACK-WASH REQUIREMENTS** help to **reduce concerns** with both required down-time to purge the vessels of the captured **Selenium** and other metals as well as the volume of waste water that must be addressed. Further, the MMRV systems will not foul, or show reduced efficiency, in the presence of even high levels of iron bacteria.

Having two filter vessels in each set operating in parallel, allows tremendous **system flexibility** as you may only require one filter operating at reduced system flow rates during low water use periods thereby realizing **savings in pump wear and energy**. In case of a single filter failure, the system would still be able to supply treated water, at the slightly reduced rate, until any system problems could be corrected.

The following pages describe the MMRV system that we feel would be best suited for this operation. The **guarantee** on the system requires a current water analysis to confirm the system sizing which was based on a 5 year average of water analyses provided us by Panoche Water and Drainage.

ABSTRACT OF THE MMRV FILTER SYSTEM

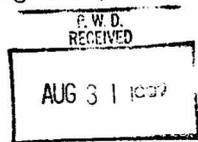
A water purification method for removing unwanted contaminants, such as metals, Hydrogen Sulfide gas, turbidity, color and odor is provided. The process comprises first injecting a jet of pressurized air into a stream of water to obtain an air/water mixture. The air/water mixture is then introduced into a reaction vessel in which the water is supersaturated with air under pressure to effect oxidation of contaminants, such as iron, manganese and organic material and to remove dissolved Hydrogen Sulfide gas. A predetermined volume of air is maintained above the air/water mixture in the reactor under pressure which is above atmospheric pressure. Excess air is removed from the reaction vessel by means of a de-gassing valve in the upper part of the vessel. The method also includes passing the air/water mixture through REZTEC filter media to effect further oxidation and to filter the water. Apparatus for carrying out the method includes a reactor vessel which has proprietary and rigidly controlled hydraulic system effect the rotation of the air/water mixture when introduced into the vessel and to maintain a uniform dispersion of small air bubbles throughout the water in the reaction vessel of facilitate oxidation and removal of contaminants.

KREBS & SISLER L.P.
 BUSINESS DEVELOPMENT CONSULTANTS
 PROJECT MANAGERS

Telephone 312 : 236 • 9724
 11 South LaSalle Street
 Chicago, Illinois 60603

August 25, 1992

Marcos B. Hedrick
 District Plant Technician
 Panoche Water and Drainage District
 52027 W. Althea Avenue
 Firebaugh, California 93622



Dear Marcos:

Thank you for shipping the water samples and also thanks for the enclosed analysis and background information on the irrigation and drainage water situation in the San Joaquin Valley and elsewhere in California. As discussed with you several times since March, the difficult but necessary tests have not been completed. I am hopeful of results before long.

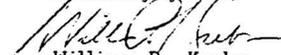
Enclosed is a write-up on the "Homestake Process", the biological cyanide degradation wastewater treatment process which we believe can be economically used and adapted to the task of extracting a very high percentage of selenium (Se) of various species from California irrigation drainage water, along with some reduction of total dissolved solids.

Last October, our firm acquired the exclusive license to commercialize the "Homestake Process" which was developed at the Homestake Mine, Lead, South Dakota. The two patents covered by our license are owned by the South Dakota School of Mines and Technology. We have done much research on waste treatment applications for the "Homestake Process" and its unique mutant bacterial strain known as pseudomonas paucimobilis mudlock. Mudlock has a powerful appetite for cyanide and consequently opens up opportunities for environmental clean-up by beneficially utilizing this otherwise toxic compound. We hope that the "Homestake Process" will solve your selenium problem.

Krebs & Sisler is a business development consulting firm established in 1972. We have nine Partners. Since 1978, we have worked out a number of large-scale systems for removing heavy metals from solid and liquid wastes, based on our own research to improve waste treatment methods. Several of these systems are ready for full-scale demonstration when funds become available.

I am sorry for the delay on testing. I will keep you posted.

Sincerely yours,


 William P. Krebs
 General Partner

WPK/hfs
 Enclosures

E. Jay Mayhew

Geological Engineer

600 S. Youngfield Ct., Lakewood, CO 80228
(303) 986-8930 (303) 985-1078Mr. Marcus Hedrick
Panoche Water District
52027 West Althed
Firebausen, California 93622

February 7, 1992

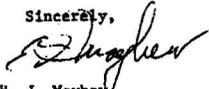
Dear Mr. Hedrick:

Upon receipt of our Keep Secret Agreement we will confer with you and if your Board of Directors agree, will then set a date and meet with you, bringing sufficient equipment loaded with activated zeolite.

We will set up the equipment and you will take your own sample of water, pass it through our column, catch your own sample and have your assay at a place of your chouce. If the results are satisfactory to you we will then run a larger, pilot scale test, using the equipment you already have on site, that is, the resin charged pilot test equipment you are now using. In that event, we will bring with us sufficient activated zeolite to charge the resin cylinder you have and repeat the process on a larger scale at a time agreed upon.

If you have any questions please call me or Mr. Burwell at any time.

Sincerely,



E. J. Mayhew

PANOCHÉ DRAINAGE DISTRICT

BOARD OF DIRECTORS

MIKE LINNEMAN
PRESIDENT

EDWARD KODA
VICE-PRESIDENT

F.E. REDFERN

JOHN E. WILLIAMS

MICHAEL STEARNS

52027 WEST ALTHEA • FIREBAUGH, CA 95822

TELEPHONE (209) 364-6136

FAX (209) 364-6122



July 27, 1993

U.S. BUREAU OF RECLAMATION
Attention: MP-822 Challenge Grant Proposals
2800 Cottage Way
Sacramento, CA 95825

Challenge Grant Application

In response to your letter of May 17, 1993, Panoche Drainage District is pleased to submit the attached Challenge Grant Application to the U.S. Bureau of Reclamation for Water Conservation and Drainage Management Projects.

Our proposal addresses the problem of the presence of selenium in drainage water. A process being developed by Boyle Engineering Corporation has promise to assist us in solving this problem. Boyle has done considerable work on treatment processes designed to eliminate selenium from wastewater. They have also worked closely with other experts in this field at UC Riverside, UC Irvine, and the University of Houston to develop and improve the ion exchange process for selenium and nitrate removal.

Our current goal is to remove sixty percent of the selenium from our drainage system. The process proposed has an excellent chance of success by concentrating the selenium into a small waste volume by a special ion exchange process and then to eliminate the selenium from the concentrated volume by biodegradation to a non-toxic material.

The demonstration of a cost effective method for treatment of agricultural drainage by the proposed process has multiple benefits:

1. Lowering of selenium in our drain water will allow us more drainage into the San Joaquin River without violating selenium water quality objectives.
2. Agriculture in other drainage areas where evaporation ponds are used for disposal can also benefit because the proposed process concentrates the selenium contamination into a treatable brine for selenium removal. This will lower the size requirements of evaporation ponds and place more land to other uses.
3. Reclamation of wastewater for other beneficial uses is a potential major benefit. The proposed process will function as a pretreatment for demineralization which can produce water for wildlife, agriculture (including agroforestry), and other municipal and industrial uses.

The proposed effort will demonstrate by field pilot tests and some laboratory experiments that the critical key components of the process will work sufficiently well to proceed to a complete pilot plant. Multiple full scale plants will then follow in a later phase.

The cost of the initial phase as we propose will be approximately \$195,000.00. Approximately 50% of the cost will be shared by Panoche Drainage District and Boyle Engineering Corporation in direct dollar expenditures as well as in-kind services. We are requesting \$96,270.00 from the U.S. Bureau of Reclamation in this grant application.

In your referenced letter you asked for a clearer definition of the following issues:

- a. The accumulation of hazardous waste.
- b. Integration with agroforestry.

We have reviewed our proposal in light of the above issues and made alterations in the work statement accordingly. It should be realized that the work done under this grant will generate only laboratory size quantities of waste brines which will be disposed using usual laboratory procedures for such disposals. The proposed project work statement has been revised to include studies to determine the quantities and amount of hazardous waste produced by the process. It is one objective of the proposed process to convert selenium waste in the waste brines to non-hazardous forms of selenium by the biomethylation process. This issue will be better understood and more clearly defined after completion of the needed laboratory studies which are proposed.

The work statement has also been expanded to investigate the agroforestry water quality needs to determine if any produced process streams from this proposed process will be compatible with the water and nutrient needs of tree growth.

We will be pleased to discuss this project with you. If you have any technical questions concerning the process, please feel free to contact Boyle Engineering Corporation (Dr. Gerald A. Guter) at (805)325-7253. If you have any questions concerning the administration aspects of our proposal, please contact me.

Sincerely,
PANOCHÉ DRAINAGE DISTRICT



DENNIS FALASCHI
General Manager

PANOCHÉ DRAINAGE DISTRICT

BOARD OF DIRECTORS

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JOHN E. WILLIAMS
MICHAEL STEARNS

52027 WEST ALTHEA • FIREBAUGH, CA 93822
TELEPHONE (209) 364-6136
FAX (209) 364-6122



July 28, 1993

Dr Sally Benson
Earth Sciences Division, 50E
Lawrence Berkeley Laboratory
Berkeley, CA 94720

Dear Dr Benson:

The Panoche Drainage District is very happy to cooperate with Lawrence Berkeley Laboratory and the University of California, Berkeley's Algal Research Laboratory on the algal-bacterial drainage treatment demonstration project that you have proposed. After your presentation to the Panoche Drainage District on Tuesday, June 15, 1993, we agreed to provide a field site, to provide earth-moving required for construction of the ponds, to help with monitoring of the system and with the collection of samples. During our tour of the proposed demonstration site of the drainage treatment site with the project team we identified a storage shed that could be used as a laboratory and a pumping plant that can be used to lift water from a drainage sump into the treatment plant. Subsurface drainage from a field of approximately 970 acres is discharged to the drainage sump. Access to the site is provided by a well maintained dirt and gravel road.

We wish the Lawrence Berkeley Laboratory Success in their competition for funds to undertake this project.

Sincerely,
Panoche Drainage District


Dennis Falaschi
General Manager

EXECUTIVE SUMMARY

It is not possible to determine from the available literature the extent of selenium removal that can be achieved in well-designed high-rate algal growth ponds alone. The amount can only be determined by in situ experiments with indigenous algae.

High-rate algal growth ponds are likely to contribute importantly in the treatment for other selenium removal systems by softening, clarifying and removing nutrients from drainage waters.

If used as treatment systems for drainage waters, high-rate algal ponds, in conjunction with in-pond methane fermentation, gas capture, and heat power generation will easily produce their own electrical energy needs and significant amounts of surplus electrical energy.

High-rate algal growth ponds, in conjunction with algal fermentation and acid gas scrubber systems, have a high probability of removing significant amounts of selenium from drainage waters. The amount can only be determined by in situ experiments with drainage water.

The cost of removing selenium, other toxic metals and nitrogen from drainage waters is highly dependent on system size. A small, one MGD unit is projected to cost about \$273.00 per million gallons (\$89.00 per acre foot) for interest and cost retirement, and \$416.00 per million gallons (\$136.00 per acre foot) for Operations and Maintenance, for a total approaching \$700.00 per million gallons of drainage water processed. Systems in the 100 MGD range may cost as little as \$140.00 per million gallons, (\$46.00 per acre foot) and produce as much as \$83.00 worth of surplus energy per million gallons.

A well-designed experimental program involving key laboratory and pilot plant experiments in situ is recommended. To carry out this program will require a research facility consisting of four 1-acre high-rate ponds supporting algae harvesting and fermentation systems and laboratory facilities. Such a facility is recommended for further study. Location of the new facility near or at the existing Los Banos Test Facility is recommended.

TOTAL PAMOUCHE DRAINAGE DISTRICT COSTS

YEAR	BASIN DRAINERS	STUDIES & ENG.	TASK FORCE	TASK FORCE	GRD DRAINAGE	LAB. REMOVAL	SELENIUM	LEGAL	GENERAL CONT.	LPA DUES	OFFSTR STOR	RECIR RES	TOTAL
			II	III	CONTRACT								
1985-86	0	17,438	68,367	0	10,350	27,991	32,634	6,740	35,398	11,008	0	0	209,926
1986-87	8,805	30,684	16,502	0	10,350	15,558	29,015	6,411	32,730	5,829	0	0	155,884
1987-88	4,885	15,000	33,133	4,300	17,601	16,790	4,900	5,000	34,015	12,040	22,434	0	170,106
1988-89	22,082	29,871	10,869	18,005	74,540	9,926	12,760	4,984	35,144	11,824	0	0	230,005
1989-90	50,644	9,671	5,610	9,426	211,500	12,526	66,476	4,505	38,706	7,767	0	0	416,831
1990-91	55,216	23,605	5,725	0	211,500	5,290	161,000	3,133	29,000	5,499	50,000	0	549,968
1991-92	18,146	21,143	5,198	0	211,500	8,957	26,987	7,372	1,608	3,190	0	70,187	374,288
1992-93	4,820	147	1,349	0	211,500	1,168	29,576	1,050	0	0	0	630	250,240
TOTALS	164,598	147,559	146,753	31,731	958,041	90,206	363,356	39,195	206,601	57,157	72,434	70,817	2,357,248

PAMOUCHE WATER DISTRICT'S SHARE OF TOTAL PAMOUCHE DRAINAGE DISTRICT COSTS

YEAR	BASIN DRAINERS	STUDIES & ENG.	TASK FORCE	TASK FORCE	GRD DRAINAGE	LAB. REMOVAL	SELENIUM	LEGAL	GENERAL CONT.	LPA DUES	OFFSTR STOR	RECIR RES	TOTAL
			II	III	CONTRACT								
1985-86	0	15,410	60,417	0	9,147	24,736	28,839	5,956	31,282	9,728	0	0	185,515
1986-87	7,781	27,116	14,583	0	9,147	13,749	25,641	5,666	28,924	5,151	0	0	137,758
1987-88	4,317	13,256	29,200	3,000	15,554	14,830	4,337	4,419	30,060	10,640	19,825	0	150,326
1988-89	19,514	26,398	9,605	15,911	65,873	8,772	11,276	4,404	31,057	10,449	0	0	203,259
1989-90	44,755	8,546	4,958	8,330	186,907	11,069	58,746	3,981	34,205	6,864	0	0	368,361
1990-91	40,796	20,860	5,059	0	186,907	4,675	142,279	2,769	25,628	4,860	44,186	0	486,019
1991-92	16,036	18,685	4,594	0	186,907	7,915	23,849	6,515	1,421	2,819	0	62,026	330,767
1992-93	4,260	130	1,192	0	186,907	1,032	26,137	928	0	0	0	557	221,143
TOTALS	145,459	130,401	129,688	28,041	847,349	86,786	321,104	34,630	182,577	50,511	64,811	62,583	2,083,148

PANOCHÉ DRAINAGE DISTRICT

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MICHAEL STEARNS

52027 WEST ALTHEA + FIREBAUGH, CA 95622

TELEPHONE (209) 394-8136

FAX (209) 364-6122



July 27, 1993

U.S. BUREAU OF RECLAMATION
 Attention: MP-822 Challenge Grant Proposals
 2800 Cottage Way
 Sacramento, CA 95825

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Sincerely,
PANOCHÉ DRAINAGE DISTRICT



DENNIS FALASCHI
General Manager

BROADVIEW WATER DISTRICT

October 22, 1993

Congressman George Miller
Chairman, Natural Resources Committee
1324 Longworth HOB
Washington, D.C. 20515

Dear Congressman Miller:

Many irrigation and drainage districts on the west side of the San Joaquin Valley have made significant progress in recent years in reducing the volume of drainage water entering the San Joaquin River. This letter and the enclosed articles describe some of the programs implemented at the Broadview Water District as well as some of the achievements during 1989 through 1992. We are continuing to encourage further reductions in drainage water at Broadview and we appreciate your review of these materials at this time.

Many farmers in the Broadview Water District have implemented innovative water management practices in recent years to reduce the volume of subsurface drain water generated in the district. In particular, farmers have reduced the length of furrow runs from 1/2-mile to 1/4-mile and even 1/8-mile on some fields. They have reduced irrigation set times from 48-hours to 12-hours and they have hired night irrigators to manage water carefully, even at night. Many farmers have replaced earthen ditch irrigation methods with aluminum pipe and sprinkler irrigation systems.

The Broadview Water District implemented an innovative tiered pricing program for irrigation water in 1989. This program, now in its fifth crop year, involves higher prices for water delivered in excess of well-defined crop specific limits. These increasing block-rate prices provide significant economic incentives for farmers to manage water carefully. Farm-level water management has improved dramatically in Broadview since 1989 and subsurface drain water volumes have been reduced by more than 50%.

Broadview Water District has worked closely with the California Water Resource Control Board to provide low-interest loans to farmers for the purchase of modern, water-saving irrigation technologies. In the past two years, Broadview farmers have purchased almost \$1.5 million worth of aluminum pipe and sprinkler irrigation systems. These water-conserving irrigation methods are rapidly becoming the standard in Broadview and drain water volumes are decreasing accordingly.

The volume of drain water collected in Broadview's subsurface drainage systems has declined from more than 4,000 acre-feet in 1986 to less than 1,000 acre-feet in 1992. At the same time, the loads of salt, boron, and selenium in Broadview's drainage water have declined by similar proportions. These volume and load reductions in Broadview are typical of drain water reductions achieved by many districts in the region in recent years.

P. O. BOX 95 • FIREBAUGH, CALIFORNIA 93622
(209) 659 - 2004 FAX (209) 659 - 3526

Congressman George Miller
Page 2
October 22, 1993

The volume of drainage water (surface and subsurface) released through Broadview's outlet has also declined substantially, dropping from over 14,000 acre-feet in 1986 to less than 1,000 acre-feet in 1992. Much of this reduction has been achieved through aggressive efforts by farmers and district staff to reduce and/or re-circulate surface runoff and subsurface drainage water. The re-use of drainage water will remain a key component of Broadview's drainage reduction program, provided that the district can maintain salt balance in the long term.

Much of the progress achieved in Broadview in recent years is described in several technical reports including the following:

Wichelns D. & Cone D. 1992. Tiered pricing motivates Californians to conserve water. *Journal of Soil and Water Conservation* 47:139-144.

Wichelns D. & Cone D. 1992. Farm-level and district efforts to improve water management during drought. *Irrigation and Drainage Systems* 6:189-199.

Wichelns D. 1991. Motivating reductions in drain water with block-rate prices for irrigation water. *Water Resources Bulletin*, 27(4): 582-592.

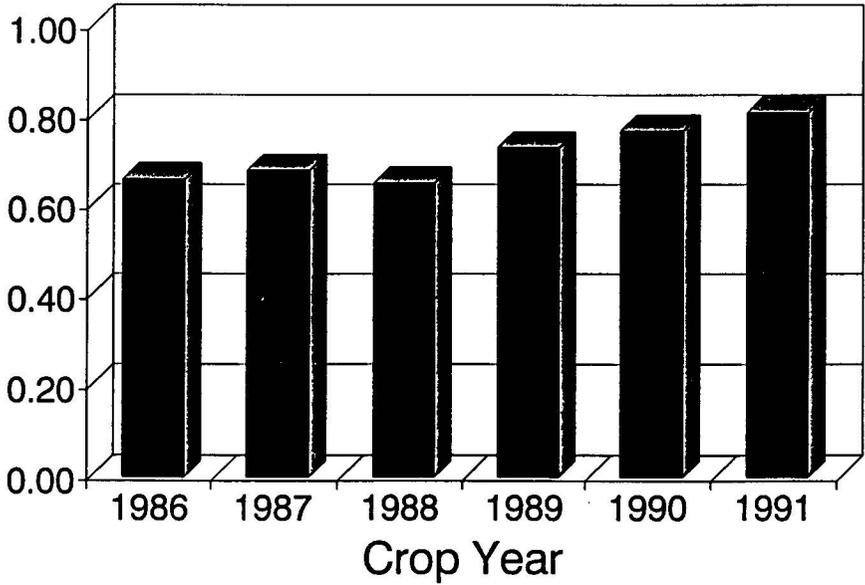
If you or your staff would like additional information or have questions, please contact me.

Sincerely,

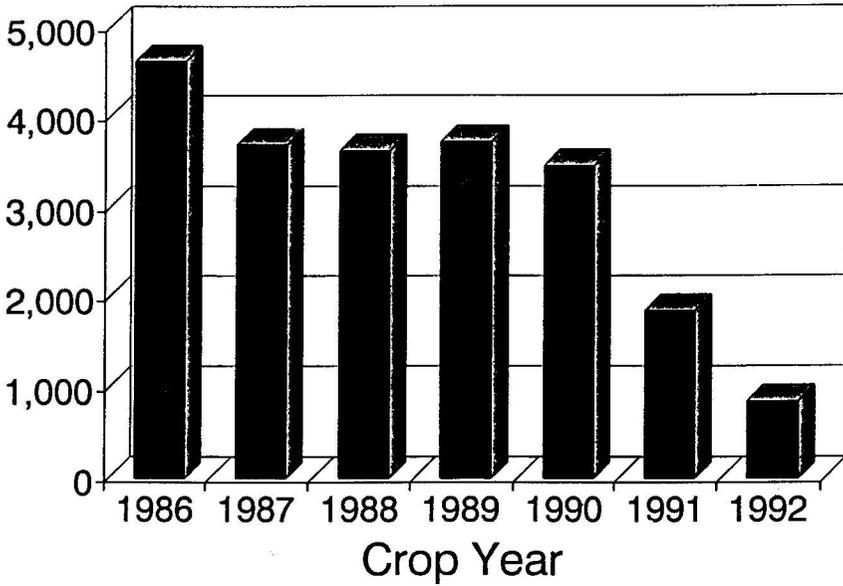


David G. Cone
Manager
BROADVIEW WATER DISTRICT

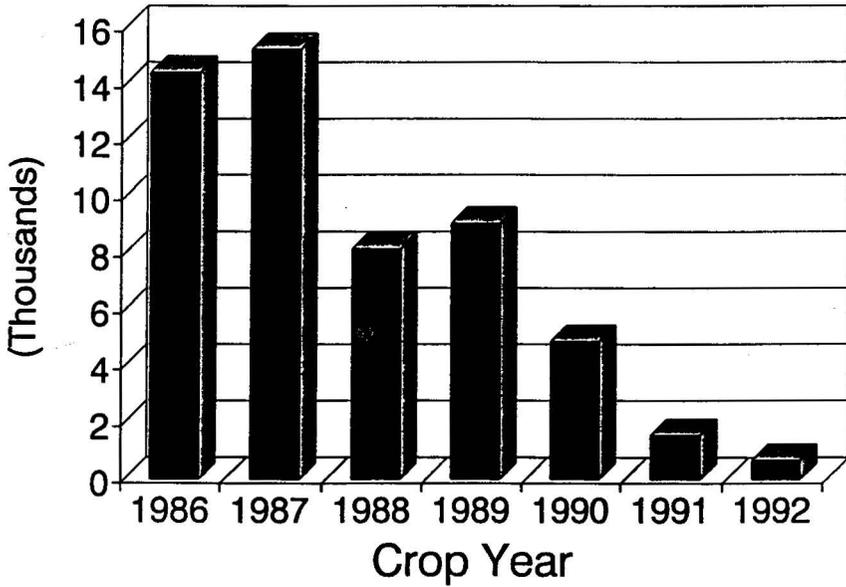
District-wide Estimated Application Efficiencies, BWD, 1986 to 1991



Collected Subsurface Drain Water Acre-Feet, BWD, 1986 to 1992



Discharged Commingled Drain Water Acre-Feet, BWD, 1986 to 1992



Farm-level and district efforts to improve water management during drought

DENNIS WICHELNS¹ & DAVID CONE²

¹*Department of Resource Economics, University of Rhode Island, Kingston, RI 02881, USA*

²*Broadview Water District, P.O. Box 95, Firebaugh, CA 93622, USA*

Accepted 1 July 1992

Key words: conservation, districts, drought management, irrigation efficiency

Abstract. The fifth year of drought in California brought reductions in surface water deliveries to many water districts. In the central San Joaquin Valley, water deliveries to Broadview Water District were reduced by 50% in 1990 and by 75% in 1991. The district increased the level of service provided to farmers during these years by providing accurate water use data, increasing the flexibility allowed in scheduling water deliveries, and managing water transfers and purchases when water was available. Farmers in the district implemented new irrigation practices and increased the efficiency of water applications. Several crops were irrigated more frequently than usual, but the amount of water applied during each irrigation event was reduced. The total amount applied during pre-irrigations and seasonal irrigations was also reduced. More than 38% of district land was idled in 1991, with the largest proportional reductions in melon, sugarbeet, and grain plantings. Field application efficiencies increased for all crops in 1990 and 1991 and the district-wide field application efficiency increased from 0.73 in 1989, to 0.77 in 1990, and 0.81 in 1991.

Introduction

The average annual rainfall in California's San Joaquin Valley ranges from 100 mm in the south to 200 mm in the north and about 300 mm on the valley's east side. The two major sources of irrigation water in the valley are groundwater that is pumped locally and surface water deliveries from state and federal projects that operate large reservoirs in the northern region of the state and in the eastern mountain ranges. In most years the combination of groundwater pumping and surface water deliveries is sufficient to produce more than \$4 billion worth of crops on 4.25 million hectares of land (San Joaquin Valley Drainage Program, 1990).

State and federal surface water deliveries are reduced in years when drought conditions limit the amount of water available in project reservoirs. For example, the allocation of water to many districts in the San Joaquin Valley was reduced by 75% during the 1977 drought. That drought was severe but it ended

relatively quickly in the spring of 1978. Short-term responses to the drought of 1977 included an increase in groundwater pumping and improvements in farm-level water management. The total value of agricultural production actually increased in 1977, as a relatively small amount of land was fallowed and average crop prices were higher than in the previous year (Howitt 1991). Rainfall returned to normal in 1978 and conventional water management practices were resumed. The most recent drought in California is now entering its sixth year and surface water allocations have been reduced significantly. At the start of the fourth year, in March 1990, water deliveries to some districts were reduced by 50%. Many of these districts received only 25% of their normal allocation during 1991. Some districts report that more than 30% of tillable land was left idle during 1991 and that farmers improved their irrigation practices to use available water efficiently.

This paper describes the farm-level and district responses to recent reductions in water allocations in the San Joaquin Valley. Farmers and district staff have successfully improved irrigation system performance and have implemented new irrigation practices to maximize the value of production from limited water supplies. District personnel have worked very closely with farmers to provide flexible water deliveries and timely information regarding farm-level water use. Some of these improvements have been implemented in other irrigation districts in the western United States (Palmer et al. 1991), where water conservation is an important program for many water delivery agencies.

The Broadview Water District

This paper reviews the changes in irrigation practices and water management that have occurred during 1990 and 1991 in the 4000-hectare Broadview Water District, which is located near Firebaugh, California. Broadview is typical of other districts in the region where surface water deliveries were reduced by 50% in 1990 and by 75% in 1991. Groundwater is largely unsuitable for irrigation in Broadview due to relatively high salinity and high boron concentrations. The drought responses of Broadview farmers are typical of those observed throughout the region.

Broadview is distinguished from other districts in the region by its increasing block-rate water pricing program that was implemented in October 1988, to motivate water conservation and reduce the volume of drain water collected in the district (Wichelns & Cone 1990). This program has increased the awareness of water management issues among district farmers and staff, and has provided a framework for collecting very detailed information describing irrigation practices and water use (Wichelns & Cone 1992). Broadview has been able to respond quickly and accurately to the changes in water management that were made necessary by reductions in water supply.

District-level activities

The district has provided four important services to assist farmers in managing water efficiently during the drought years:

- field-specific information regarding historical and expected water use has been provided to all farmers,
- the minimum time required for scheduling changes in water deliveries has been reduced,
- water transfers and purchases have been arranged to supplement a farmer's water allotment when water has been available, and
- the water available for pre-irrigation in the fall of 1990 was allocated and delivered according to an equitable and efficient timetable.

These enhancements in the information, operations, and transactions provided by the district have enabled farmers to select cropping patterns carefully according to expected water use, to begin and end irrigation events promptly according to field-specific crop water requirements, and to move water among water districts to maximize the efficiency of water use.

Broadview began collecting crop-specific irrigation data for all crops and fields in the district in 1986. The data include the size of fields irrigated, the amount of water applied during each irrigation event, and the total water applied during pre-irrigation and seasonal irrigations. These data have been summarized for each farmer, to allow review of historical irrigation data for individual fields (Table 1). Many farmers use these data to plan their cropping patterns accurately when reductions in water allotments are expected to limit production alternatives.

The Broadview cropping pattern was not affected significantly in 1990, because the reduction in water supply was announced after pre-irrigation water had been delivered in the previous fall and early winter. In 1991, however, the 75% reduction in water supply caused 38% of the district to be idled, with the greatest proportional reductions occurring in melons, sugarbeets, and grain. Idle land in Broadview increased from 183 hectares in 1989 to 313 ha in 1990

Table 1. Example of field-specific irrigation data prepared for all fields in the Broadview Water District.

Farmer: Jones, 1990

Field	Crop	Hectares (ha)	Pre-irrigation ^a	Seasonal irrigations				Total
				First	Second	Third	Fourth	
6-2	Cotton	55.85	274	207	192	174	104	951
6-3	Tomatoes	60.71	238	238	219	192	137	985

^a Cotton fields are pre-irrigated before the crop is planted. Tomato fields are irrigated after planting, but before the seedlings have emerged from the soil.

Table 2. Crop plantings in the Broadview Water District, crop years 1990 and 1991.

Crop	1990	1991	Area reduction from 1990 to 1991	
	(ha)	(ha)	(ha)	(%)
Cotton	1,787	1,549	238	13.3
Melons	329	80	249	75.7
Tomatoes	344	268	76	22.1
Wheat	365	123	242	66.3
Barley	118	0	118	100.0
Alfalfa seed	222	185	38	16.9
Alfalfa hay	0	0		
Sugarbeets	121	0	121	100.0
Oat hay	11	16		
Onion seed	11	4		
Cropped total	3,309	2,225	1,084	32.8
Fallow	313	1,400		-347.3
Total	3,622	3,625		

and 1400 ha in 1991 (Table 2). This represents a four-fold increase in fallow land from 1990 to 1991.

Cotton plantings declined by 238 ha (13.3%) in 1991, representing the smallest proportional reduction of the major crops grown in the district. Alfalfa seed declined by 37 ha (16.9%) and tomatoes were reduced by 76 ha (22.1%). Melon and wheat plantings were reduced by 75.7% and 66.3%, while no sugarbeets or barley were planted in 1991. The total cropped area in Broadview was 2225 ha in 1991, or 1084 ha (32.8%) smaller than in 1990.

The district's normal policy for scheduling water deliveries requires a 48-hour advance notice before beginning a water delivery and a 24-hour notice before closing a farm-level turnout. This was relaxed in 1990 and 1991 to allow farmers maximum flexibility in scheduling water deliveries. Many farmers have applied frequent, but shallow, irrigations during these years, in place of the deep and infrequent irrigations that were common during earlier years. The district's flexible delivery policy has allowed farmers to begin and end water deliveries on short notice, sometimes in the same day, permitting them to irrigate small portions of fields for very short periods of time.

Many Broadview farmers own or lease land in several irrigation districts in the San Joaquin Valley. Water allocations vary among districts according to historical water contracts and their agreements with state and federal water suppliers. During the drought years, many farmers desired to transfer water among districts to achieve optimal crop production. The district worked with the farmers and the water agencies to complete these transactions in time to allow efficient water use during the 1990 and 1991 seasons. Water was also

available for purchase from the state's water bank, but the relatively high price (\$216 to \$247 per MI) could not be justified for the field crops grown in Broadview. Some farmers did purchase well water developed in other districts (\$123 to \$133 per MI) to finish irrigating some of their fields. The district assisted these farmers with the water transfer procedures.

A limited supply of water was available to Broadview farmers during October and November of 1990 for pre-irrigation of 1991 crops. The district required farmers to submit applications describing the fields to be pre-irrigated and the dates when fields would be ready to receive water delivery. The district divided the amount of water available by the total number of hectares included in the applications, resulting in an average allocation of 198 mm/ha. This is about 60% of the 335 mm historical average depth of pre-irrigations in Broadview.

The district worked with farmers to schedule the pre-irrigation deliveries so that farmers would receive water only after their fields had been prepared for pre-irrigation. The plan provided 10 days of water delivery at 0.14 m³/sec (12.2 MI per day) to each 63-hectare field that had applied for pre-irrigation water. Some farmers used sprinklers to pre-irrigate their fields, while others pre-irrigated in alternate furrows to reduce the time required to pre-irrigate the complete field. Most farmers blocked the ends of furrows to retain all water on the field by reducing surface runoff to a minimum. None of these practices had been used before in Broadview.

The pre-irrigation plan was supported by Broadview farmers, who viewed it as an equitable and efficient scheme to allocate the limited water supply. Some farmers chose to pre-irrigate entire fields to the average depth of 198 mm, while others chose to pre-irrigate only a portion of a field to a greater depth. Both groups of farmers applied additional pre-irrigation water to the same fields later in the winter, after the water supply situation for 1991 was announced. In the end, pre-irrigation depths ranged from 131 mm to 485 mm, with a mean depth of 302 mm and a standard deviation of 79 mm.

The average depth of water applied on cotton fields that were pre-irrigated with sprinklers was 226 mm, while the average depth on fields pre-irrigated with gated pipe was 378 mm, and the average depth applied using conventional earthen head ditches was 317 mm. These data reflect the relative efficiency of sprinklers, while suggesting that the use of gated pipe does not, by itself, guarantee reductions in pre-irrigation depths. Farmers who adjust irrigation set times and furrow lengths in conventional furrow systems can reduce pre-irrigation depths below historical averages.

The two melon fields were pre-irrigated with 210 mm and 226 mm, using siphon tubes and 400 m furrow lengths. Sprinklers were used to pre-irrigate one tomato field in 1991 (235 mm), while siphon tubes and 400 m furrow lengths were used on another (238 mm). The historical average pre-irrigation depths for melons and tomatoes in Broadview are 335 mm and 244 mm, respectively.

Farm-level adjustments

Broadview farmers implemented several improvements in traditional furrow irrigation methods during 1990 and 1991, including the use of gated pipe for head ditches, reduction of furrow lengths and set times, packing of furrows prior to irrigation events, and the irrigation of alternate furrows. Many farmers worked more closely than usual with field irrigators to improve their understanding of drought-induced irrigation goals. Where possible, some farmers also upgraded their technology by using sprinkler systems for pre-irrigation of some crops and seasonal irrigation of other crops. One farmer installed a tailwater return system in 1990 and another farmer installed a similar system in 1991.

Broadview farmers reduced the amount of water applied during most irrigation events, while the number of irrigations was increased for some crops, including cotton and tomatoes. Cotton fields are usually irrigated three or four times in Broadview and some fields receive a fifth irrigation. For example during 1986 through 1988, most of the cotton fields were irrigated at least three times, about half of the fields were irrigated a fourth time, and a few fields received a fifth or sixth irrigation (Table 3). The average depth of each irrigation event ranged from 162 mm to 219 mm for the first three irrigations during

Table 3. Event-specific district average irrigation depths for cotton, Broadview Water District, 1986 through 1991.

Irrig. event	Year					
	1986	1987	1988	1989	1990	1991
	(Irrigation depth, in millimeters) ^a					
Pre-irrig.	332	360	344	338	326	302
First	219	186	210	183	152	116
Second	201	174	207	189	143	113
Third	180	162 (24)	168 (25)	158 (31)	122	119
Fourth	125 (13)	131 (18)	119 (12)	125 (26)	91 (25)	91 (24)
Fifth	.	195 (2)	98 (4)	113 (14)	98 (15)	49 (11)
Sixth	.	.	91 (1)	40 (1)	49 (4)	43 (1)
Seventh	.	.	.	.	61 (1)	.
Eighth	.	.	.	.	55 (1)	.
Total ^b	991 (30)	985 (25)	991 (27)	1018 (32)	866 (33)	732 (30)

^a Numbers in parentheses are the number of cotton fields for which irrigation deliveries were recorded, when only a subset of all cotton fields were irrigated.

^b Numbers in parentheses are the total number of cotton fields.

Table 4. Event-specific district average irrigation depths for tomatoes, Broadview Water District, 1986 through 1991

Irrig. event	Year					
	1986	1987	1988	1989	1990 ^c	1991
	(Irrigation Depth, in millimeters) ^a					
Pre-emerg.	216	229	372	186	244	174
First	247	146	146	104	125	101
Second	235 (4)	262	165	128	101	94
Third	244 (3)	320 (2)	259 (4)	128	125	76
Fourth	448 (2)	232 (2)	110 (3)	140	107 (6)	98
Fifth	.	.	24 (1)	107 (5)	91 (6)	64
Sixth	.	.	.	67 (3)	104 (6)	76
Seventh	.	.	.	85 (2)	101 (3)	67 (4)
Eighth	.	.	.	94 (1)	110 (2)	76 (3)
Ninth	.	.	.	.	.	113 (2)
Tenth	.	.	.	.	.	101 (1)
Total ^b	978 (5)	1003 (3)	963 (5)	829 (7)	924 (7)	820 (6)

^a Numbers in parentheses are the number of tomato fields for which irrigation deliveries were recorded, when only a subset of all tomato fields were irrigated.

^b Numbers in parentheses are the total number of tomato fields.

^c Rainfall in May of 1990 was sufficient to allow farmers to skip one irrigation on tomatoes that year.

1986 through 1988 and the average depth of the fourth irrigation ranged from 119 mm to 131 mm.

During 1989 through 1991, about 80% of the cotton fields in Broadview were irrigated four times and half of these were irrigated a fifth time (Table 3). The average depth per event during the first three irrigations declined steadily in 1989, 1990, and 1991. The average depth of the fourth and fifth irrigations declined between 1989 and 1990. In 1991, the average depth of the fifth irrigation was just 49 mm.

As noted above, the tiered pricing program was implemented in Broadview prior to the 1989 season and drought-induced reductions in water allocations occurred in 1990 and 1991. The average depths of cotton pre-irrigations and the first three seasonal irrigations have declined steadily through these years. The district average depth for the first three irrigations was less than 120 mm in 1991, declining from an average of 162 mm to 219 mm during 1986 through 1988 (Table 3). The average depth of water delivered to cotton fields, including pre-irrigation and seasonal irrigations, declined from about 990 mm during 1986 through 1988 to 866 mm in 1990 and 732 mm in 1991.

Some Broadview farmers irrigate tomato fields prior to planting, while

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Table 5. Event-specific district average irrigation depths for melons, Broadview Water District, 1986 through 1991.

Irrig. event	Year					
	1986	1987	1988	1989	1990	1991
	(Irrigation depth, in millimeters) ^a					
Pre-irrig.		430 (1)	326	323	317	216
First	259	268	143	134	88	116
Second	137	155	101 (10)	76	94	30
Third	122	140 (6)	76 (6)	49 (5)	70 (4)	30
Fourth	125 (4)		40 (5)	79 (1)		101 (1)
Fifth	52 (2)		192 (1)			
Sixth	76 (1)					
Total ^b	655 (5)	607 (7)	634 (11)	567 (9)	547 (6)	445 (2)

^a Numbers in parentheses are the number of melon fields for which irrigation deliveries were recorded, when only a subset of all melon fields were irrigated.

^b Numbers in parentheses are the total number of melon fields.

others apply water after the crop is planted, but before the seedlings emerge. The average depth of pre-emergent irrigations on tomatoes, whether applied before or after planting, was between 216 mm and 372 mm during 1986 through 1988 (Table 4). The average depth during 1989 through 1991 ranges from 174 mm to 244 mm. As in the case of cotton pre-irrigations, farmers have reduced the depth of pre-emergent irrigations on tomatoes by using sprinklers, reducing the length of furrow runs, and reducing irrigation set times.

Most tomato fields were irrigated three or four times during 1986 through 1988, with the average depth of each event ranging from 110 mm to 448 mm (Table 4.) In recent years, most tomato fields were irrigated five or six times, with some fields receiving seven or eight irrigations. The average depth of each irrigation ranged from 64 mm to 140 mm during 1989 through 1991. Farmers irrigated tomatoes more frequently, using less water per irrigation event, and the average depth of water applied to tomato fields has declined from about 981 mm during 1986 through 1988 to 820 mm in 1991.

The number of irrigation applied on melon fields has not declined in recent years, but the average depth per irrigation has been reduced. The average depth of irrigations on most melon fields ranged from 40 mm to 268 mm during 1986 through 1988, when most fields were irrigated three or four times (Table 5). Most melon fields were irrigated only three times during the recent three years and the average depth ranged from about 30 mm to 134 mm. The average depth of water applied on melons has declined from about 640 mm in 1986 through 1988 to 547 mm in 1990 and 445 mm in 1991.

Field application efficiencies

Changes in average irrigation depths describe the ability of Broadview farmers to apply less water per irrigation event as irrigation practices are improved and as the district improves the flexibility of water deliveries. Irrigation efficiencies require consideration of crop water requirements in addition to irrigation depths. The efficiency of water use has increased steadily in Broadview since the inception of tiered water pricing in 1989 and through the water-short years of 1990 and 1991.

Field application efficiency is defined as the net crop water requirement ($ET_{\text{crop}} - P_e$) divided by the volume of water delivered to a farm field (V_f). This measurement does not adjust for leaching requirements, cultural practice water requirements, or water stored in the soil for a subsequent crop. These uses of water will vary among growing conditions and locations. Crops may be grown most effectively with respect to water use where leaching requirements and other cultural practice requirements are minimized (Bos, 1979). Similarly, surface runoff and deep percolation *are not* deducted from the delivered water volume before calculating the field application efficiencies. Field application efficiencies that are greater than one suggest that the crop was either under-irrigated or that the crop used water from the shallow water table.

Estimated field application efficiencies in Broadview increased for all crops except wheat between 1988 and 1989 (Table 6). Further improvements were observed for cotton, sugarbeets, and alfalfa seed in 1990. The efficiencies for cotton, wheat, and alfalfa seed increased in 1991 to the highest levels observed during recent years. The efficiencies in 1991 clearly reflect the drought-induced reductions in water allotments, and they suggest that Broadview farmers have achieved relatively high application efficiencies by improving irrigation practices to maximize production from limited water supplies.

Improvements in water management in 1989 and 1990 contributed to increases in field application efficiencies during these years. For example, the 33% increase in the efficiency for wheat between 1989 and 1990 reflects better scheduling of wheat planting to maximize the usefulness of winter rainfall. Irrigations in late spring were also reduced to save a portion of the limited water supply for use on summer crops. All irrigations on the two sugarbeet fields in Broadview were applied using sprinklers in 1990, while furrows were used to apply late-season irrigations on the single sugarbeet field in 1989. This change in irrigation system contributed to the 34% increase in the sugarbeet field application efficiency between the two years. The 4% increase in the alfalfa seed efficiency reflects closer management of irrigations on this crop in 1990 to make more water available for other crops. This likely resulted in greater use of water in the shallow water table by the alfalfa seed plants.

The estimated field application efficiency for melons was unchanged be-

Table 6. Crop-specific estimated field application efficiencies in the broadview water district, 1986 through 1991.

Crop	Year					
	1986	1987	1988	1989	1990	1991
	(Estimated efficiency) ^a					
Cotton	0.68	0.71	0.65	0.71	0.75	0.80
Tomatoes	0.55	0.44	0.51	0.63	0.56	0.51
Melons	0.38	0.36	0.45	0.57	0.57	0.54
Wheat	0.53	0.43	0.58	0.49	0.65	0.84
Sugarbeets ^b	0.54	0.62	0.59	0.85	1.14	.
Alfalfa seed ^c	1.09	1.42	1.67	1.76	1.84	2.10
Dry beans ^d	0.58	0.61	0.55	0.69	.	.
District-wide	0.66	0.68	0.65	0.73	0.77	0.81

^a Field application efficiencies are defined as the estimated crop evapotranspiration, minus effective rainfall, divided by the depth of water delivered to farm fields. Surface runoff and deep percolation are not deducted from the delivered water depth before calculating the estimated efficiency.

^b Field application efficiencies for sugarbeets may exceed 1.00 if the crop is able to use water in the high water table. No sugarbeets were planted in Broadview in 1991.

^c Field application efficiencies for alfalfa seed are greater than 1.00 because: 1) farmers under-irrigate the alfalfa plants to generate stress that increases bloom and seed production, while minimizing vegetative growth; and 2) the root system of alfalfa seed becomes very deep during the two or three years that the crop is grown, and the plants will often utilize water in the high water table.

^d No dry beans were planted in Broadview in 1990 and 1991.

tween 1989 and 1990, while the efficiency for tomatoes declined by 11%. This decline reflects continued use of furrow irrigation for the first watering of tomatoes on two fields in the district and numerous late-season irrigations to preserve the crop while waiting for late harvest on another field. If these three fields are not considered, the estimated efficiency for tomatoes is 0.64, or about the same efficiency that was estimated in 1989. Field application efficiencies for tomatoes and melons in Broadview declined slightly in 1991, as some farmers used furrows during pre-irrigation and others applied water late in the season.

The district-wide estimated field application efficiency increased from 0.65 to 0.73 (12.3%) between 1988 and 1989, and from 0.73 to 0.77 (5.5%) between 1989 and 1990 (Table 2). This represents a 17% increase above the average estimated efficiency for Broadview from 1986 through 1988. In 1991, the estimated district-wide efficiency is 0.81, or 23% greater than the three-year average.

Summary

Water deliveries to the Broadview Water District were reduced by 50% in 1990 and by 75% in 1991. Cropping patterns were largely unaffected in 1990 because fields had been pre-irrigated prior to the reduction in water supply. In 1991, however, the 75% reduction caused 38% of the district land to be idled, with the greatest proportional reductions occurring in melons and sugarbeets. The district increased the level of service provided to farmers during the two recent drought years by providing accurate water use data, increasing the flexibility allowed in scheduling water deliveries, and managing water transfers and purchases whenever these could be transacted.

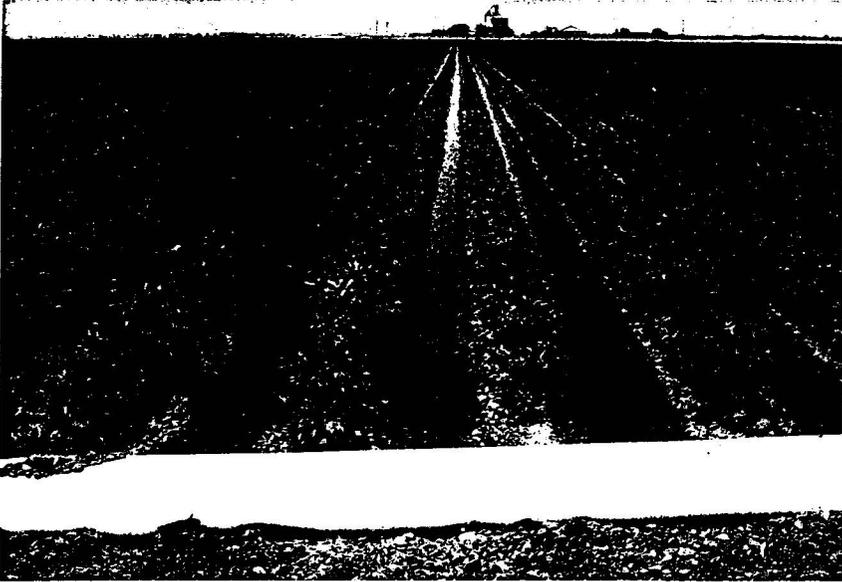
Broadview farmers implemented new irrigation practices and increased the efficiency of water applications. Several crops were irrigated more frequently than usual, but the amount of water applied during each irrigation event was reduced and the total amount applied during pre-irrigations and seasonal irrigations was also reduced. Field application efficiencies increased for all crops in 1990 and 1991 and the district-wide efficiency increased from 0.73 in 1989, to 0.77 in 1990, and 0.81 in 1991.

Acknowledgement

This study was supported by the Water Conservation Office in the Department of Water Resources, Sacramento, California. This paper is Rhode Island Agricultural Experiment Station Contribution Number 2771.

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Tiered pricing motivates Californians to conserve water

By Dennis Wichelns
and David Cone

Water quality problems in irrigation return flows prompted a San Joaquin Valley water district to take a new look at water use and pricing

CALIFORNIA'S Broadview Water District implemented an increasing block-rate pricing plan in October 1988 to motivate the use of water conservation practices. The goal of these practices: to reduce the volume of drain water collected beneath farm fields. The program's success was to be measured by observed changes in irrigation practices and reductions in water deliveries and collected drain water (17). The positive results obtained in subsequent years prompted the district's board of directors in 1990 to adopt tiered pricing as a permanent district policy.

Irrigation and drainage issues

The Broadview Water District is located on the west side of the San Joaquin Valley.

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Reprinted from the *Journal of Soil and Water Conservation*, March/April 1992, Volume 47, Number 2.

near Firebaugh, California. The district delivers high-quality surface water to 18 farms, ranging from 160 acres to 1,280 acres.

Broadview has a contract with the U.S. Bureau of Reclamation for 27,000 acre-feet of water per year and must recover all water costs and operational expenses from farmers in the district. The price of water historically has been determined by adding water delivery costs to the contract price paid to the Bureau. All farmers are charged the same price for water regardless of location within the district. The average unit price of water from 1986 through 1988 was \$16.00 per acre-foot. All farmers also pay an annual assessment of \$42.00 per acre for district overhead expenses.

Broadview is located in a drainage problem area. Impervious clay layers restrict the percolation of irrigation water through the soil profile. Subsurface drainage systems of perforated pipes, sumps, and discharge pumps are required on many farms to maintain the saline high-water table at a depth that will not damage crop yields or reduce

the long-term productivity of farm fields. Drainage systems have been installed beneath 70 percent of the 10,000 acres in the district.

Drain water collected in Broadview and other districts in the drainage problem area contains several elements found naturally in local soils. But the elements degrade water quality when discharged into rivers or streams (7). State water quality authorities have directed that the boron, molybdenum, and selenium loads in agricultural drainage water entering the San Joaquin River be reduced to achieve water quality standards (10).

State agencies and university researchers have recommended farm-level improvements in irrigation practices to reduce the depth of water applied to farm fields and the volume of drain water collected in the region (2). Tiered pricing of irrigation water was first recommended as one method for motivating water conservation in California during the 1977 drought (6). More recently, state and federal agencies have recommended tiered pricing to address irrigation and drainage issues (9, 11).

Broadview district board members and other farmers are well-informed about drainage issues in the region. Prior to 1983, the district had no outlet for drain water and

recirculated all subsurface drain water and surface runoff within its water delivery system. Over time, the salinity of delivered water and farm fields in the district increased to levels that reduced plant growth and crop yields. Dominant crops in the district changed from salt-sensitive tomatoes and cantaloupes to less profitable but salt-tolerant cotton and grains (19).

An outlet for drainage water was obtained through agreements with local water districts in 1983, allowing Broadview to release up to 50 acre-feet per day of mingled surface runoff and subsurface drain water, provided the salinity did not exceed 2,500 parts per million of total dissolved solids. The district released almost 90,000 acre-feet of drainage water containing an estimated 200,000 tons of salt from January 1983, when the outlet was opened, to October 1988, when tiered water pricing was adopted. Much of this salt would have been recirculated in water deliveries and applied to farm fields if the outlet had not been available.

Water quality problems at the Kesterson National Wildlife Refuge, made public later in 1983, generated intense scrutiny of irrigation and drainage practices on the west side of the San Joaquin Valley (7). Although Broadview waters did not drain into Kesterson, the district did participate actively in

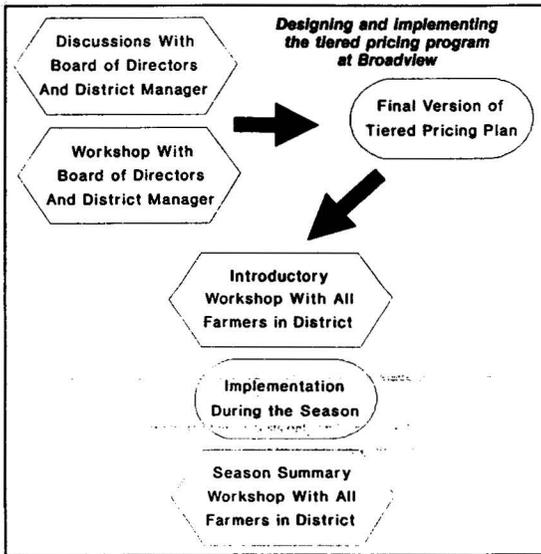
discussions regarding state and local water quality and drainage issues. The district implemented a detailed monitoring program to measure the volume and quality of its drain water and to identify strategies for reducing drain water volume.

The regional plan for implementing the state's water quality guidelines was released in 1988. It directed districts to adopt drainage operation plans to reduce the loads of salt and other elements in agricultural drainage water entering the San Joaquin River (8). At that time, the district began to examine policies that would be consistent with the state's objectives and ensure continued use of the district's drainage outlet, while imposing minimal costs on agricultural production. Among the options considered were limitations on the amount of water sold to each farmer, restrictions or fees on the amount of drain water the district accepted from farmers in its drainage ditches, and higher prices for irrigation water.

Board members did not favor restrictions on water deliveries because the legal implications of this policy within a reclamation district were not clear. A legal challenge to the policy likely would require development of detailed information describing the relationship between applied water and drain water volume to justify restrictions on water deliveries as the best method of reducing drain water volume. The board was not eager to adopt a policy that would require additional research or generate legal challenges.

Policies that address drain water directly, such as fees or volume restrictions, were feasible within the district framework but not appropriate when a portion of the drain water collected by one farmer was actually generated by another farmer. Water applied in excess of crop water requirements on one field can contribute to drain water collected beneath another field through lateral subsurface movement within a regional high water table (1, 3, 4, 5). A fee or restriction on drain water volume would have placed a disproportionate share of the costs of drain water reduction on farmers with drainage systems when this occurs (18).

The Broadview board preferred to charge higher prices for irrigation water if a plan could be designed to achieve drain-water reductions fairly and effectively, while satisfying the district's cost recovery goal and not imposing higher costs only on farmers with drainage systems. A tiered pricing plan was designed in which a higher price would be charged for water applied in excess of crop-specific tiering levels. The pricing structure is designed to distribute the costs of drain water disposal among all farmers who apply water that contributes to drain water





Using traditional methods, tomatoes (above) are irrigated in every furrow using an earthen head ditch and siphon tubes. As water conservation efforts increased, other methods have been tried. The melons (right) are being irrigated in alternate furrows but still out of a head ditch. Seed onions (below) are irrigated in every furrow using collapsible polyethylene gated pipe that allows more efficient control of irrigation than a head ditch.



volume, whether or not a drainage system has been installed beneath their fields.

The Broadview program

The Broadview board selected a tiered pricing program to encourage farmers to manage irrigation water more carefully and to reduce the volume of water applied to farm fields. The major components of the Broadview program that have contributed to its success include the following:

- ▶ Involvement of the district board in designing and updating elements of the pricing program.
- ▶ Establishment of prices and tiering levels that represent realistic goals and are relevant to local conditions.
- ▶ Collection of field-specific data describing water deliveries, irrigation events, and other cultural practices.
- ▶ The timely exchange of information among district farmers.

Specific features of these components were determined during discussions involving the district board of directors, other farmers, and the district manager. The board held special workshops to design the pricing program, to describe the plan to all farmers in the district, and to report results achieved during the irrigation season.

Discussions with the board of directors. The Broadview board includes five farmers who own land in the district and are elected by a vote of all landowners. Four of the five current board members have farmed in the district for more than 20 years. The concept of tiered water pricing was discussed at several board meetings prior to its approval. These discussions helped to determine the structure of a program that would be appropriate for Broadview and to identify elements of the plan that would be needed to ensure success. Three principal topics usually were discussed: the irrigation and drainage issues that led to the requirement for

districts to achieve drain water reductions, the potential of tiered water pricing schemes to reduce water use and drain water volume, and practical considerations for implementing a program in Broadview. Many of the discussions also revealed information that should be presented to board members and other farmers when describing the potential impacts of a tiered pricing program.

The financial impacts of tiered prices were described to board members using graphs depicting the marginal, average, and total water costs of alternative plans. Initial reaction to the possible use of tiered prices varied according to perceptions of current water use in the district. Some board members thought most farmers already applied water efficiently; tiered prices, they believed, would raise irrigation costs without reducing water deliveries. Others suggested that the improvements required to meet drain water reduction goals would be small enough so the economic incentive provided by a tiered pricing policy was not required.

A critical juncture in the discussions about adoption of a tiered pricing program occurred while discussing current irrigation practices. Data describing actual irrigation depths for individual fields in the district from 1986 through 1988 showed reasonable district average irrigation depths, but a wide range in irrigation depths among farmers. For example, the mean of field-specific irrigation depths for cotton from 1986 through 1988 was 3.2 feet, while the range varied from 1.2 to 5.0 feet. The mean depth for



tomato fields was also 3.2 feet, while the range was from 2.3 to 4.6 feet. Similar ranges in field-specific irrigation depths were observed for other crops.

The range and variation of the field-specific irrigation data indicated that potential existed for reducing water deliveries if the current economic incentives were provided to district farmers. The board members concluded that tiered pricing would motivate farmers who were applying significantly more water than the district average depth to reduce water use, while not penalizing farmers whose irrigation depths were

already below the district average.

Selection of prices and tiering levels. Following adoption of tiered pricing as a district policy for the 1989 season, the board held a special meeting to select water prices and tiering levels. The meeting provided an opportunity for board members to express any remaining concerns about tiered water prices and to examine more closely the farm-level economic impacts of alternative pricing designs. The board members selected a block-rate structure including only two prices. In this way, farmers could readily identify and remember the appropriate prices during the season. Plans including three or more prices were viewed as too complex for the first year of a new water pricing program.

The board preferred to maintain the current \$16.00 water price for the first price block to ensure that water delivery costs would be recovered even if all farmers completed the season using water from the first block only. The second price, \$40.00 per acre-foot, was chosen to provide a significant incentive for farmers to reduce water use and to recover the costs of collecting and releasing drain water.

The total cost of managing drain water could be raised by charging a flat-rate surcharge of \$3.15 per acre-foot for all water delivered in the district. Alternatively, the district could place no surcharge on water sales up to a specified amount of water per acre, while placing a much higher surcharge on water delivered above this amount. The \$24.00 per acre-foot surcharge in Broadview's tiered pricing scheme becomes effective after 2.9 acre-feet have been delivered to cotton fields. This surcharge on water delivered in excess of the tiering level raises the same amount of revenue as a flat-rate surcharge of \$3.15 per acre-foot for all water

purchased when a farmer applies 2.34 acre-feet per acre. This is about the average depth of cotton irrigation in the district. The tiered pricing scheme, however, provides a much stronger incentive to reduce water deliveries than would a flat-rate surcharge.

A pricing program that accounts for variation in crop water requirements was selected to minimize potential distortions in farm-level cropping choices. A single set of increasing block-rates and tiering levels for all crops would encourage farmers to plant crops with lower crop water requirements. This is desirable in a program designed primarily to conserve water, but is not required if the goal is to reduce drain water volume.

Crop-specific tiering levels are required so that higher prices are charged only for water applied in excess of crop water requirements. Such a program does not penalize a sugarbeet farmer who applies water near the relatively high crop-water requirement for this crop any more than it penalizes a barley farmer who applies water near its relatively low crop-water requirement. Crop-specific tiering levels increase the number of details that describe the pricing structure, but they are essential if the program is to reduce drain water volume successfully without causing unnecessary changes in cropping patterns.

Field-specific pricing—the application of increasing block-rate prices for water delivered to each field—also is necessitated by the drain water reduction goal. Coarse-textured soils frequently require more water than fine-textured soils in surface irrigated systems because more water is lost as it advances along the furrows. Fine-textured soils seal more rapidly and generally require less irrigation water. Much of the deep percolation on a coarse-textured soil contributes to

drain water volume. A pricing program that allows more water to be applied on coarse-textured fields than on fine-textured soils before higher prices become effective will not provide sufficient incentive to reduce water applications on the coarse-textured soils, and drain water volume may not be reduced.

Board members suggested that the crop-specific tiering levels should be developed according to criteria appropriate and relevant for district farmers. Published crop water requirements or evapotranspiration rates were considered inappropriate for farm-level irrigation decisions. Such data often are determined in experimental settings and may not reflect soil characteristics and cultural practices that must be considered when planning irrigation in some areas. For example, soils in the Broadview district have a high clay content, and cracking often occurs in the irrigation furrow as the soils dry. Some farmers irrigate more frequently than crop water scheduling programs would suggest to minimize soil cracking problems.

Tiering levels relevant to Broadview were selected by reducing the average of crop-specific irrigation deliveries for the most recent three years by 10 percent. This plan uses existing Broadview data and reflects an implicit goal—reducing district average irrigation depths by 10 percent—that farmers can easily recall throughout the season. The method also accounts for characteristics of Broadview soils and cultural practices common in the district.

Average irrigation depths for the six major crops grown during the 1986 through 1988 period ranged from 2.06 feet for alfalfa seed to 4.58 feet for sugarbeets. The three-year average for cotton and tomatoes in the district was 3.2 feet, while the average depth for rice in an adjacent water district was 3.65 feet. On-farm recirculation is not practiced in the Broadview district because the district collects all of the surface and subsurface drainage water. A portion of this is recirculated and blended with the freshwater delivered to farm fields. Water deliveries are measured using propeller meters in field turnout gates.

Ten-percent reductions in the average irrigation depths result in tiering levels that range from 1.9 feet for alfalfa seed and melons to 5.1 feet for rice. Cotton and tomato fields are allowed 2.9 feet at the lower water price, while sugarbeet fields are allowed 3.9 feet. Tiering levels for barley and wheat are 1.7 feet and 2.1 feet, respectively.

The tiered pricing program has minimal impact on farm-level crop choices, as noted above. In addition, the impact on farmers who double-crop land is no greater than the

Crop-specific average irrigation depths and selected tiering levels for the increasing block-rate pricing program in the Broadview Water District

Crop	Delivered Water*				Block-Rate Pricing Program Tiering Level
	1986	1987	1988	1986-1988 Average	
acre-feet per acre					
Cotton	3.21	3.13	3.27	3.20	2.9
Tomatoes	3.21	3.29	3.15	3.22	2.9
Melons	2.15	1.99	2.20	2.11	1.9
Wheat	2.01	2.55	2.35	2.30	2.1
Sugarbeets	5.01	3.81	4.92	4.58	3.9
Alfalfa seed	2.13	2.24	1.80	2.06	1.9
Rice†	5.72	5.24	5.99	5.65	5.1

*Most water deliveries in Broadview include some recirculated surface runoff and subsurface drain water.

†Rice irrigation data for 1986 through 1988 are from Firebaugh Canal Water District.

Example of water delivery information provided to each farmer with his or her monthly water bill in the Broadview Water District

Farmer: Jones Month: July	Initial Allotment of Water Available at \$16 per Acre-Foot	Total Deliveries Through the Previous Month		Current Month Deliveries		Amount of Current Month's Delivery at \$16 per Acre-Foot		Amount of Current Month's Delivery at \$40 per Acre-Foot		Total Water Cost				
		(AF/A)*	(AF)*	(AF/A)	(AF)	(AF/A)	(AF)	(AF/A)	(AF)	\$16 Water (\$)	\$40 Water (\$)	Total (\$)		
Field Crop	Acres													
6-2 Cotton	138	2.90	400.2	2.45	337.5	0.67	91.9	0.45	62.7	0.21	29.2	1,003	1,168	2,171
6-3 Tomatoes	150	2.90	435.0	2.43	363.9	0.80	120.0	0.47	71.1	0.33	48.9	1,138	1,956	3,094
Total amount due for July													5,265	

*AF/A, acre-feet per acre; AF, acre-feet.

Example of field-specific irrigation data prepared for all fields in the Broadview Water District

Farmer: Jones Field Crop	Acres	Preirrigation*	Seasonal Irrigations				Total
			First	Second	Third	Fourth	
align="center">acre-feet per acre							
6-2 Cotton	138	0.90	0.68	0.63	0.57	0.34	3.12
6-3 Tomatoes	150	0.78	0.65	0.72	0.63	0.45	3.23

*Cotton fields are preirrigated before crop is planted. Tomato fields are irrigated after planting, but before the seedlings have emerged from the soil.

impact on other farmers because each crop planting receives an allotment of water in the lower price block before the higher price becomes effective. Board members view this aspect of the pricing program favorably because it allows farmers maximum flexibility in choosing the number and variety of crops grown each year.

Data collection and observation. The tiered pricing program has minimal impact on the district's recordkeeping and billing procedures. The amount of new information required is small, and electronic spreadsheets are used to organize the data in a framework useful to the district manager and individual farmers. Field-specific water deliveries are readily available for fields serviced by a single-metered delivery gate. In cases where a single gate provides water to more than one field, the water master records the volume of water delivered to individual fields.

Electronic spreadsheets compute monthly water bills according to the price and volume of water purchased in each of the two price blocks and provide current per-acre water delivery data to farmers throughout the season. The spreadsheets reduce the time required to compute water bills each month and display clearly the impact of higher prices to farmers who have purchased water in the higher price block (see table). Farmers use this information to monitor their position with respect to the higher price block during the season.

Information exchange. During many discussions with district board members, the lack of communication among farmers regarding specific irrigation practices became apparent. Some board members were surprised to learn about some of the irrigation methods used by other members and the resulting depths of water applied to crops. These discussions revealed the need for better data sharing among farmers. Field-specific worksheets were developed for each crop to provide up-to-date information describing irrigation depths to interested farmers. The worksheets include the depth

of water applied during each irrigation event and are updated throughout the season (see table). Discussions among board members also generated anecdotal information that was useful in describing opportunities to improve irrigation practices to other farmers in the district.

Prior to the start of the 1989 season, all farmers and landowners in the district were invited to a workshop on the tiered pricing program that was to be implemented in October 1988. More than half of the farmers in the district attended the workshop or were represented by their irrigation supervisor. The district manager and board members explained the tiered pricing program and answered questions from the group about the potential impacts on farm-level irrigation practices and expenditures.

A similar workshop for landowners, farmers, and field supervisors is conducted at the end of each session to review irrigation and drainage data generated during the year and to consider any changes in the program for the following year. The workshops allow farmers to describe experiences gained during the season and to report the usefulness of improvements in irrigation practices they have implemented. The district manager conducts the workshops, using the field-specific irrigation data and observations of irrigation practices to generate discussion when needed.

Throughout the 1989 and 1990 seasons, farmers discussed irrigation topics with the district manager when they visited the district office to obtain current irrigation

data. The implications of improved irrigation methods on other cultural practices and crop yields were discussed often. One farmer noted that by applying water more carefully on cantaloupes he could make better use of water in the high water table, reduce irrigation depths, and produce a higher yield of better quality melons. Another farmer noted that his tomato yields increased when he irrigated some portions of a field for short periods of time and other portions for longer periods—to accommodate variation in soil characteristics within the field. Several farmers noted that cotton yields could be increased by reducing the length of furrow runs to improve irrigation distribution uniformity. Others suggested that improved irrigation methods enhanced crop cultivation, spraying, and harvest operations.

The information shared during these discussions was recorded by many Broadview farmers throughout the 1989 and 1990 seasons. On many occasions, farmers reported that they would experiment with some of the practices that other farmers were implementing. While some of this information may have been shared among farmers during the normal course of an irrigation season, the tiered pricing program motivated a much more rapid pace of information exchange than would have occurred otherwise.

A success

Average irrigation depths and drain water volumes declined during 1989 and 1990.

Crop-specific field delivery ratios are calculated as the estimated crop evapotranspiration, minus effective rainfall, divided by the depth of water delivered to farm fields. Values approaching one suggest very efficient irrigation, while smaller values indicate less efficient irrigation. The estimated field delivery ratios for cotton, tomatoes, melons, sugarbeets, and alfalfa seed were higher in both 1989 and 1990 than during any of the previous three years. The district-wide delivery ratio increased from 0.66 during 1986 through 1988 to 0.73 in 1989 and 0.77 in 1990. Water use efficiency in Broadview increased 17 percent in 1990 compared to the 1986 through 1988 period.

The volume of drain water collected in 20 drainage sumps in the district declined from an average of 3,521 acre-feet during 1986 through 1988 to 2,706 acre-feet in 1989 and

2,665 acre-feet in 1990 (see table). Estimated salt and boron loads in collected drain water also declined from the earlier average loads. The selenium load in drain water has remained nearly constant. While the precise relationship between drain water volume and constituent loads is not fully understood, reductions in volume will reduce drain water collection and disposal costs that are presently determined by the volume of drain water collected.

The tiered water pricing program at Broadview includes two prices for irrigation water (\$16.00 and \$40.00 per acre-foot) and crop-specific tiering levels. The final design of the pricing plan was selected after several alternatives were presented to district board members. Discussions held during numerous board meetings and a special workshop identified the essential components of the

program and revealed information that would be useful in describing the plant to district farmers.

The tiered pricing program provides an economic incentive for farmers to manage irrigation water carefully, generates timely and accurate information describing irrigation in the district, and creates an environment in which this information is exchanged easily among district farmers. All of these components have contributed to the program's success and will be useful in designing similar programs in other irrigation and drainage districts.

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Crop-specific estimated field delivery ratios in the Broadview Water District, 1986-1990

Crop	Year					
	1986	1987	1988	1986-1988 Average	1989	1990
	<i>Estimated Ratio*</i>					
Cotton	0.68	0.71	0.65	0.68	0.71	0.75
Tomatoes	0.55	0.44	0.51	0.50	0.63	0.56
Melons	0.38	0.36	0.45	0.40	0.57	0.57
Wheat	0.53	0.43	0.58	0.51	0.49	0.65
Sugarbeets†	0.54	0.62	0.59	0.58	0.85	1.14
Alfalfa seed‡	1.09	1.42	1.67	1.39	1.76	1.84
Dry beans§	0.58	0.61	0.55	0.58	0.69	-
District-wide	0.66	0.68	0.65	0.66	0.73	0.77

*Field delivery ratios are defined as the estimated crop evapotranspiration, minus effective rainfall, divided by the depth of water delivered to farm fields. Surface runoff and deep percolation are not deducted from the delivered water depth before calculating the estimated ratio.

†Field delivery ratios for sugarbeets may exceed 1.0 if crop is able to use water in the high water table.

‡Field delivery ratios for alfalfa seed are greater than 1.00 because (a) farmers underirrigate the alfalfa plants to generate stress that increases bloom and seed production, while minimizing vegetative growth, and (b) the root system of alfalfa seed becomes very deep during the two or three years that the crop is grown, and the plants will often utilize water in the high water table.

§No dry beans were planted in Broadview in 1990.

Drain water volume and estimated constituent loads in 20 subsurface drainage systems in the Broadview Water District, 1986-1990.

Constituent	Drain Water Volume by Year		
	1986-1988 Average	1989	1990
Drain water volume (acre-feet)	3,521	2,706	2,665
Estimated salt load (tons)	25,924	19,524	21,799
Estimated boron load (tons)	30.34*	27.01	26.16
Estimated selenium load (tons)	0.76*	0.69	0.76

*Boron and selenium data are not available for 1986 and 1987. These values are calculated using 1988 data only.

MOTIVATING REDUCTIONS IN DRAIN WATER WITH BLOCK-RATE PRICES FOR IRRIGATION WATER¹

Dennis Wichelns²

ABSTRACT: Increasing block-rate prices for irrigation water were implemented during 1989 in a 10,000-acre irrigation district in California's San Joaquin Valley. The program motivated improvements in irrigation practices that reduced the volume of water delivered to farm fields and the volume of drain water collected in on-farm drainage systems. The ratio of net crop water requirements to field deliveries increased from 0.65 in 1988 to 0.73 in 1989. The volume of drain water collected at a subset of 20 drainage systems was reduced by 351.1 acre-feet (11.5 percent). Estimated loads of salt, boron, and selenium were reduced by 2,407 tons (11.0 percent), 3.33 tons (11.0 percent), and 0.07 tons (9.2 percent).

(**KEY TERMS:** irrigation; drainage; water pricing; water quality; nonpoint source pollution.)

INTRODUCTION

Irrigation and drainage in California's San Joaquin Valley gained national attention in 1983 when waterfowl mortalities and deformities were attributed to selenium contained in agricultural drainage water stored in a set of holding ponds at the Kesterson National Wildlife Refuge (Letey *et al.*, 1986). Much of the subsurface drain water collected beneath farmland on the west side of the San Joaquin Valley contains selenium, boron, molybdenum, and other elements occurring naturally in local soils (Deverel and Gallanthine, 1988). California has implemented water quality standards that require a reduction in the amount of salts and selenium entering the San Joaquin River in drain water released from farms in the region. The state's Water Resources Control Board has suggested that the regional standards can be achieved by reducing the volume of drain water discharged from the region by 30 percent throughout a drainage problem area of 94,000 acres (State Water Resources Control Board, 1987).

Collection and disposal of drain water in the San Joaquin Valley is described by both point source and nonpoint source characteristics. Deep percolation on farm fields without drainage systems can contribute to a high water table that is being drained by systems installed on neighboring farms. Drain water collected in individual drainage systems may be generated by excess irrigation on overlying fields or may result partially from nonpoint source contributions to the water table from other farms in the area. When this occurs, it may be difficult and very costly to determine the amount of drain water produced by individual farmers.

Point source outlets of drain water are created when farmers install subsurface drainage systems and pump drain water from the ground into drainage ditches and other waterways. It is relatively easy to measure the volume of drain water discharged from individual drainage systems using flow meters placed on outlet pipes. However, when nonpoint sources contribute to the volume collected and discharged by point source outlets, efficient drain water reduction policies must consider the nonpoint contributions to achieve regional objectives at minimum cost. One example of nonpoint source contribution is the lateral movement of water in the saline water table in the drainage problem area.

Standard point source control policies implemented at drainage system outlet pipes will not motivate efficient reductions in drain water volumes when nonpoint sources are present. The policies will generate high incremental costs of drain water reduction for some farmers and low incremental costs for others. Nonpoint source pollution policies will be required to achieve efficient solutions to drainage externalities. Candidate policies include incentives and regulations that motivate adoption of best management practices, taxes and subsidies on inputs that generate or reduce

¹Paper No. 90074 of the *Water Resources Bulletin*. Discussions are open until April 1, 1992.

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nonpoint source pollutants, and restrictions on the use of selected inputs.

Griffin and Bromley (1982) describe the conceptual foundations of nonpoint taxes, standards, and incentives for reducing surface runoff. Shortle and Dunn (1986) examine the implications of selected nonpoint policies in a stochastic setting when farmers and regulators have access to different information regarding farm-level management. Knapp *et al.* (1990), describe the efficiency and distributional impacts of alternative nonpoint policies in an empirical analysis of cotton production in the San Joaquin Valley.

Gardner and Young (1988) examine combinations of nonpoint pollution policies to control irrigation-induced water quality problems in the Colorado River. Dinar *et al.* (1989), examine the effect on farm-level decisions of drainage fees, higher water costs, and increasing block-rate prices for irrigation water. These studies describe the conceptual foundations of economic incentives that modify the price of inputs that generate or reduce effluent from nonpoint sources. Results of simulation models describe the potential reductions in pollution that can be achieved with incentive programs, such as increasing block-rate prices for irrigation water.

This paper examines an increasing block-rate pricing program that was actually implemented in a California irrigation district in 1989. The goal of the program is to reduce the volume of drain water collected in the district. Irrigation and drainage data collected during 1989 describe a reduction in irrigation deliveries, relative to crop water requirements, and a reduction in the volume of drain water collected by a relevant subset of drainage systems in the district. Farmers achieved these reductions through improvements in irrigation management that were motivated by many factors including crop yield objectives, water quality concerns, and the increasing block-rate prices for water.

Precise measurement of the impact of tiered prices on irrigation deliveries will require additional data collected during subsequent years. This paper describes the observed responsiveness of farmers to the tiered pricing program and the irrigation and drainage data that were collected during 1989. This information provides insight into the potential success of economic incentive programs in motivating efficient use of irrigation water and reducing drain water volume.

THE BROADVIEW PROGRAM

The 10,000-acre Broadview Water District, located near Firebaugh, California, implemented increasing

block-rate prices for irrigation water in the 1989 crop year (October 1988 through September 1989). The goal of the program is to motivate improvements in water management that will reduce the volume of drain water collected in the 25 on-farm subsurface drainage systems installed beneath 6,500 acres in the district.

The appropriate block-rate pricing structure for achieving the drain water reduction goal includes crop-specific tiering levels (irrigation depths at which the price of water rises) and field-level accounting of water deliveries. Crop-specific tiering levels are required because the volume of drain water generated per unit of applied water varies among crops according to crop water requirements. Field-specific accounting is required because drain water coefficients also vary among soil types.

Crop-specific tiering levels allow larger amounts of water to be applied on crops with higher water requirements before higher prices become effective. A pricing program that includes only a single tiering level that is imposed on all crops would distort farm-level cropping pattern decisions in favor of crops with relatively low water requirements. This design is sensible when the ultimate goal of the program is strictly water conservation, but will impose unnecessary farm-level costs when the primary goal is drain water reduction.

Field-level accounting of water deliveries motivates careful water application on all farm fields, regardless of soil or drainage system characteristics. Broadview soils range in texture from relatively coarse (sandy loam) to relatively fine (clay and clay loam). Surface irrigations on the coarser soils generate more drain water than those on the finer soils, as longer set times are required to move water across the field. A program that allows farmers to purchase irrigation water at prices based on the average depth of water applied on several fields provides less incentive to reduce applied water on coarse textured soils when a farmer has both coarse and fine textured fields. The potential to significantly reduce drain water is greater when farmers are motivated to reduce applied water on the coarse textured soils.

A truly efficient pricing structure would actually include soil-specific tiering levels to address the variation in drain water coefficients among soil types. However, such a policy would be considered inequitable by farmers with lighter soils who would face more restrictive tiering levels than farmers with heavier soils. Field-specific accounting in a program with tiering levels that are not soil-specific is a second-best attempt to improve economic efficiency, while minimizing perceived inequities among farmers.

PROGRAM DESIGN

Prior to implementing block-rate prices at Broadview, the single price of irrigation water was \$16.00 per acre-foot. This price is sufficient to recover the variable costs of delivering irrigation water, including the price paid to the U.S. Bureau of Reclamation and the cost of energy required to lift the water through a series of ponds and laterals in the district. Fixed costs of district operations are recovered through an annual assessment of \$42.00 per acre.

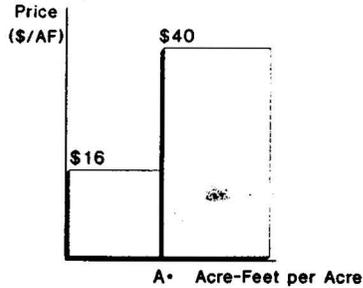
Most of the drain water collected in Broadview drainage systems must be lifted uphill one or more times before the district releases it into regional drainage ditches. Silt deposited by surface runoff causes rapid deterioration of pump components and must be removed regularly. The average annual cost to maintain Broadview's drainage ditches and to operate its drainage water discharge outlet is about \$77,000, or \$21.00 per acre-foot of collected drain water. This cost could be recovered with a surcharge of \$3.08 per acre-foot on all of the 25,000 acre-feet of water delivered to all fields in the district each year.

A flat-rate surcharge of \$3.08 per acre-foot of delivered water would not provide significant incentive to reduce irrigation deliveries. One goal of the block-rate pricing program is to recover district drainage costs through higher prices for units of applied water that generate the most drain water. The base price of \$16.00 per acre-foot is retained in the new price structure for water delivered up to crop-specific tiering levels (Figure 1). Additional water is priced at \$40.00 per acre-foot, the price considered sufficient to recover total drainage disposal costs through payments for water purchased in the higher price block.

A two-price block-rate design was selected for Broadview to motivate drain water reduction, while maintaining an easily understandable price structure. Pricing schemes with several blocks were considered too complex for use in the first year of the new pricing program. The two-price program provides the desired motivation for drain water reduction and allows farmers to easily monitor cumulative irrigation depths, relative to the two price blocks, throughout the season.

Tiering levels for the 1989 crop year were set at 90 percent of the district-wide average irrigation depths for 1986 through 1988 for all crops. This approach incorporates locally relevant crop water requirements, soil characteristics, and irrigation practices. Tiering levels based on district average irrigation depths motivate farmers to reduce or eliminate excessive irrigations, while not requiring changes in cultural practices where irrigation depths are already less than the

district average. The 10 percent reduction was previously determined to be sufficient to motivate a 15 percent reduction in drain water volume throughout the district (Wichelns and Nelson, 1989).



- A* is the tiering level that varies among crops.
 A* = 2.9 for cotton and tomatoes,
 1.9 for melons and alfalfa seed,
 2.1 for wheat, 1.7 for barley,
 3.9 for sugarbeets, and 5.1 for rice.

Figure 1. Increasing Block-Rate Prices for Irrigation Water.

Average annual irrigation depths for the six major crops grown during 1986 through 1988 range from 2.06 feet on alfalfa seed to 4.58 feet on sugarbeets (Table 1). The three-year average for cotton and tomatoes in Broadview is 3.2 feet, while the average irrigation depth for rice in an adjacent water district is 5.65 feet. All of the data presented in Table 1 describe farm-level deliveries of irrigation water and include surface runoff and deep percolation. Deliveries are measured using propeller meters placed in field turnout gates. On-farm recirculation is not practiced in Broadview because the district collects all of the surface and subsurface drainage water. Some portion of the drainage water is recirculated and blended with fresh water delivered to farm fields.

Ten-percent reductions in the average irrigation depths result in tiering levels that range from 1.9 feet for alfalfa seed and melons to 5.1 feet for rice (Table 2). Cotton and tomato fields are allowed 2.9 feet at the lower water price, while sugarbeet fields are allowed 3.9 feet. Tiering levels for barley and wheat are 1.7 feet and 2.1 feet.

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TABLE 1. Crop-Specific Average Irrigation Depths for Major Crops in the Broadview Water District, 1986 Through 1989.

Crop	Year					Comparison of 1989 With the 1986-1988 Average
	1986	1987	1988	1986-1988 Average	1989	
Cotton	3.21	3.13	3.27	3.20	3.34	+0.14
Tomatoes	3.21	3.29	3.15	3.22	2.72	-0.50
Melons	2.15	1.99	2.20	2.11	1.93	-0.18
Wheat	2.01	2.55	2.35	2.30	3.02	+0.72
Sugarbeets	5.01	3.81	4.92	4.58	3.73	-0.85
Alfalfa Seed	2.13	2.24	1.80	2.06	1.84	-0.22
Rice*	5.72	5.24	5.99	5.65	5.40	-0.25

*Rice irrigation data for 1986 through 1988 are from the Firebaugh Canal Water District.

TABLE 2. Crop-Specific Tiering Levels for Selected Crops in the Broadview Water District.

Crop	Tiering Level (equivalent depth, in feet)
Cotton	2.9
Tomatoes	2.9
Melons	1.9
Wheat	2.1
Barley	1.7
Sugarbeets	3.9
Alfalfa Seed	1.9
Rice	5.1

IRRIGATION SUMMARY

Several improvements in water management were observed during 1989. Farmers displayed increased interest in irrigation depths throughout the season and shared information regarding irrigation practices and crop management. Several farmers worked with consultants to schedule irrigations, and others implemented improved irrigation practices including shortened furrow lengths, reduced set times, and alternate-furrow application during some irrigations.

Water deliveries were reduced on tomato, melon, and sugarbeet fields in Broadview in 1989, while average deliveries increased on cotton and wheat fields. The average cotton and wheat irrigation depths of 3.34 feet and 3.02 feet are higher than those observed during any of the previous three years (Table 1). The average depths applied on tomatoes (2.72 feet), melons (1.93 feet), and sugarbeets (3.73 feet) are lower than those observed during the same time period. The average depth applied on alfalfa seed (1.84 feet) is lower than that observed during two of the previous three years.

Much of the increase in the average irrigation depths on cotton and wheat in 1989 can be explained

by evapotranspiration (ET) rates that exceeded average levels in critical months. Reference ET was higher than average from April through August, and cotton growth degree days accumulated rapidly, early in the season. The first irrigation was applied during late May and early June on most fields. Higher than average reference ET values were sustained in July and August, resulting in a continuation of cotton irrigations beyond the normal period. In past years, the majority of cotton fields have received three summer irrigations in addition to the preirrigation applied in winter. In 1989, only four cotton fields (12 percent) were irrigated three times in summer, while 14 fields (44 percent) were irrigated four times and 13 fields (41 percent) received a fifth irrigation. Farmers clearly responded to crop water requirements in 1989, and the imposition of tiered prices did not produce immediate reductions in applied water for all crops.

Irrigations on 7 of 32 cotton fields were completed without exceeding the 2.9 feet of water available at \$16.00 per acre-foot. The per-acre cost of exceeding the tiering level on remaining fields is calculated by multiplying the excess irrigation depth (actual depth minus the tiering level) by \$24.00, the difference between \$40.00 per acre-foot and \$16.00 per acre-foot. The per-acre cost of exceeding the tiering level on 25 of the cotton fields ranges from \$2.64 per acre on a field that received 3.01 feet of water to \$36.24 per acre for a field receiving 4.41 feet.

Rainfall in winter usually contributes a portion of the crop water requirement for grain crops that are planted in November and December in Broadview. Rainfall during December 1988 was higher than the three-year average and stimulated early germination. Higher than average reference ET during December and January promoted rapid growth of the grain crops. Rainfall during January through April was below average and did not contribute to crop water requirements. Irrigations began in January and continued through May, resulting in an average

irrigation depth of 3.02 feet. This exceeds the average for the previous three years by 0.72 feet.

None of the grain fields completed the season within the lower price block. The per-acre cost of exceeding the tiering level ranges from \$5.52 per acre on a field that received 2.13 feet of water to \$65.04 per acre on a field receiving 4.61 feet.

A sprinkler system was used for the first irrigation on the single sugarbeet field in Broadview and quarter-mile furrows were used during remaining irrigations. The total water applied to the sugarbeet field was 3.73 feet, which is less than the average for the previous three years. The farmer reported that irrigations were managed more closely in 1989 and that additional time was allowed to elapse between irrigation events. The sugarbeet field was irrigated completely within the lower price block. Sugarbeet tonnage was equal to that achieved in previous years and the sugar content was higher than expected.

The average irrigation depth for alfalfa seed was 1.84 feet in 1989, which is less than the three-year average for this crop. Two of the five alfalfa seed fields received water from the \$40.00 price block. The per-acre cost of exceeding the tiering level ranges from \$4.08 to \$7.92 per acre.

Irrigations on tomato and melon fields in 1989 provide additional examples of successful reductions in applied water, as a result of improvements in water management in Broadview. Farmers report that these crops are particularly susceptible to overwatering and that investments in irrigation management are rewarded with yield improvements. Surface irrigation methods result in nonuniform infiltration of water when soil characteristics and water requirements vary widely within fields. Farmers often overirrigate some portions of a field while delivering the minimum depth needed to satisfy the crop water requirement in other portions of the field. Reduced tomato and melon yields have been observed in the overirrigated portions of typical 160-acre fields in Broadview.

Farmers shared information regarding improvements in the irrigation of tomatoes and melons and potential yield effects in discussions that were motivated by the water pricing program. Several farmers responded by increasing their efforts to manage irrigations more closely on these crops. In past years most irrigations were applied to an entire field over a period of many days, using 12-hour and 24-hour sets. Farmers now irrigate selected portions of tomato and melon fields by delivering water only to furrows where measurements of soil moisture indicate that water is needed. Irrigation sets of six hours and eight hours are becoming commonplace on tomatoes and melons, especially during the final irrigations, when the potential for yield improvements and drain water reduction may be significant.

Four of seven tomato fields and five of nine melon fields completed the season within the lower price block. The per-acre cost of exceeding the tiering level ranges from \$6.00 to \$16.08 per acre for tomatoes and from \$1.20 to \$6.48 per acre for melons.

Field delivery ratios are defined as the estimated crop evapotranspiration, minus effective rainfall, divided by the depth of water delivered to farm fields. These ratios are similar to irrigation efficiencies, but do not account for leaching requirements, cultural practice water requirements, or water stored in the soil for a subsequent crop. Field delivery ratios simply describe the ratio of net crop water requirement to the depth of water delivered to the field. Ratios that approach unity imply more efficient use of water than ratios that are closer to zero, but the ratios are not direct measures of irrigation efficiency. In addition, surface runoff and deep percolation are *not* deducted from the delivered water depth before calculating the ratios. Therefore, estimated field delivery ratios will generally be less than typical irrigation efficiency measurements for a given field.

The estimated field delivery ratio for cotton fields in the Broadview Water District increased from 0.65 to 0.71 (9.2 percent) between 1988 and 1989 (Table 3). Estimated delivery ratios also increased for tomatoes (15.7 percent), melons (26.7 percent), sugarbeets (44 percent), alfalfa seed (5.4 percent), and dry beans (25.5 percent). The district-wide irrigation delivery ratio increased from 0.65 to 0.73 (12.3 percent) between 1988 and 1989.

DRAINAGE SUMMARY

Four of the 25 drainage systems in Broadview were expanded to include additional drained acres between 1988 and 1989. All of the fields drained by a fifth system are adjacent to irrigated fields that lie outside the Broadview Water District. The volume of drain water collected by this system increased by 91 percent between 1986 and 1987, by 128 percent between 1987 and 1988, and by 55 percent in 1989. Much of the persistent increase in drain water volume from this system is likely due to subsurface lateral flows (nonpoint source contribution) that are generated by irrigations on fields that are not in Broadview. These five drainage systems are not included in the comparison of drain water volume and constituent loads presented below.

A subset including 20 of the 25 drainage systems in Broadview represents a consistent number of drained acres during 1986 through 1989 and eliminates the one drainage system that appears to be dominated by nonpoint source contribution from subsurface lateral

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flows. These 20 systems drain 4,896 acres, or about 77 percent of the land with drainage systems in Broadview.

The volume of drain water collected by these 20 drainage systems during the 1989 crop year suggests that the ultimate goal of the pricing program has been achieved. Drain water was reduced below the average volume collected during 1986 through 1988 at

15 of the 20 drainage systems (Table 4). Twelve drainage systems produced less water than the volume collected during 1988. Reductions at individual drainage systems between 1988 and 1989 range from 5 acre-feet (4.1 percent) at System 20 to 214 acre-feet (27.6 percent) at System 13. The total volume of drain water collected in the subset of 20 systems in crop year 1989 is 815 acre-feet (23.1 percent) less than the

TABLE 3. Crop-Specific Estimated Field Delivery Ratios in the Broadview Water District, 1986 Through 1989.

Crop	Year				
	1986	1987	1988	1986-1988	1989
	(estimated ratio)*			Average	
Cotton	0.68	0.71	0.65	0.68	0.71
Tomatoes	0.55	0.44	0.51	0.50	0.63
Melons	0.38	0.36	0.45	0.40	0.57
Wheat	0.53	0.43	0.58	0.51	0.49
Sugarbeets	0.54	0.62	0.59	0.58	0.85
Alfalfa Seed**	1.09	1.42	1.67	1.39	1.76
Dry Beans	0.58	0.61	0.55	0.58	0.69
District Wide	0.66	0.68	0.65	0.66	0.73

*Field delivery ratios are defined as the estimated crop evapotranspiration, minus effective rainfall, divided by the depth of water delivered to farm fields. Surface runoff and deep percolation are not deducted from the delivered water depth before calculating the estimated ratio.

**Field delivery ratios for alfalfa seed are greater than 1.00 because: (1) farmers underirrigate the alfalfa plants to generate stress that increases bloom and seed production, while minimizing vegetative growth; and (2) the root system of alfalfa seed becomes very deep during the two or three years that the crop is grown, and the plants will often utilize water in the shallow high water table.

TABLE 4. Drain Water Volume Collected in 20 Subsurface Drainage System in the Broadview Water District, 1986 Through 1989.

Drainage System	Area Drained (acres)	Year					Comparison of 1989 With the 1986-1988 Average
		1986	1987	1988	1986-1988	1989	
		(acre-feet)						Average
1	405	349	190	147	229	130	-99
2	600	643	385	330	453	417	-36
3	280	22	52	50	41	70	+29
4	285	74	52	150	92	121	+29
5	100	113	119	132	121	98	-23
6	100	96	17	66	60	40	-20
7	290	197	152	48	132	63	-69
8	145	78	47	43	56	36	-20
9	300	252	153	100	168	88	-80
10	300	171	176	169	172	129	-43
11	150	194	190	110	165	19	-146
12	345	156	263	111	177	180	+3
13	600	820	629	774	741	560	-181
14	275	206	158	184	183	96	-87
15	150	95	124	129	116	102	-14
16	169	382	301	275	319	281	-38
17	85	102	100	46	82	46	-36
18	60	41	50	40	44	76	+32
19	230	46	14	23	28	29	+1
20	27	158	134	130	141	125	-16
Total	4,896	4,197	3,307	3,058	3,521	2,706	-815

three-year average annual volume and 352 acre-feet (11.5 percent) less than the volume collected in 1988.

The estimated salt load contained in collected drain water in 1989 decreased from the average salt load during 1986 through 1988 at 16 of the 20 drainage systems. The total estimated salt load from the subset of systems in 1989 is 6,400 tons (24.7 percent) less than the three-year average salt load. The estimated salt load decreased by 2,407 tons (11.0 percent) between 1988 and 1989 (Table 5).

Estimated boron loads decreased at 13 of the 20 drainage systems between 1988 and 1989. The total estimated boron load from the subset of systems decreased by 3.33 tons (11.0 percent) between the two years. Estimated selenium loads decreased at 14 of the 20 drainage systems between 1988 and 1989, and the estimated total load of selenium decreased by 0.07 tons (9.2 percent).

CONCLUSIONS

The Broadview pricing program provides farm-level evidence that increasing block-rate prices for irrigation water can motivate improvements in cultural practices that will reduce the volume of drain water collected beneath farm fields. Higher prices for water applied in excess of selected tiering levels provide a significant incentive for reducing applied water, while having minimal impact on the total farm-level expenditure for water. The framework is general in its approach to motivating careful use of water resources and in reducing the off-farm effects of irrigation. Details of individual pricing structures will vary with program objectives and the level of water delivery accounting that can be undertaken by individual water districts.

The district-level costs of implementing a tiered pricing program include the improvements required to record water deliveries for individual fields. At the present time, this is not common practice among irrigation districts in the San Joaquin Valley. Many

districts will need to install additional water delivery meters or monitor deliveries through existing meters more carefully, to record field-specific and crop-specific irrigations. Record-keeping and billing procedures in district offices will require modification to accommodate multiple prices and tiering levels.

The information generated when districts implement tiered water pricing will be valuable to farmers and district staff in reviewing irrigation practices and identifying opportunities to improve water management. Crop-specific irrigation data describing actual water deliveries to individual fields allow farmers to compare results of irrigation practices. These discussions often motivate farmers to consider alternative irrigation methods. The data also improve farm-level crop planting decisions when water allocations are reduced during critically dry years or when farmers consider producing crops they have not grown previously.

ACKNOWLEDGMENTS

The author appreciates the assistance provided by David Cone, Manager of the Broadview Water District, and the District Board of Directors. The comments and suggestions of three anonymous reviewers are also appreciated. This paper is Rhode Island Agricultural Experiment Station Contribution Number 2682.

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TABLE 5. Drain Water Volume and Estimated Constituent Loads in 20 Subsurface Drainage Systems in the Broadview Water District, 1986 Through 1989.*

Measure	Units	Year			
		1986	1987	1988	1989
Drain Water Volume	Acre-Foot	4,197	3,307	3,058	2,706
Estimated Salt Load	Tons	29,971	25,869	21,931	19,524
Estimated Boron Load	Tons	-	-	30.34	27.01
Estimated Selenium Load	Tons	-	-	0.76	0.69

*Boron and selenium data are not available for 1986 and 1987.

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CASE STUDY**Responding to Water Quality Problems through Improved Water Management**

Broadview Water District is located on the west side of the San Joaquin Valley, near Firebaugh. It is comprised of about 9,500 acres of highly productive farmland with 18 farms ranging from 160 acres to 1,280 acres. The district has a water supply contract with the U.S. Bureau of Reclamation for 27,000 acre-feet of water per year. This represents the district's only water supply since the groundwater is considered unsuitable because of its relatively high salinity and boron concentrations.

The district is situated in the drainage problem area of the Grassland Basin. Impervious clay layers restrict the percolation of irrigation water through the soil profile. Subsurface drainage systems of perforated pipes, sumps and discharge pumps are required on many farms to maintain the saline high-water table at a depth that will not damage crop yields or reduce the long-term productivity of farm fields. Drainage systems have been installed beneath 70% of the district.

Drain water collected in Broadview and other Grassland Basin districts contains several elements found naturally in local

soils, but the elements degrade water quality when discharged into rivers or streams. State water quality authorities have directed that the boron, molybdenum and selenium loads in agricultural drainage water entering the San Joaquin River be reduced to achieve water quality objective levels.

The subsurface drain water within the district is discharged into open drains and mixed with surface drain water (tail water). The mixed water can either be discharged to the San Joaquin River along with drain water from other districts or recycled into the district's irrigation water supply.

In order to meet the water quality objectives, Broadview has developed an extensive water management program. The entire water management program revolves around the monitoring of water quantity and water quality.

Since the volume of applied water has a direct impact on subsurface drain flows, the water management program focuses on improving irrigation effectiveness and efficiency. The major components of the Broadview program that have contributed to the success include:

- Collection of field-specific data describing water deliveries, irrigation events, and other agricultural practices.
- Tiered water pricing.
- The timely exchange of information among district farmers.

- Flexibility in scheduling water delivery turn ons, turn offs and changes.

- Low interest loan for the purchase of sprinkler and gated pipe irrigation systems.

- Water transfers and purchases to help farmers manage water.

- Participation in demonstration projects to improve water management.

Broadview has shown that improvements in field application efficiencies have increased by almost 23% from 1986 to 1991. The 1992 efficiencies appear to be even better than in 1991.

Over the last seven years, farmers in Broadview have implemented many new irrigation practices and increased the effectiveness and efficiency of water application. Several crops are now irrigated more frequently than in the past, but the amount of water applied during each irrigation event has been reduced and the total amount of water applied during pre-irrigations and seasonal irrigations has also been reduced.

The table below shows the reductions from the subsurface drainage systems associated with the improvements in water management as well as regional changes resulting from drought impacts.

This case study was prepared by Broadview Water District.

Drain water volume and estimated constituent loads, Broadview Water District, 1986 through 1991

Measure	Units	1986-88 (ave.)	1989	1990	1991
All 25 Drainage Systems					
Drain Water Volume	(acre-feet)	3,986	3,736	3,464	1,860
Estimated Salt Load	(tons)	29,365	27,086	28,499	17,378
Estimated Boron Load	(tons)	36.17	36.84	34.33	18.53
Estimated Selenium Load	(tons)	0.93	0.99	1.04	0.60



PROGRAM FEATURES

PURPOSE: To further Westlands' longstanding commitment to maximize the benefit of the limited water supply and minimize drainage problems by promoting efficient irrigation management.

INFORMATION

- o **IRRIGATION GUIDE** - A weekly mailing that provides farmers crop water use information from which to estimate the amount and timing of irrigations for various crops. This information is based on observed weather and is verified by monitoring moisture changes in the crop root zone.
- o **IRRIGATION MANAGEMENT HANDBOOK** - Provides farmers with current technical information on soils, crop characteristics, irrigation scheduling, water use planning, and salinity management in Westlands.
- o **PROFITABLE PRACTICES** - A bi-monthly publication that highlights progressive efforts by farmers to conserve water and reduce costs.
- o **WORKSHOPS** - Several workshops held each year provide farmers with timely information and innovative water management ideas and an opportunity to share their experiences.

MONITORING

- o **ADVISORY MEETINGS** - Water Management Specialists meet periodically with small groups of farmers to share experiences and identify areas of need to which program resources can be targeted.
- o **CROP WATER USE MONITORING** - Conditions throughout the District including weather, soil type and moisture, crop growth, and water use, are measured to verify crop water use models and validate other Program activities.

ASSISTANCE

- o **COMPUTER PROGRAMS** - A computer and assistance is available to farmers to run programs designed to help them with irrigation cost evaluations (ICE); sprinkler system operation (SPACE) and alternative irrigation management practices and PG&E electricity time of use rate evaluation (AGWATER). Experienced Water Management Specialists are available to assist farmers with these programs.
- o **TECHNICAL ASSISTANCE** - Experienced Water Management Specialists are available to help farmers solve their water management problems.
- o **IRRIGATION IMPROVEMENT PROGRAM** - Provides cost sharing to farmers to retain the services of approved private irrigation consultants with the goal of improving distribution uniformity and irrigation efficiency while maintaining or increasing crop yields.

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The Statement of
Jerald R. Butchert, General Manager of
Westlands Water District
Presented to the
Senate Subcommittee on Water and Power
August 29, 1989

District Background/History

Westlands Water District (Westlands or the District) was formed in 1952 under provisions of the California Water District Law upon petition of landowners, many of whom were also farmers in the area, within Westlands' boundaries. Westlands' formation was a necessary step in order to establish a contracting entity for a surface supply of irrigation water for the farmers. In developing the area, farmers had relied upon pumped water from underground aquifers, which were being severely overdrafted.

For the principal purpose of furnishing water for irrigation, the Secretary of Interior (Secretary) was authorized under the San Luis Act of June 3, 1960, to construct, operate and maintain the San Luis Unit as an integral part of the Central Valley Project. The San Luis Unit would also provide water for municipal and domestic purposes, as well as recreation and fish and wildlife benefits.

Agricultural drainage service also was provided for in the San Luis Act. Thus, Section 1(a) of the Act states, in part, that:

Construction of the San Luis Unit shall not be commenced until the Secretary has...received satisfactory assurance from the State of California that it will make provision for a master drainage outlet and disposal channel for the San Joaquin Valley, as generally outlined in the California water plan, Bulletin Numbered 3, of the California Department of Water Resources, which will adequately serve, by connection therewith, the drainage system for the San Luis unit or has made provision for constructing the San Luis interceptor drain to the delta designed to meet the drainage requirements of the San Luis unit as generally outlined in the report of the Department of the Interior, entitled "San Luis

Unit, Central Valley Project," dated December 17, 1956.

Westlands' Water Supply

In 1963 Westlands entered into a long-term water service contract with the U.S. Department of the Interior's Bureau of Reclamation (Bureau). The contract provided for surface water delivery from the San Luis Unit of the Central Valley Project over a period of 40 years from the date of the initial water delivery to the unit, which happened to have occurred in 1968. The contract provides for both water and drainage service, and was the traditional water service contract that the Bureau was signing for other water entities at that time.

The 1963 contract provides for 900,000 acre-feet of water annually for Westlands, which at that time consisted of about 400,000 acres. In 1965, at the insistence of the United States, Westlands merged with the adjacent Westplains Water Storage District, which contained some 200,000 acres, but had not contracted for a water supply. At that time, the United States committed the remaining yield of the San Luis Unit, some 250,000 acre-feet annually, to provide a water supply for the added acreage. It was recognized by both the United States and the farmers and landowners that 250,000 acre-feet was insufficient for the needs of the additional acreage. However, the 1963 contract provided for the purchase by Westlands of additional (interim) water, if and when available.

The merger was accomplished by passage of a special statute by the California Legislature. A basic provision of that statute assured the lands in the original Westlands district a prior right to water under any contract in effect for that District, namely, the 1963 contract. This supply provides about 2.6 acre-feet per acre to the 338,323 acres currently eligible to receive project water in this area of the District, an adequate but not abundant supply for the present cropping pattern.

However, the 250,000 acre-feet for the former Westplains area provides only half that much, 1.3 acre-feet for each of the 187,551 eligible acres, a clearly inadequate supply. Until the San Felipe Project came on line, however, an additional 100,000 to 150,000 acre-feet of interim water has been

available in most years to meet the needs of the farmers in the former Westplains area.

Acreege Limitation

Prior to the first significant deliveries of San Luis Unit water to Westlands in 1968, much of the land was held in large ownerships. Only about 129,000 acres were held in ownerships of 160 acres or less and were immediately eligible for project water. However, as distribution facilities were completed and Project water became available, most of the owners who held land in excess of 160 acres entered into recordable contracts. Those contracts, which are a condition to receiving Project water for excess land, require that the landowner agree to sell his land within 10 years (five years under the new law) at a Bureau-approved price which does not include any increment of value attributable to the availability of Project water and to persons who will be non-excess landowners.

By the mid-1970s, more than 350,000 acres had been placed under such contracts and nearly 135,000 acres had been sold at Bureau-approved prices to new owners in parcels of 160 acres or less. As a result, the numbers of both landowners and farms had more than doubled, from about 2,500 to nearly 5,300 and from 97 to about 220, respectively. The average size of the farming operations had been cut in half, from 4,640 acres to about 2,400. Two of the largest farms, Giffen, Inc., and Anderson, Clayton & Co., sold nearly 77,000 acres. This land was purchased by 607 individuals who operated 77 separate farms.

The sale of excess land was halted in 1976 by a Federal District court order, which required the Bureau of Reclamation to conduct such sales under formal rules and regulation in accordance with the Administrative Procedures Act, rather than under less formal guidelines and instructions. At the same time, there was increasing interest in Congress to modify the original Reclamation Act of 1902. Consequently, formal rules and regulations for the sale of excess land were not adopted until after passage of the Reclamation Reform Act of 1982.

Excess land sales resumed under formal rules and regulations in 1984. In the past five years, approximately 100,000 acres has been sold to new

owners. Southern Pacific, for example, has sold some 70,000 acres. In addition, many of the existing larger farms were broken up in order to comply with the provisions of the Act.

Clearly, the social goals of breaking up large ownerships and widely distributing project benefits have been largely achieved in Westlands. Critics who claim that interest-free repayment of the capital costs of irrigation projects, such as the Central Valley Project, is an unwarranted subsidy overlook an important fact: In order to maximize the distribution of benefits derived from the expenditure of public funds, the United States Congress placed limits on the amount of land a person could own and irrigate with Project water. Currently there are 612 farms in Westlands which receive project water. These farms average 875 acres each.

Crop Production

In 1988, the farmers in Westlands produced crops with a gross farm-gate value of more than \$650 million. This is equivalent to about one-third of the total agricultural production in Fresno County, which is the nation's leader in that respect. Some 35 crops are produced in Westlands, including cotton, tomatoes, lettuce, cantaloupes, almonds, garlic, onions, broccoli, carrots, and a variety of other vegetables. The acreage of all vegetables and melons has more than doubled since 1980, while the plantings of wheat and barley have sharply declined.

Drainage History/Background

Adequate drainage is necessary anywhere irrigated agriculture exists. Throughout the world, irrigated agriculture has resulted in salt buildup in the soil, particularly in arid or semi-arid areas. Irrigation water carries salts which accumulate in the soils, eventually retarding plant growth and lowering productivity if the salts are not removed. Leaching, the agricultural practice used to remedy salt buildup, is the application of water in excess of crop needs to carry salts below the crop root zone.

Salt accumulation is complicated in Westlands and other areas of the western San Joaquin Valley because of impermeable clay layers that lie beneath the soils. These clay layers make it virtually impossible for leaching flows

to carry water away from the crop root zone, resulting in highly saline perched groundwater. Without adequate drainage, the perched water table rises into the crop root zone, posing a dangerous hazard.

Efforts to maintain economical agricultural operations in areas where salt accumulation is a problem has resulted in the practice of installing subsurface drains to collect and carry excess salty water away for disposal, or discharge to a salt sink.

In the 1960s, Westlands and several other water agencies, urged the Bureau to develop drainage facilities as required by the San Luis Act. From 1968 to 1975, 82 miles, or 40 percent of the Drain and 1,280 acres, or 21 percent of the Kesterson Regulating Reservoir were constructed. The Drain would have been a concrete-lined canal with capacity to carry approximately 150,000 acre-feet of drainage water per year from the San Luis Unit.

The Drain was designed to empty into the western Sacramento-San Joaquin Delta near Chipps Island. However, the Drain's construction was halted in 1975 because of funding limitations and disagreements over the potential environmental impacts of drainage water discharge into the Delta. An outlet was never constructed and Kesterson became the terminus of the Drain.

With the intent of increasing habitat for waterfowl in the San Joaquin Valley, the United States Fish and Wildlife Service (FWS) in cooperation with the Bureau in 1970 designated Kesterson Reservoir as a National Wildlife Refuge. The location of the refuge is situated along the Pacific Flyway. At the time of the designation, it was known that the only reliable permanent water supply for the refuge would be subsurface saline drainage water transported through the San Luis Drain.

The Bureau started construction of Westlands' drainage collector system on 42,000 acres in the northern part of the district in 1976. The system consists of about 108 miles of open-joint collector pipelines at 0.5-mile intervals. About 5,000 acres of grower-funded subsurface on-farm drainage systems were installed and connected to the collector system between 1978 and 1981. A moratorium on these on-farm drainage system hookups was imposed in May 1981 because of the limited capacity of Kesterson Reservoir. During 1980 the Bureau renewed technical studies that were needed to obtain a discharge permit from the California State Water Resources Control Board (SWRCB) for the

Drain to discharge into the Delta.

In 1983 FWS biologists discovered waterfowl deformities and deaths at Kesterson, which later were attributed to excessive amounts of selenium. In order to minimize waterfowl attraction to Kesterson, the Bureau reduced the number of ponds and provided additional water deliveries to neighboring wetlands. A hazing program was also started to discourage the waterfowl from nesting at Kesterson.

Selenium is a naturally-occurring trace element found in rocks and soils at numerous locations throughout the world. Relatively large quantities of the mineral are found in the alluvial fans of Panoche and Little Panoche Creek in western Fresno County, including the area of Westlands served by the collector drainage system. Selenium is a necessary dietary element for humans and other animals, but can cause chronic or acute toxic effects when taken in elevated amounts.

Certain vegetation can absorb and accumulate selenium. Selenium uptake in crops depends on several factors including plant species, soil type and chemical form of selenium present. A recent study conducted by the Cooperative Extension of the University of California, Publication 3330, concluded, however, that selenium levels are not a human health concern in the crops grown on the west side of the San Joaquin Valley, where the District is located. Animals (invertebrates and vertebrates) also accumulate selenium through plant and animal food sources, causing concern for waterfowl and shorebirds that ingest plant, animal and sediment materials.

Tests completed in 1984 determined that selenium poisoning was the probable cause of death for 12 coots and one grebe found at Kesterson. The hazing program continued in an effort to keep waterfowl from using Kesterson. It was concluded that the selenium at Kesterson came from the agricultural drainage water carried to the reservoir via the San Luis Drain.

As the year 1984 began, completion of the Drain beyond Kesterson was still considered to be the most viable solution to the agricultural drainage problem. However, the discovery of selenium's toxic effects on waterfowl led to much controversy over the potential dangers of selenium and, possibly, other naturally-occurring trace elements. The resulting uproar and national attention left in doubt the concept of completing the Drain.

State Water Resources Control Board Order No. WQ 85-1

A neighboring landowner petitioned the Regional Water Quality Control Board (RWQCB) in April 1984, to prohibit the discharge of waste water into Kesterson Reservoir until waste discharge requirements were set. The landowner also petitioned the RWQCB to levy a fine, issue a cease and desist order prohibiting the discharge of drainage water, and issue a cleanup and abatement order. The RWQCB refused to take the actions requested by the landowner; consequently, he appealed to the State Water Resources Control Board (SWRCB).

The SWRCB held a series of three hearings to evaluate the different aspects of the petition and issued Order No. WQ 85-1 on Feb. 5, 1985. The order stated that the issuance of a cleanup and abatement order to the USBR was appropriate, and gave the Bureau three years to implement the order. Selenium was designated as the substance of most concern in terms of the harmful constituents contained in the drainage effluent discharged into the Kesterson facility.

The Closure of Kesterson Reservoir

On March 15, 1985, a congressional hearing was held in Los Banos, California, to consider Interior's progress in carrying out the SWRCB cleanup and abatement order. Citing possible criminal violations under the federal Migratory Bird Treaty Act as a result of the waterfowl deaths at Kesterson, the Interior Department abruptly, and without prior warning, announced that it would immediately begin the process of closing Kesterson Reservoir and the San Luis Drain. Again with no prior warning, Carol Hallett, Special Assistant to Secretary of Interior Donald Hodel, also announced that the Bureau would terminate irrigation deliveries to the 42,000-acre area of Westlands served by the drainage collector system.

The April 3, 1985 Agreement

The adverse impact which the loss of irrigation water and the closure of the Drain would have on farming within Westlands was immediately recognized. The potential losses in farm land values and crop production were considered

very substantial, and even more so when the investment in the District's distribution and drainage systems were added. The shut-down would have affected 51 water user families, many of whom had poured their entire life savings into their farms.

Recognizing the seriousness of the potential disaster, Secretary Hodel agreed to examine the possibility of continuing water deliveries to that portion of Westlands. After intense negotiations between Interior, Westlands, farmers' representatives, the governor of California and other concerned parties, an agreement was signed on April 3, 1985, ensuring that water deliveries to the 42,000-acre area of Westlands would continue.

The agreement also required that the District halt drainage water deliveries to Kesterson by June 30, 1986. At the insistence of Interior, Westlands was required to do this even if it meant plugging the collector drains.

When District involvement in the drainage problem began, the District hired an engineering consultant, CH2M-Hill, Inc., and an environmental consultant, Jones & Stokes Associates, of Sacramento. One of their first recommendations included the possibility of disposing of drainage water by irrigating salt-tolerant forage crops for an interim one-year period. Wildlife experts, however, noted that the forage would be a potential threat to waterfowl by the possible uptake of selenium in the grasses. This potential hazard forced Westlands to modify its plans to include the construction of storage basins and utilizing land application to handle drainage water produced during the fall and winter months. For the long-term Westlands planned to construct several evaporation ponds to dispose of up to 10,000 acre-feet of drainage water annually.

In August 1985, Westlands purchased 366 acres of a 3,500-acre site to be used for the evaporation ponds. The project site is located south of Adams Avenue and west of the San Luis Drain. Largely because of the supplemental environmental safeguards that were required for the storage basins, cost estimates for the project far exceeded original estimates. Westlands decided to scale back the proposed interim project to land application of drainage water on bare soil.

The 366-acre site was used for the land application of approximately 213 acre-feet of drainage water until November 1985, when land applications were discontinued because the soil profile had become saturated with the applied drainage water.

In September 1985, Westlands started a pilot water conservation and management program for farmers in the 42,000-acre area, recognizing that effective water conservation measures are key in any drainage water reduction program. Under the voluntary program, participating farmers received \$8 per acre from Westlands to hire an irrigation consultant. Any fees exceeding the \$8 per acre were paid by the farmers. During the 1985-86 season, about 94 percent of the land in the drainage service area participated in the program.

In 1986 Westlands approved a voluntary recycling program for the 42,000-acre drainage service area to provide an alternative for those water users who preferred to recycle their drainage water rather than have the collector drains serving their fields plugged. Program participants recycle the drainage water by blending it with "fresh" irrigation water and receive \$25 for each acre-foot of drainage water recycled. The payment to water users is based on eliminating the expense of installing 104 earthen plugs.

For a variety of reasons, none of the alternatives examined were capable of meeting the June 30, 1986 deadline for terminating all drainage flows to Kesterson and Westlands was forced to plug the drainage collector system. Westlands began to immediately review a variety of other disposal alternatives including modification of the interim project, intensified irrigation water management, various treatment technologies and deep-well injection.

Barcellos Settlement

Further defining the roles of the Bureau and Westlands in terms of drainage obligation was the settlement of the Barcellos litigation in 1986. The Federal District Court judgment resolved key drainage issues. Among them was the definition of both Westlands' and the Bureau's roles in attempting to solve the drainage problem.

The Barcellos settlement obligates Interior's Bureau of Reclamation to develop a plan for agricultural drainage service by Dec. 31, 1991. This plan is to provide for drainage service facilities which are both cost-effective

and financially feasible. The facilities must be able to transport, treat and dispose of 60,000 to 100,000 acre-feet of drainage water annually. The judgment also contains a schedule for the authorization (if needed), funding and construction of the drainage facilities by the United States.

If the Bureau does not produce a drainage service plan by the deadline set forth in the judgment, Westlands' can assert claims against the federal government based on commitments in the San Luis Act and the 1963 contract. The drainage service obligation that can be claimed against the federal government is limited to the removal and disposal of not to exceed 100,000 acre-feet of drainage water annually for the duration of the Judgment which expires Dec. 31, 2007.

In regard to Westlands' drainage obligations, the Barcellos settlement requires Westlands' landowners to place \$5 million each year into a drainage trust fund until the fund totals \$100 million. The trust fund money is to provide up-front cost-sharing for future drainage facilities. The cost-sharing payment is up to 35 percent of the estimated construction costs for drainage service facilities for that year. Westlands began collecting the amounts required by means of assessments on lands within the District's boundaries in 1988. Westlands is also required to pay its share of annual operation and maintenance costs for any drainage service facilities.

Other Westlands Drainage Projects

Notwithstanding the obligation of the Bureau as provided for in both the San Luis Act and the Barcellos settlement, Westlands continued to pursue possible solutions to the agricultural drainage problem. Since the District started tracing the available alternatives, nearly \$7 million has been expended on various drainage projects. That figure does not include any staff time or expenses in connection with the various projects.

Westlands/EDF Loan. Westlands and the Environmental Defense Fund (EDF) cooperated to jointly request a federal loan of \$3.7 million, approved as part of the Energy and Water Development Appropriations Act of 1985, to conduct feasibility studies and prototype testing of the most promising technologies for solving the drainage problem. Interior never released the funds because of concerns over its authority to make such a loan. By July 1986, efforts to

pursue the loan were dropped by Westlands when it was discovered that private borrowing was available at a lower interest rate.

Selenium Removal Plant. In 1986 Westlands decided to pursue a one-million-gallon-per-day version of a selenium removal plant that had been operating for 15 months on a smaller pilot scale. The process, developed by a British engineering firm, Binnie & Partners, had successfully removed up to 98 percent of the selenium in the farm's drainage water, as well as boron, which is toxic to many crops when concentrated. When the plant was modified to hold costs close to the original budget, the plant could not consistently succeed in reducing the drainage water selenium level to 10 parts per billion (ppb) or less. Because selenium levels of 10 ppb or less could not be reached unless extensive, costly changes were made to the plant, Westlands postponed indefinitely research on the selenium removal plant. From October 1986 through September 1988 Westlands expended more than \$2 million on the selenium removal plant.

Deep-Well Injection Prototype. Also in 1986 Westlands decided to pursue a program involving deep-well injection of drainage water into the earth below a 5,000-7,000-foot-deep geologic formation. The drilling of the \$3.6 million, 8,100-foot-deep prototype deep-well was completed on July 16, 1989 after a month of work by project consultant URS Corporation and its subcontractors. URS expects initial testing of the prototype, which is designed to inject one million gallons of drainage water each day, to begin in March 1990. Deep-well injection is viewed by the District as a potential method of disposing drainage water. To date, Westlands has spent about \$1.5 million on the deep-well injection prototype.

Profitable Practices. Sharing proven water-saving ideas, whether practical or highly technical, is the focus of a new Westlands' publication, "Profitable Practices." This one-page water management fact sheet provides water users with new and workable water saving practices that are currently being used by fellow water users in Westlands. Farmers, in conjunction with District water conservation specialists, develop ideas for the publication with is published about every other month.

Water Conservation Program. In 1987 Westlands approved a \$100,000 District-wide water conservation cost-sharing program similar to the pilot

program established for water users in the 42,000-acre area. Participants are reimbursed \$8 per acre to hire an approved irrigation consultant to evaluate current irrigation practices and advise farmers of possible improvements. Program participation has reached enrollment capacity each year since it started.

Microbial Treatment Process. In late 1987 Westlands provided \$5,000 and office space at its Tranquillity Field Office for a University of California, Riverside pilot study to reduce selenium levels in evaporation pond sediments and drainage water. The process is a microbial treatment technique that encourages certain fungi to transform selenium into a relatively nontoxic gaseous form that dissipates harmlessly into the air. Although the process works by effectively eliminating selenium from the soil, the process is unable to rapidly accomplish major clean-ups, such as that required at Kesterson.

Ditch Seepage Loss/Geology and Hydrogeology of the Panoche Fan studies. Westlands expanded its drainage reduction efforts and authorized two studies. The first examined the extent of seepage losses from unlined, on-farm ditches and ponds as contributions to subsurface drainage; the second employed a variety of highly technical equipment to locate subsurface streambeds or sand stringers in selected areas of the Panoche Fan and to determine whether or not they are contributing to the drainage problem. Findings of the ditch seepage loss study, presented in December 1988, indicated that 27,000 acre-feet of water, or about 2.2 percent of the District's total water supply, was actually seeping from the unlined canals. The Panoche Fan study concentrated first on the upper 15 feet of the soil profile in the drainage service area. Lateral movement of groundwater was not found to be a significant cause of high water tables in the area. A second phase, which will attempt to identify upslope streams, began this year. Westlands spent nearly \$20,000 on the ditch seepage loss study, and will spend at least \$116,000 at the completion of the Panoche fan studies.

Selenium Removal/Cogeneration. Westlands began examining a cogeneration/evaporation system using natural gas to power turbines to produce electricity. The waste heat would be used to desalt drainage water.

Two firms were retained, URS Corporation and Resource Management International, and both concluded that cogeneration merited further

investigation because revenue from the sale of electricity and water could offset some of the costs of the project, including its construction cost and the costs of handling the dry salts. Westlands contracted with RMI in April 1988 for a Selenium Removal Cogeneration Development Strategy. RMI's study indicated that the project did not, at least initially, have any fatal flaws. This project is looked at with a great deal of interest; it is the only one that currently offers any sort of return on investment by having a salable product to help offset costs. In addition, it reclaims salty drain water and reduces the salt disposal problem. To date, Westlands has expended \$223,476.18 on the cogeneration/selenium removal project.

The Bureau's Role After SJVDP

As discussed elsewhere, the United States has a continuing obligation to provide drainage service to the San Luis Unit of the Central Valley Project, including Westlands. In a joint federal-state effort, the San Joaquin Valley Drainage Program was developed to study the drainage problem and make recommendations for possible solutions and/or alternatives for handling the subsurface agricultural water. The SJVDP has developed a great deal of necessary and useful information. However, it will not result in a drainage plan as required in the Barcellos judgment, and certainly will not fulfill the United States' obligation to provide drainage service as prescribed by the San Luis Authorization Act and the 1963 water service contract with Westlands.

We are pleased that the U. S. Bureau of Reclamation, in recognition of its obligation, has initiated a program within the Mid-Pacific Region to develop a drainage plan. That planning effort will be able to use a great deal of the information developed by the San Joaquin Valley Drainage Program, as well as the results of the numerous studies and prototype programs undertaken by Westlands and some other San Luis Unit districts.

Westlands will be working hand-in-hand with the Bureau in developing a drainage plan. We sincerely hope that the Congress will do everything within its power to provide adequate resources to allow the Bureau to complete this planning process in a timely, complete and professional manner.

As detailed elsewhere, the landowners in Westlands have been, and will continue to contribute \$5 million per year until \$100 million has been

accumulated in a drainage trust fund for the District's 35 percent up-front financing of drainage facilities. We would urge that the Congress provide the additional federal funding to carry out its drainage obligation and implement the plan in a timely manner.

Implementing the Bureau's New Mission

You have asked us to respond to three related questions regarding the new mission of the Bureau in California, the opportunities for cooperation between environmental and water development interests and the Bureau's role in fostering such cooperation. The Bureau already has taken, and is taking a variety of steps to restore and enhance the fisheries and other environmental values in the rivers and streams within the Central Valley Project. As a contracting agency, Westlands applauds these efforts. The CVP should be managed in a way that protects and, ideally, improves fish, wildlife and environmental values, while protecting the financial integrity of the Project.

Another part of the Bureau's new mission is improved management of the system, as well as management of the water supply. This requires improved maintenance of the existing system, but also should include additions to or upgrading of existing facilities, so that already-developed water can be transported or conveyed to areas of need. The whole concept of water marketing cannot become a reality without adequate plumbing.

For example, a bottleneck now exists in moving water south of the Delta to meet the growing needs of the San Jose area, as well as the continuing needs of farmers in Westlands and other districts in the San Joaquin Valley. Specifically, the problem is a lack of capacity in the federal Delta-Mendota Canal to convey the full amount of water the Bureau is allowed to pump from the Delta under its permit from the State Water Resources Control Board. This conveyance problem has arisen since the San Felipe Project came on line two years ago.

Congress has already approved one solution to this problem as part of the Coordinated Operation Agreement legislation, which provides for the so-called Wheeling and Purchase agreement between the federal and state water agencies. In brief, this would allow the State Water Project facilities to be used to wheel Central Valley Project water and for Central Valley Project

water to be sold to the State Water Project. Both the COA itself and the Wheeling and Purchase provision were broadly supported by both the water and environmental communities.

While negotiations have been underway for some time, it is obvious that final agreement still is several years away. When a satisfactory agreement is reached, we urge Congress to quickly approve that agreement, an action required by the COA legislation, in order to allow improved management of the two water systems.

In the meantime, and in view of the urgency of the need to alleviate this conveyance bottleneck, farmers in Westlands have made a commitment to pay about \$5 million to install a link between the federal Delta-Mendota Canal and the State Aqueduct, which has adequate capacity to convey the additional water to users in the San Felipe or San Luis service areas. This short-term (five- to seven-years) intertie facility would be built at no expense to the federal government and turned over to the Bureau of Reclamation, thus adding to the operational flexibility and improving the management of the State and Federal water projects. If there is interim water available and it can be conveyed to the San Luis Unit without impairing the ability of the CVP to meet delta water quality standards, then and only then would the additional water be made available.

The additional operational flexibility may also provide some important environmental benefits. For example, the fisheries in the San Joaquin River system could be greatly improved if some water could be released from New Melones Reservoir on the Stanislaus River and/or Millerton Reservoir on the San Joaquin, then picked up in the Delta at the Tracy Pumping Plant and conveyed back to the contracting users through the Delta-Mendota Canal and California Aqueduct.

It should be noted that the Bureau already has initiated an effort aimed at finding ways to restore the San Joaquin River and thereby enhance the fisheries and other environmental values. A number of us in the water supply business believe there are opportunities to improve water conservation and management on the San Joaquin River in order to accomplish these goals. In initiating this program, the Bureau's Regional Director, Larry Hancock, has solicited the input and participation of the major environmental and water

organizations.

Waterfowl habitat could be improved on the Pacific Flyway if water could be provided to the Grasslands area of western Merced County in the fall and winter through the Federal and State facilities. When released into the San Joaquin River in the spring, it helps downstream migration of salmon smolts. That water could then be picked up in the Delta and pumped back again to meet the summer needs of the CVP contractors, provided adequate pumping and conveyance capacity is available. We have suggested a modest version of such a program to leaders of the major environmental and wildfowl organizations in California in connection with our intertie project.

Let me emphasize, however, that whether we're talking about restoring environmental values or water marketing, the key to accomplishing these goals is having adequate conveyance and pumping facilities to move water from the area where it is available to the area it is needed. This may mean better conveyance facilities in and around the Delta, and more pumping and conveyance capacity to move the required volume of water during the often brief periods of time when it will not adversely affect environmental values. In this regard, the facilities proposed for the Mid-Valley Canal could be a real boon in accomplishing some of these goals.

It is simply a fact of life that whether we want to move water from one place to another for environmental purposes, for urban use or for irrigation, we simply have to have adequate plumbing. Anything the Congress could do to assist in expediting this needed plumbing would be a first step in furthering the new mission of the Bureau of Reclamation.



June 15, 1990

Hon. Manuel Lujan, Jr.
Secretary of the Interior
Department of the Interior
Washington, D.C. 20240

Dear Mr. Secretary:

Just over two years ago, I wrote your predecessor, Secretary Donald P. Hodel, a letter in my capacity as chairman of the San Joaquin Valley Drainage Program Citizens Advisory Committee. That letter enclosed written material for his use in establishing a United States Government position on what are appropriate policies regarding the repayment of federal funds expended on the cleanup of Western Reservoir, on the Drainage Program itself, and on potential forthcoming solutions to the Valley's drainage problems. The principal enclosure accompanying that letter was a May 1988 Policy Statement unanimously endorsed by the diverse membership of the Citizens Advisory Committee (CAC), a committee which, as you know, has recently been formally chartered pursuant to Section 3 of the Federal Advisory Committee Act. Copies of both my letter to Secretary Hodel and the Policy Statement are enclosed with this letter, for your convenience.

The members of the CAC have asked me to write again, this time to you, for two reasons. First, they all believe that some resolution of the repayment issues set forth above is required before significant progress is likely to be made in addressing the Valley's drainage problems and thus they all believe it is appropriate specifically to request that you, as Secretary of the Interior, take prompt action in addressing these repayment issues. In its Policy Statement the CAC acknowledges that others, including the Congress, the California Legislature, and the State Administration, also will have major roles to play in sorting through these issues, but your position, as the principal decision-maker in allocating past and current is costs most crucial.

Second, the CAC is concerned that, as the Drainage Program nears the end of its five-year life on September 30 of this year, no clear successor has emerged either to oversee implementation of the Program's forthcoming recommendations or otherwise to carry on a coordinated policy in addressing the Valley's drainage

Hon. Manuel Lujan, Jr.
 June 15, 1990
 Page 2

problems. The current Program's Policy Management Committee, consisting of high-level officials of five Federal and State agencies, is apparently willing to continue working together in some form. The CAC certainly applauds that continuation. All five agencies have important missions and each deserves funding to carry out its responsibilities relating to the drainage issue. Furthermore, a coordinated liaison function, with the CAC itself, with technical advisory bodies and with other interested regulatory, scientific, and local interests would be helpful in maintaining the momentum which has been generated in working towards resolution of the Valley's drainage problems.

Accordingly, let me conclude this letter by specifically recommending to you on behalf of the CAC that you ensure that some formal joint Federal-State venture dealing with drainage issues, that includes the participation of a variety of agencies representing diverse perspectives, continue operating beyond September 30, 1990. Thank you for considering our Committee's views.

Sincerely yours,



Chester O. McCorkle, Jr., Chair
 Citizens Advisory Committee

COM:lk

Enclosure

cc: Hon. George Deukmejian, Governor of California
 Senator Alan Cranston
 Senator Pete Wilson
 Congressman George Miller
 Congressman Vic Fazio
 Congressman Gary Condit
 Congressman Rick Lehman
 Congressman Chip Pashayan
~~Chairman, Policy Management Committee~~
~~Chairman, Drainage Program~~
 Edgar A. Imhoff, Program Manager



MAY 27 1988

Honorable Donald P. Hodel
Secretary of the Interior
U.S. Department of the Interior
Washington, DC 20240

Dear Mr. Secretary:

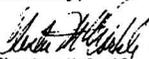
The Assistant Secretary for Water and Science, Wayne Marchant, responded to my March 11, 1988, letter to you by inviting the San Joaquin Valley Drainage Program Citizens Advisory Committee to provide written material for your use in considering repayment of Federal funds expended on San Joaquin Valley agricultural drainage problems. The enclosed policy statement presents the Committee's consensus position on repayment of Federal funds expended on Kesterson Reservoir cleanup, the San Joaquin Valley Drainage Program, and forthcoming solutions to the drainage problem.

In summarizing the Committee's position, we believe the principal responsibility for the costs of Kesterson cleanup should be borne by the U.S. Bureau of Reclamation without reimbursement from water users; the varied beneficiaries of the San Joaquin Valley Drainage Program should bear responsibility for payment and/or repayment of drainage program costs which are fairly attributable to them; and, the costs of implementing solutions to drainage problems should generally be distributed by a formula which ties costs to benefits.

As I mentioned in my letter of March 11, 1988, the Committee represents a broad cross section of interests concerned with west side San Joaquin Valley agricultural drainage-related problems. We believe our consensus position on repayment issues reflects a fair representation of those interests and trust that the Policy Statement will be useful to you in the decisionmaking process.

Please contact me if we can provide further information or clarification of the Policy Statement.

Sincerely,


Chester McCorkle, Chair
Citizens Advisory Committee

Enclosure

2800 Cottage Way, Room W-2143, Sacramento, California 95825-1898. (916) 978-4981

San Joaquin Valley Drainage Program
CITIZENS ADVISORY COMMITTEE

POLICY STATEMENT
ON
REPAYMENT OF KESTERSON RESERVOIR CLEANUP
AND THE
SAN JOAQUIN VALLEY DRAINAGE PROGRAM COSTS

May 1988

The Citizens Advisory Committee to the San Joaquin Valley Drainage Program consists of 14 individuals of diverse backgrounds and interest united in their conviction that solutions must be found to drainage problems in the San Joaquin Valley which are both economically and environmentally sound.

The committee members understand that the problems being confronted are technologically complex and politically controversial and are likely to require expensive remedies. Major controversy has already erupted regarding the proper method of addressing the problem of cleaning up Kesterson Reservoir. Controversy also lurks in the background regarding who else besides the U.S. Government, if anyone, bears responsibility for repayment of the Federal Government's costs of whatever cleanup method is ultimately selected; controversy also exists regarding who, if anyone, should repay the costs of the San Joaquin Valley Drainage Program (SJVDP), a U.S. Department of the Interior--State of California joint program distinct from the U.S. Bureau of Reclamation's cleanup program. And, eventually, as the SJVDP and others turn toward the implementation of proposed solutions to the valley's drainage problems the issue of financial responsibility will arise in still a third context.

This statement addresses only issues of financial responsibility. It is premature to address what the best physical, technical, and institutional solutions to the valley's drainage problems may be and committee members are divided on how the Kesterson cleanup issue should be handled. However, the committee as a whole believes that a united approach to the issues of financial responsibility holds great promise for facilitating solutions to the valley's drainage problems that are

broadly acceptable to the various public and private interests affected by these problems. And they have agreed to make a concerted effort over time to reach consensus on these financial issues. This statement is the first expression of this consensus-oriented effort.

The financial responsibility issues can be viewed from many different perspectives. One such perspective, the legal, the committee must expressly disavow. Several opinions of the office of the Solicitor of the Interior, interpreting statutes passed by the Congress, have addressed Kesterson and SJVDP repayment issues. This committee expresses no views either on the validity of those opinions or on how they should be interpreted by the Secretary of the Interior as he strives to take a position on repayment. Instead, the committee's intent in making this statement is to express its views on what are proper repayment policies and then to leave to the Congress, the State Legislature, the Secretary, and other decisionmakers the determination whether new laws or legal opinions may be required to implement the suggested policies.

* * * * *

Kesterson Reservoir Cleanup

The committee believes that the principal responsibility for the costs of cleanup of Kesterson Reservoir should be borne by the U.S. Bureau of Reclamation. The Bureau, in conjunction with the U.S. Fish and Wildlife Service, chose Kesterson Reservoir as an appropriate site for the disposal of subsurface agricultural drainage from the Westlands Water District portion of the San Luis Unit. Moreover, the Bureau has been collecting drainage fees for nearly a decade from all the San Luis Unit contractors, without apparent benefit for those contractors. (On the other hand, the level of the current drainage fee [50 cents per acre foot] is unlikely to be sufficient to meet the actual costs of handling the Unit's drainage problems.) Finally, the contractors had relatively little influence over where their drainage was disposed of. For all these reasons and others, the committee believes that the equitable resolution of the Kesterson repayment question is to have the Bureau absorb the lion's share of Kesterson cleanup costs, without reimbursement from water users.

San Joaquin Valley Drainage Program Studies

On the other hand, the committee believes that the beneficiaries of the San Joaquin Valley Drainage Program should bear responsibility for payment and/or repayment of all the costs of the Program which are

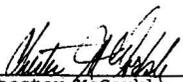
fairly attributable to them. The benefits of all the various aspects of the Program are not subject to precise allocation formulae at this time. Certainly, a successful program will have a diverse set of beneficiaries, including Federal, State, and local water districts and their water users, as well as the public at large, which has interests in both the quality of water for drinking purposes and fish and wildlife protection. But the committee does believe that general criteria linking relevant research and development activities to their most direct beneficiaries can be fashioned. For example, costs of treatment and disposal research and development should be the primary responsibility of the affected water districts and their water users. On the other hand, primary research generating baseline geological and environmental information should be a shared public/private responsibility. The results of this research should directly benefit not only the affected economic interests but the greater publics, regional, state, and national affected by drainage problems. To the extent the research benefits these broader public interests, it should be borne by them and not be subject to reimbursement by the water users.

Solutions

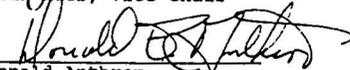
Finally, the committee recognizes that a definitive statement on the allocation of financial responsibility for implementing solutions which arise out of the SJVDP and from other sources must ultimately await the actual development of those solutions. It does agree, however, that a formula tying costs to benefits, as was suggested above in proposing a methodology for handling the existing SJVDP costs, will lead to the most appropriate resolution of future funding and repayment questions as well.

In this connection, it is important also to be aware that among the probable solutions to the valley's drainage problems are several which may in themselves be capable of generating substantial revenue that in the overall economic calculus could be a major offset to the solutions' cost. The leasing or sale of conserved and/or reclaimed water; sale of electricity from cogeneration plants or solar ponds; sale of salt or other byproducts of treatment and disposal plants--these are all possible sources of revenue as solutions to the valley's drainage problems are developed. As the feasibility of these possibilities is examined and proposals for their implementation are developed, revised formulae for cost and benefit allocation are likely to suggest themselves.

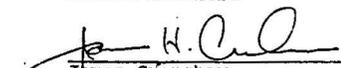
The committee, at this juncture, looks at all these possibilities from an optimistic perspective. They give hope and reason for diverse interests to work together in addressing the valley's vexing drainage problems. With its own common effort, as exemplified by this statement, the committee will make its own contribution to progress in converting these problems into solutions.

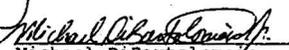

 Chester McCorkle, Chair

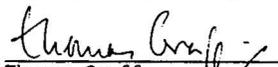

 Jean Auer, Vice-Chair


 Donald Anthrop

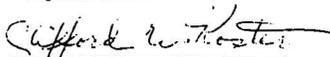

 Jerald Butchert

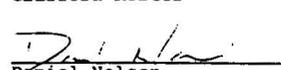

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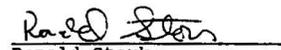

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United States Department of the Interior

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WASHINGTON, D.C. 20240



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APR 21 1988

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APR 15 1988

Mr. Chester McCorkle
Chair, Citizens Advisory Committee
San Joaquin Valley Drainage Program
2800 Cottage Way
Room W-2143
Sacramento, California 95825-1898

Dear Mr. McCorkle:

Secretary Hodel asked me to respond to your March 11, 1988, letter concerning repayment for Federal funds expended on San Joaquin Valley agricultural drainage problems. We appreciate your offer of assistance with this difficult issue.

You are correct that the Secretary is considering a number of options to resolve this issue. In recent months, we have received the views of various interested parties, including several members of the Citizens Advisory Committee. If you would like to augment that information by providing additional written material, we would be pleased to insure that such material is considered in the decision process.

Sincerely,

Assistant Secretary
for Water and Science

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 Los Banos, California 93635
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 Fax: (209) 826-0524

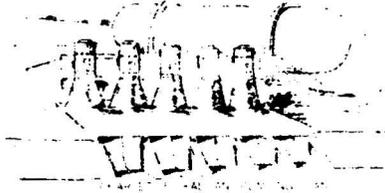
San Luis Water District

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October 1, 1993

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Honorable Bruce Babbitt
 Secretary of the Interior
 U.S. Department of the Interior
 1849 C Street, NW
 Washington, DC 20240

Dear Mr. Secretary:

For the past several years, the San Luis Unit Contractors (Panoche, San Luis, and Westlands Water Districts) have worked with the Department to develop equitable repayment policies with respect to Kesterson and other drainage related costs. The Contractors understand that resolution of these issues has become a high priority for the Department and that the repayment policy report requested by the Congress was recently updated by the Mid-Pacific Regional Office. The Contractors look forward to the opportunity to review this draft report and to provide input on the issues as you work to develop an appropriate policy.

As part of the participation in this process, the Contractors developed the enclosed memorandum, dated May 20, 1991, discussing the factual background of the drainage repayment issues; the nature and magnitude of the expenditures involved as of September 30, 1990; some fundamental legal and policy considerations; and recommended positions with respect to the various categories of expenditures.

The Contractors' memorandum was originally developed in response to language included as part of the 1991 Appropriations Act Statement of Managers in 1990, which directed the Secretary of Interior to:

... review the Department's repayment policies with respect to Kesterson and other drainage related costs with input from the Congress, state and local agencies, and the public and submit a report on this policy, no later than March 31, 1991, to the

Honorable Bruce Babbitt

Page 2

October 1, 1993

appropriate committees of the House and Senate. Recommendations on past and future allocations between Federal and non-Federal interests as well as recommendations on cost allocations between reimbursable and non-reimbursable functions shall be included in the report. (House Report 101-889). (Emphasis added).

Other input was prepared as well, including recommendations of the San Joaquin Valley Drainage Program's Citizen's Advisory Committee. This federally appointed committee consisted of key representatives for urban, environmental and agricultural interests. These recommendations are further detailed in the attached memorandum

Subsequent appropriations bills have continued to address the policy report. The Energy and Water Development Appropriations Bill, 1992 included, in part:

. . . Kesterson Reservoir, California--The Committee awaits the report required by House Report 101-889 from the Secretary of the Interior on the Department's repayment policies with respect to Kesterson and other drainage related costs. No portion of Kesterson and other drainage related costs shall be recovered from non-Federal entities until a cost allocation formula has been established in accordance with this report. However, the appropriate non-Federal share of the funding included in this appropriation shall be recovered by the conclusion of Fiscal Year 1992, pursuant to the recommended cost allocation formula. (House Report 102-???)

Similar language was included in the 1993 and 1994 Appropriations Bills (House Report Nos. 102-555 and 103-135).

The Department's work to develop the report has been affected by litigation involving drainage repayment issues. The litigation and related settlement discussions pertain to Sumner Peck Ranch, Inc., et al., vs. Bureau of Reclamation, et al., and Westlands Water District vs. U.S. Department of the Interior, et al., (Case No CV-F-91-048 OWW in the United States District Court for the Eastern District of California) involving certain claims for drainage service, as well as the Kesterson Repayment dispute. On August 23, 1993, Westlands filed its Cross-Claim in this action to include that dispute in order to preserve its ability to litigate these issues in the future, if necessary.

During the House Energy and Water Appropriations Hearings held on April 20, 1993, Congressman Vic Fazio asked several specific questions pertaining to the status of the requested

Honorable Bruce Babbitt
Page 3
October 1, 1993

report and was advised by Acting Commissioner Larry Hancock that it was anticipated that a report would be submitted to Congress by the end of the year. During this questioning, it was further noted by Mr. Hancock that litigation involving drainage issues had complicated the development of a report, that the settlement discussions under way could have some impact on the cost allocation process, and that the Department wished to move cautiously on the report.

Notwithstanding the Cross-Claim, Westlands recognizes that successful settlement of these drainage issues, including the Kesterson Repayment dispute, is in the best interests of its landowners and water users, and believes the United States would concur that its interests would be served as well, as is evidenced by the above referenced discussion between members of the Congress and Acting Commissioner Larry Hancock.

Presented below, as a supplement updating the May 20, 1991 memorandum, is additional information relevant to the drainage repayment issue.

Significant appropriation and expenditure activity has occurred on certain of the drainage activities since the preparation of the May 20 memorandum, which reflected activities through September 30, 1990. Kesterson monitoring and evaluation costs of \$2.6 million and \$1.4 million were expended in fiscal years ended September 30, 1991, and September 30, 1992, respectively. The amounts of \$2.8 million have been appropriated in each of the 1993 and 1994 federal budgets as well. As discussed in the May 20, 1991 memorandum, these annual expenditures have not been for activities that are reimbursable under current law.

Since September 30, 1990, an additional \$2.3 million in capital expenditures relating to the construction of the San Luis Drain and Kesterson Reservoir have been placed into repayment status. The Contractors have been unable to determine the specific nature of these charges and question the propriety of continuing to place certain costs into repayment status for facilities which were never completed as required by the San Luis Act and which currently do not provide service to the water users.

As of September 30, 1990, the amount of \$1.2 million had been expended on the San Luis Unit Drainage Plan required by the Barcellos Judgement. This amount has increased to \$3.3 million through September 30, 1992. Westlands' rejected the draft Plan, claiming it failed to meet criteria established in that Judgement. This rejection was approved by the Court on May 29, 1992. Again, costs which would be reimbursable if drainage service were provided cannot be placed into repayment status when no plan or facilities are in place, and no service is made available.

The Contractors have reviewed the Inspector General's Report on the Department of the Interior Irrigation Drainage Programs (Report No. 93-I-1302) and are familiar with its recommendations. This report recognizes the need to develop repayment policies for both past and future drainage expenditures to assure fairness to both the United States and the anticipated

Honorable Bruce Babbitt
Page 4
October 1, 1993

beneficiaries of the expenditures. The Contractors may have additional comments on some of the substantive content, but the general concepts pertaining to the need to resolve this issue are supported.

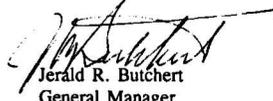
In conclusion, various federal parties and Congress have acknowledged that development of a drainage repayment policy requires extensive thought and public input. The Contractors also encourage the Department to consider the information provided and take into account the need for the Department to maintain flexibility in resolving the drainage litigation referenced above as it prepares its report for the Congress. The Contractors look forward to working with you to accomplish these goals of developing logical and equitable solutions to these complex issues.

Sincerely,



Brian Ketelhut
General Manager
San Luis Water District

Sincerely,



Jerald R. Butcher
General Manager
Westlands Water District

Sincerely,



Dennis Falaschi
General Manager
Panoche Water District

Enclosure

cc: Dan Beard
Roger Patterson

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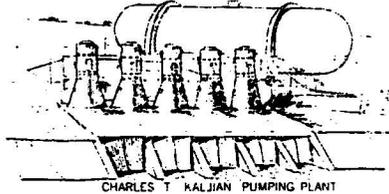
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CHARLES T. KALJIAN PUMPING PLANT

May 20, 1991

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Legal Counsel

Summers

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District Engineers

Honorable Manuel Lujan
 Secretary of the Interior
 U.S. Department of Interior
 1849 C Street, NW
 Washington, DC 20240

Dear Mr. Secretary:

In the federal Fiscal Year (FY) 1990 Appropriations Act Statement of Managers, Congress directed the Secretary of Interior in part to:

... review the Department's repayment policies with respect to Kesterson and other drainage related costs with input from the Congress, state and local agencies, and the public and submit a report on this policy, no later than March 31, 1991, to the appropriate committees of the House and Senate. Recommendations on past and future allocations between Federal and non-Federal interests as well as recommendations on cost allocations between reimbursable and non-reimbursable functions shall be included in the report. Pub.L. No. 101-514, 104 Stat. 2074, 2085 (1990). (Emphasis added).

The enclosed memorandum dated May 20, 1991, from the San Luis Unit Contractors (Panoche Water District, San Luis Water District, and Westlands Water District), discusses the factual background of the drainage repayment issues, the nature and magnitude of the expenditures involved, some fundamental legal and policy considerations, and recommended positions with respect to the various categories of expenditures.

Based on the analysis, it is apparent that there are substantial drainage related costs which have not benefitted, nor ever will be of benefit to, the water users. These costs should not be reimbursable by the San Luis Unit Contractors. The analysis is also helpful in determining the legitimate federal and nonfederal liability associated with a project not in service.

On the other hand, consistent with the approach of the Statement of Managers language, the Contractors are willing to discuss these principles in the context of the Kesterson situation to determine a logical and equitable resolution to these issues.

Honorable Manuel Lujan
Page 2
May 20, 1991

We hope this memorandum will be helpful to the Department in the development of its Report to the Congress and that it will initiate a meaningful dialogue with respect to the Department's repayment policies. We're submitting this report in the spirit of the appropriations language and hope you will seriously consider our viewpoint during your deliberations. We look forward to working with you on this issue.

Sincerely,



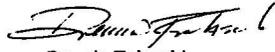
Daniel Nelson
General Manager
San Luis Water District

Sincerely,



Gerald Butchert
General Manager
Westlands Water District

Sincerely,



Dennis Falaschi
General Manager
Panoche Water District

Enclosure

cc: Commissioner Dennis Underwood
Assistant Secretary John Sayre
Solicitor Thomas L. Sansonetti
Regional Solicitor John W. Burke III

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EXECUTIVE SUMMARY

The issue of nonfederal liability for costs associated with the Kesterson Reservoir, San Luis Drain, and other drainage-related expenditures has not been resolved. Despite the millions of dollars that have been expended to date, the U.S. Bureau of Reclamation ("Bureau") has not indicated yet from whom those costs might be collected, if at all. This greatly concerns the Contractors of the Central Valley Project's ("CVP") San Luis Unit. This problem is compounded by the fact that the Bureau still has no final plan for correcting drainage problems.

The major expenditures in question fall into two basic categories and are for the following activities:

O&M Expenditures

1. Kesterson Monitoring and Related Activities - The Bureau has earmarked (and characterized) \$2.8 million for federal Fiscal Year 1990-91, and about the same amount in the proposed 1991-92 Budget, for ongoing monitoring and evaluation of the Kesterson contamination and the efforts to clean it up.

Capital Expenditures

2. San Luis Drain and Kesterson Construction - \$40 million when construction was halted in 1985 and ongoing operation and maintenance costs.
3. Kesterson Cleanup Plan - \$26.5 million as of September 30, 1990, for Bureau expenditures as required by a State Water Resources Control Board order and agreed to by the Bureau.
4. Kesterson Mitigation - An unspecified amount. These expenditures cover the Bureau's purchase of land that will replace wildlife habitat no longer available at Kesterson, plus costs associated with maintaining that acreage and securing a water supply.
5. San Joaquin Valley Drainage Program - \$54.5 million as of September 30, 1990, for the Bureau's share of the federal-state program to study and investigate the causes of and potential solutions to San Joaquin Valley drainage problems.
6. Bureau Drainage Plan - \$1 million as of September 30, 1990, for preparation of a Drainage Plan for the San Luis Unit as required by the Barcellos Judgment in the litigation involving Westlands and the United States.

The concern as to who would be asked to pay these costs was heightened last year when the Bureau included \$2.8 million for costs of Kesterson monitoring and related activities in the Fiscal Year 1991 Operations and Maintenance (O&M) budget, rather than deferring those costs, consistent with its historical policy, in a construction-in-progress account.

The issue subsequently was brought to the attention of the Congress. In a House Conference Report accompanying the Energy and Water Development Appropriations Act of 1991, the Secretary of Interior was directed to review the Interior's repayment policies with respect to Kesterson and other drainage-related costs. Additionally, a report was to be submitted on March 31, 1991, with recommendations on past and future allocations between federal and nonfederal interests, as well as on cost allocations between reimbursable and nonreimbursable functions. The Secretary was unable to complete the report by the deadline.

The factual background and legal and policy analyses require several conclusions.

First, Kesterson monitoring expenditures are not O&M costs which are reimbursable by the Contractors and their water users. This is because they are neither (1) being made to operate and maintain Bureau facilities effectively as a going concern for the purpose for which they were designed, nor (2) are they being made to overcome adverse effects resulting from the normal operations of completed facilities which were originally well constructed in accordance with existing obligations.

Second, significant portion of the drainage-related costs are nonreimbursable because (1) they were general and investigative in nature; and (2) there are no drainage service facilities in operation so, therefore, no benefits are being received by the Contractors. The facilities are not in operation because of the Secretary's unilateral decision to close them. Equally important, the costs cannot be attributable to facilities which are capable of providing drainage service. To require payment where there is no benefit is contrary to basic Reclamation law principles and the terms of the Contractors water service contracts.

Third, any costs potentially attributable to the Contractors because of their relationship to drainage service facilities which ultimately can be constructed should be deferred in a construction-in-progress account until such time that the facilities are operable and drainage service is provided.

Fourth, Kesterson cleanup expenditures should be non-reimbursable and not included in the construction component of rates for service at any time. They were made to correct environmental problems caused by the Bureau's failure to complete the San Luis Drain to the Delta as authorized by the 1960 San Luis Act and contemplated by the Contractors' water service contracts. The expenditures have not contributed in any way to project facilities or activities that would provide drainage service for the Contractors and their water users.

Fifth, expenditures by the Bureau to purchase mitigation lands for wildlife in lieu of Kesterson Reservoir and thereafter to maintain them for that purpose, including purchase of an annual water supply, should not be attributed to San Luis Unit costs and, thus, should not be reimbursable by the Contractors or their water users. Kesterson was built pursuant to the 1960 San Luis Act as an element of the Drain to regulate the flow of drainage water, not as a wildlife refuge. The Bureau's failure to complete the Drain to a terminal point in the Delta and its use of Kesterson as the Drain terminus caused the build up of drainage waters that led to Kesterson's closure. Moreover, the Contractors derived no benefits from the use of Kesterson as a wildlife refuge that would justify any obligation to reimburse mitigation costs in the O&M, cost-of-service, or full cost water rates payable by the water users.

In addition to its critical importance to the San Luis Unit Contractors, the resolution of these repayment issues is likely to serve as precedent concerning federal action to correct irrigation-induced contamination at other sites throughout the West.

II.

OVERVIEW OF ISSUES AND SUMMARY OF CONCLUSIONS

The issue of nonfederal liability, if any, for costs of (1) Kesterson monitoring and related activities, (\$2.8 million in 1991), (2) construction of the Kesterson Reservoir and San Luis Drain (\$40 million), (3) the Kesterson Cleanup Plan (\$26.5 million), (4) the San Joaquin Valley Drainage Program ("SJVDP") (\$54.5 million), and (5) the U.S. Bureau of Reclamation's implementation of a drainage plan for the San Luis Unit (\$1 million to date) has not been resolved.

The San Luis Unit Contractors ("Contractors") would like to resolve the issue. The Contractors include Panoche Water District ("Panoche"), San Luis Water District ("SLWD"), and Westlands Water District ("Westlands").

The \$2.8 million in Kesterson monitoring costs were included in the Bureau's O&M budget for 1991 as part of the total \$221,516,000 for all Bureau project O&M costs. Those costs, along with funds for all other Bureau activities, were appropriated by the Energy and Water Development Appropriations Act of 1991. The Statement of Managers accompanying the Act directs the Secretary of Interior in part to:

... review the Department's repayment policies with respect to Kesterson and other drainage related costs with input from the Congress, state and local agencies, and the public and submit a report on this policy, no later than March 31, 1991, to the appropriate committees of the House and Senate. Recommendations on past and future allocations between Federal and non-Federal interests as well as recommendations on cost allocations between reimbursable and nonreimbursable functions shall be included in the report. Pub.L. No. 101-514, 104 Stat. 2074, 2085 (1990). (Emphasis added).

The inclusion of Kesterson monitoring costs as an O&M obligation, as outlined in the Bureau's request for appropriations, is even more significant because it abandons 80 years of Bureau practice. Further, the ultimate outcome of the repayment issue may establish a precedent for the Bureau's actions at other sites throughout the West that have irrigation-induced contamination problems. The decision could be precedential in terms of what repayment may be required for correcting such problems and what portion of the costs will be federally funded.

The following is a summary of the conclusions based upon the factual background and analyses which follow.

Kesterson monitoring expenditures are not O&M costs that are reimbursable by the Contractors and their water users. The reason is that they are not O&M costs as defined by federal court decisions. Under these decisions, for expenditures to be reimbursable O&M costs they must meet one of two tests: They must have been made to operate and maintain Bureau facilities effectively as a going concern to the end for which they were designed; or they must have been made to overcome injurious effects resulting from the normal and ordinary operation of completed facilities that were originally well constructed in accordance with the relevant statutory and contractual obligations. The Kesterson monitoring expenditures meet neither test because the San Luis Drain and Kesterson Reservoir which were not operational facilities when the

expenditures were made and which were never completed in accordance with relevant statutory and contractual obligations.

The costs of constructing a portion of the San Luis Drain and Kesterson Reservoir should not be included at this time in the San Luis Unit Plan-in-Service Account for reimbursement by the Contractors' water users with cost-of-service and full cost rates for water service. These facilities are not in operation because of the unilateral decision of the Secretary to close them. The costs cannot be attributed to a system that is capable of providing drainage service to the Contractors. Under federal Reclamation law, putting the construction cost of facilities in a Plan-in-Service Account for reimbursement is based upon the fundamental premise that the facilities have been completed and are providing the intended service. The very term "cost-of-service" denotes an assumption that service is being provided.

Contracts between the United States and Reclamation project beneficiaries under Reclamation law establish "debtor-creditor" relationships in which payment is expected for project benefits. To require payment when there is no benefit is contrary to basic Reclamation law principles and the terms of the contracts. Therefore, the construction costs of the Drain and Kesterson should be held in the San Luis Unit Construction-in-Progress Account until it can be determined whether they ultimately contribute to the provision of drainage service to the Contractors. Further, as noted above, it follows that any ongoing operation and maintenance expenditures related to the Drain and Kesterson, should not be included as reimbursable O&M costs.

The other expenditures in question have not yet been included by the Bureau as components of rates for service presently required to be paid by the Contractors and their water users. Decisions about the inclusion of any of these costs, which may be reimbursable, should be deferred by the Bureau until facilities to provide drainage service are completed and it becomes time to transfer appropriate construction costs into the San Luis Unit Plan-in-Service Account for inclusion in the capital cost component of rates for service.

Of these expenditures, a significant portion of the SJVDP expenditures should be nonreimbursable. The reason is that they were made to investigate drainage problems of the entire western San Joaquin Valley, and perhaps other parts of the country as well, and not simply problems of the San Luis Unit. Federal statutes provide that expenditures for general engineering and research studies or for area-wide or basin-wide investigations, as contrasted with investigation expenditures for a particular project, are nonreimbursable.

Kesterson cleanup expenditures also should be nonreimbursable and not included in the construction component of rates for service at any time. The reason is that they were made to correct environmental problems caused by Bureau failure to complete the San Luis Drain to the Delta as authorized by the 1960 San Luis Act and contemplated by the Contractors' water service contracts. The expenditures have not contributed in any way to project facilities or activities that would provide drainage service for the Contractors and their water users.

Expenditures by the Bureau to purchase mitigation lands for wildlife in lieu of Kesterson Reservoir and thereafter to maintain them for that purpose, including purchase of an annual water supply, should not be attributed to San Luis Unit costs and, thus, should not be reimbursable by the Contractors or their water users. Kesterson was built pursuant to the 1960 San Luis Act as an element of the Drain to regulate the flow of drainage water, not as a wildlife refuge. The Bureau's failure to

complete the Drain to a terminal point in the Delta and its use of Kesterson as the Drain terminus caused the build up of drainage waters that led to Kesterson's closure. Moreover, the Contractors derived no benefits from the use of Kesterson as a wildlife refuge that would justify any obligation to reimburse mitigation costs in the O&M, cost-of-service or full cost water rates payable by their water users.

The expenditures for preparing the Drainage Plan required by the Barcellos Judgment between Westlands and the U.S. might turn out to be reimbursable, if the plan is developed and implemented in the future by the construction of facilities that provide needed drainage service to the Contractors and their water users.

III.

CHRONOLOGY: BACKGROUND OF EVENTS

- 1960 San Luis Unit Act of June 3, 1960, authorized the Unit as part of the CVP.
- 1961 The State of California notified the Department of Interior that it would not provide a master drain.
- 1962 Bureau's Definite Plan Report of December 12, 1962, included analysis of drainage discharges into the western Delta and the timing and rates of discharge from the Kesterson Reservoir.
- 1963 and 1974 In 1963, the Bureau executed a long-term water service contract with Westlands, which will expire in 2008. The 1955 Contract between Panoche and the Bureau was superseded by the 1974 water service contract, which also will expire in 2008. The 1959 Contract between San Luis Water District and the Bureau likewise was superseded by a 1974 water service contract, and will expire in 2008, as well.
- 1965 The Public Works Appropriations Act of October 28, 1965, and subsequent appropriations acts, provided for the completion of water quality compliance studies before providing a Delta terminus for the Drain.
- 1967 The State of California again notified the Bureau that it would not build a drain. Later, the Bureau Commissioner testified before a House Appropriations Subcommittee that it would build the drain and an unnamed regulating reservoir, which later became Kesterson.
- 1968 A report of the National Technical Advisory Committee on Water Quality Criteria was totally silent regarding selenium or the potential for any selenium toxicity in drainage waters and in fish, other aquatic life, and wildlife.
- 1968 Drain construction commenced and later included Kesterson Reservoir construction.
- 1970 The Bureau, in cooperation with the U.S. Fish and Wildlife Service, designated Kesterson as a National Wildlife Refuge to increase San Joaquin Valley waterfowl habitat, knowing the only reliable water supply would be agricultural drainage water.
- 1972-1980 The Bureau's Environmental Impact Statement for the Drain made no mention of any investigations regarding the potential for toxic elements or nonmetallic elements such as selenium. Additional Bureau land classification reports did not contain any information in regard to the potential for leaching selenium from irrigated lands.
- 1975 Construction of the Drain was halted at Kesterson when the Drain was only 40 percent complete to the Delta and the Kesterson ponds were only 21 percent complete.

- 1978 Beginning in 1978 through 1982, collector drains were installed within about 42,000 acres in Westlands and connected to the drain. Also, about 5,000 acres of grower-funded subsurface on-farm drainage systems were connected to the collector system.
- 1979 The Bureau notified the Contractors that the Drain was available for service.
- 1980 The Bureau renewed studies for a Drain discharge permit.
- 1981 The Bureau imposed a moratorium on all collector Drain hookups because of limited capacity at Kesterson.
- 1982 Congress enacted the Reclamation Reform Act to change the acreage limitations provisions and increased the water rates to be charged according to the amount of land held in a landholding.
- 1983 Federal biologists discovered selenium contamination at Kesterson.
- 1984 The federal-state San Joaquin Valley Drainage Program was formed to investigate drainage and drainage-related problems and to identify possible solutions in the western San Joaquin Valley.
- 1984-1989 The State Water Resources Control Board issued a Cleanup and Abatement Order to the Bureau prohibiting further discharges into Kesterson and requiring the Bureau to formulate a cleanup plan for Kesterson.
- 1985 On March 15, 1985, the Secretary announced the closure of Kesterson Reservoir, the discontinuance of drainage service, and the termination of delivery of irrigation water to the lands which drain into the reservoir. Westlands and the Bureau agreed on April 3, 1985, to defer the discontinuance of drainage service for a year to allow Westlands to find alternatives to the Drain, including plugging the drains if there were no other alternatives, and to continue the delivery of irrigation water to the affected area of Westlands.
- 1986 Westlands' collector drains were plugged and the San Luis Drain and Kesterson Reservoir were closed.
- 1986 The stipulated judgment in the Barcellos case described the conditions under which the San Luis Drain or alternative drainage service facilities providing drainage service to Westlands are to be completed by the Bureau and paid for in part by Westlands.
- 1986 The Department of Interior's Solicitor concluded in his Opinion M-36901 that the Secretary had many options available to implement the San Luis Unit legislation, including the drain, and affirmed the Secretary's authority to finance the drain's construction under the indexable cost ceiling provided in the 1960 Act.
- 1986 The Coordinated Operations Agreement was enacted, mandating the determination of individual contractor repayment of deficit balances,

and providing for interest to be calculated on O&M deficits accruing on or after October 1, 1985.

- 1987 The Bureau published the Irrigation Ratesetting Policy for the Central Valley Program (CVP) to establish the basis for rates of payment of water service from contracting districts and their water users sufficient to eliminate deficits created over the years by the type of fixed rate contracts that the Contractors (along with all other CVP contractors) had executed.
- 1987 The Solicitor issued another opinion that concluded the Secretary was authorized to finance San Joaquin Valley Drainage Program activities relating to the ultimate resolution of San Luis Unit drainage problems through provisions in the 1960 Act.
- 1989 The San Joaquin Valley Drainage Program's Citizens Advisory Committee issued a statement that said the principal responsibility of the Kesterson cleanup should be borne by the Bureau without reimbursement from the water users, and the costs of the program should be distributed equitably among the beneficiaries of the program.
- 1990 The Bureau's proposed fiscal year 1991 O&M budget included \$2.8 million for Kesterson monitoring and expenditures.
- 1990 While the San Joaquin Valley Drainage Program officially ended in 1990, a follow-up program has started and the source of funding is unknown.
- 1990 The Statement of Managers accompanying the Energy and Water Development Appropriations Act of 1991 directed the Bureau to review its repayment policies with respect to Kesterson and other drainage-related costs and to submit a report on this policy. The report is to include recommendations on past and future allocations between federal and nonfederal liability.

IV.

BACKGROUND1. 1960 San Luis Unit Act

The San Luis Unit of the CVP, by which the Bureau provides water service to the Contractors, was authorized by the San Luis Unit Act of June 3, 1960 ("1960 San Luis Act"), Pub.L. No. 86-488, 74 Stat. 156. The Act provided, among other things, for construction of the "... San Luis interceptor Drain to the Delta designed to meet the drainage requirements of the San Luis Unit as generally outlined in the report of the Department of the Interior, entitled San Luis Unit, CVP, dated December 17, 1956." Id. at Section 1(a). Construction of the interceptor drain (also referred to herein as the "San Luis Drain" or "the Drain") by the Bureau was to be provided for if the State of California did not provide a master drain for the San Joaquin Valley. Id.

Section 8 of the 1960 San Luis Act authorized appropriations in pertinent part as follows:

There is hereby authorized to be appropriated for construction of the works of the San Luis unit, including joint-use facilities, authorized by this Act, other than distribution systems and drains, the sum of \$290,430,000, plus such additional amount, if any, as may be required by reason of changes in costs of construction of the types involved in the San Luis unit as shown by engineering indexes ["indexable cost ceiling"]. ... There are also authorized to be appropriated, in addition thereto, such amounts as are required (a) for construction of such distribution systems and drains as are not constructed by local interests, but not to exceed in total cost the sum of \$192,650,000 and (b) for operation and maintenance of the unit. ... Id.

2. 1961 State and Department of the Interior Notification Regarding Drain Construction

In 1961, the Director of the California Department of Water Resources ("DWR") notified the Bureau that the state would not provide a master drain and the Bureau should proceed with construction of the Drain to serve the San Luis Unit only. In that same year, the Secretary of the Interior ("Secretary") notified Congress that provision had been made for constructing the interceptor Drain.

3. 1962 Bureau Definite Plan Report of December 12

Commencing with the Interior Appropriations Acts of July 9, 1952, (66 Stat. 451) and July 31, 1953, (67 Stat. 266), Congress specifically required a land classification or soil survey for new irrigation projects. The 1953 language provided, in part:

... the Secretary shall certify to the Congress that an adequate soil survey and land classification has been made and that the lands to be irrigated are susceptible to the production of agricultural crops by means of irrigation or that the successful irrigability of those

lands and their susceptibility to sustained production of agricultural crops by means of irrigation has been demonstrated in practice . . .

Bureau manuals and instructions on land classification issued from time to time over the next 15 years included little, if any, guidance as to the closely related subject of drainage and the effects of drainage effluent on downstream resources. In the Bureau Definite Plan Report of December 12, 1962, analyses of drainage dealt with discharges into the western Delta and concerned the timing and rates of discharge from the Kesterson Regulating Reservoir.

4. 1963 and 1974 Contractors' Long-Term Contracts for Water and Drainage Service

Westlands Water District. On June 5, 1963, the Bureau and Westlands executed a long-term contract for water service and drainage service from the San Luis Unit ("1963 Contract"). In the explanatory recitals, the contract states in part as follows:

WHEREAS, the United States is providing an interceptor drain designed to meet the drainage requirements of the San Luis Unit of the Federal CVP; and

WHEREAS, the District desires to contract, pursuant to the Federal Reclamation laws and the laws of the State of California, for the furnishing by the United States of a supplemental water supply from the Project and for drainage service by means of the interceptor drain for which the District will make payment to the United States upon the basis, at the rate, and pursuant to the conditions hereinafter set forth. . . .

The 1963 Contract defines the "interceptor drain" in Paragraph 1(d) as follows:

The physical works constructed by the United States pursuant generally to the Act of June 3, 1960 (74 Stat. 156) in order to meet the drainage requirements of the area served by the San Luis Unit which have been calculated to be 150,000 acre-feet per year at a maximum rate of flow of 250 cfs [cubic feet per second]. Such physical works shall not include those facilities necessary for the collection, conveyance, and discharge of drain water for disposal by the interceptor drain. (Emphasis added).

Paragraph 6(a) of the contract states the payment rate for drainage service and provides for notice of the Drain's availability for service, as follows:

Before December 15 of each year the Contracting Officer shall notify the District in writing of the rate of payment to be made by the District for water which the District is required to accept and pay for during the ensuing year pursuant to the provisions of Article 3 hereof. The rate so announced may not be in excess of

Eight Dollars (\$8) per acre-foot and shall include a drainage service component of not to exceed Fifty Cents (\$.50) for the interceptor drain and a water service component of not to exceed Seven Dollars and Fifty Cents (\$7.50). The United States shall notify the District in writing when the interceptor drain becomes available for service. The drainage service component shall be included in the rate of payment beginning with the year following the date the District is notified that such service is available. (Emphasis added).

The 1963 Contract will expire in the year 2008.

Panoche Water District. The Bureau and Panoche entered into an initial contract in 1955, prior to authorization of the San Luis Unit. This contract was superseded by a 1974 long-term contract for water service and drainage service from the San Luis Unit and water service from the Delta-Mendota Canal ("Panoche 1974 Contract"). Paragraphs 1(d), 4(a), and 7(a)(3) of the Panoche 1974 Contract define "San Luis Drain," specify provisions for notice of availability of drainage service and specify a drainage service rate of \$0.50 per acre-foot of San Luis Unit water furnished. Later contract amendments in 1986 and 1988 did not change those provisions or supersede them. The Panoche 1974 Contract will expire in the year 2008.

San Luis Water District. The Bureau and SLWD entered into an initial contract in 1959, also prior to authorization of the San Luis Unit. This contract was superseded by a 1974 long-term contract for water service and drainage service from the San Luis Unit ("SLWD 1974 Contract"). Paragraphs 1(e), 4(a), and 7(a)(3) are the same as paragraphs 1(d), 4(a) and 7(a)(3) in the Panoche 1974 Contract. Later contract amendments in 1986 did not change or supersede those provisions. The SLWD 1974 Contract also will expire in the year 2008.

The provisions regarding the drain, its availability for service and the payment rate therefore are virtually identical in all three Contractors' contracts for water and drainage service. Each of the contracts was executed pursuant to Section 9(e) of the Reclamation Project Act of 1939 ("1939 Act"). 43 U.S.C. § 485h(e). No provision is made in any of them for payment for drainage service in the event that the Drain is not available for service or is removed from service.

5. 1965 and Subsequent Appropriations Acts Provisos

The Public Works Appropriations Act of October 23, 1965, Pub.L. No. 89-299, 79 Stat. 1096, includes the following provisos:

[San Luis interceptor drain---Conditions---Terminal point.]--Provided further, That the final point of discharge for the interceptor drain for the San Luis unit shall not be determined until (1) completion of a pollution study by the Department of Health, Education, and Welfare, (2) development of a plan to minimize any detrimental effect of the San Luis drainage waters on San Francisco Bay, and (3) agreement is reached by the Secretary with the State of California, subject to the approval of the President, limiting the Federal share of the costs of the drain to Antioch to not more than 60 per

centum thereof, and if found necessary to extend the drain beyond Antioch, the Federal share of such extension shall be determined on the basis of an equitable apportionment of the additional costs between the Federal Government and the non-Federal entities who are to use the facilities: Provided further, That no funds shall be made available under this appropriation for the construction in Contra Costa County, California, of any portion of the interceptor drain in connection with the San Luis unit which terminates at any point east of Port Chicago. 79 Stat. 1101.

Subsequent appropriations acts altered the language, but set forth essentially the same requirement for completion of studies and plans for water quality compliance prior to providing a terminus for the interceptor Drain to the Delta.

6. 1967 State and Bureau Notifications Regarding Drain Construction

In 1967, the State of California notified the Bureau that, having reconsidered State construction of a master drain, it again decided not to build it and that the Bureau should proceed with construction of the San Luis Drain. In the same year, the Commissioner of Reclamation testified before a House Appropriations Subcommittee that the state had withdrawn and that the San Luis Drain, including an unnamed regulating reservoir (which later became Kesterson Reservoir), would be constructed by the Bureau to provide drainage service for the San Luis Unit.

7. 1968 Report of the National Technical Advisory Committee on Water Quality Criteria to the FWPCA

On April 1, 1968, the "Report of the Committee" from the National Technical Advisory Committee on Water Quality Criteria to the Federal Water Pollution Control Administration ("FWPCA"), an agency in the Department of Interior, was published. The Section of the report dealing with agriculture reflects the state-of-the-art information concerning selenium in land drainage waters by being totally silent regarding selenium or the potential for any selenium toxicity. Similarly, the section concerning fish, other aquatic life, and wildlife is silent regarding selenium.

8. 1968 Commencement of Drain Construction and Intended Drain Service

In 1968, the Bureau awarded the first construction contract for the San Luis Drain. Construction plans included the channel of the Drain and Kesterson Reservoir. The Drain was designed to convey up to 150,000 acre-feet per year of saline subsurface drainage water from the San Luis Unit service area to the Delta near Antioch, approximately 125 miles north of the San Luis Unit service area. The Drain was needed to serve about 300,000 acres in Westlands, 38,000 acres in Panoche, and approximately 10,000 acres in SLWD, but only the first drainage construction contract was awarded and the area to be served was limited to approximately 42,000 acres in the northeast corner of Westlands.

At the time the Drain was constructed, it was anticipated that the Bureau would contract with other users for the drain. The Drain was built with capacity to serve other federal water users outside of the San Luis Unit service area. The Drain, even after the State of California dropped from the process, was intended to serve lands elsewhere in the San Joaquin Valley, not just the San Luis Unit.

Section 5 of the San Luis Act permits the use of the Drain by other "... parties under contracts the terms of which are as nearly similar as is practicable to those required by the Federal Reclamation laws in the case of irrigation repayment or service contracts. ..."

In 1978, Public Law 95-46 required a Special Task Force Report on the San Luis Unit. The Task Force was authorized to review the management, organization, and operations of the San Luis Unit to determine the extent to which it conformed to the purposes and intent of the 1960 Act and the Act of June 17, 1902, (32 Stat. 388).

In its report, the Task Force also referenced Section 5 of the 1960 Act as permitting the use of the Drain by others. The report states:

"If and when drainage service is requested by other parties, it appears that the Secretary can contract separately with these other parties under similar terms used under Reclamation law." (Special Task Force Report on San Luis Unit, Central Valley Project, California, Public Law 94-46, pp. 15).

Kesterson Reservoir, located approximately 60 miles north of Mendota, was designed by the Bureau as a series of ponds to cover 4,500 surface acres. It was intended to be operated as a regulating reservoir controlling the flow of drainage water into the Delta upon completion of the remainder of the drain. However, it never became a regulating reservoir because the Drain was never extended beyond Kesterson. Instead, the Bureau operated Kesterson as a site for disposal by evaporation and percolation of the salty drainage water conveyed by the San Luis Drain. As the water evaporated, the concentration of salts in the reservoir increased.

9. 1970 Designation of Kesterson as a National Wildlife Refuge

In 1970, the Bureau in cooperation with the U.S. Fish and Wildlife Service ("FWS") designated Kesterson Reservoir as a National Wildlife Refuge to increase San Joaquin Valley waterfowl habitat. At that time, these agencies knew that the only reliable permanent water supply for the refuge would be drainage water conveyed by the San Luis Drain. The FWS indicated no cause for concern about the quality of drainage waters, nor about selenium contained therein. Contractors of the San Luis Unit were not parties to the decision to designate the reservoir as a refuge.

10. 1972-1980 State-of-the-Art Information Concerning Drainage

The Bureau's Environmental Impact Statement ("EIS") for the San Luis Drain dated October 4, 1972, discussed drainage return flows from irrigation as follows:

The salts in the subsurface agricultural drain flows will be principally those of the applied irrigation water that remain after evapotranspiration by the growing crops.

* * *

Previous concerns regarding the possible adverse effects of pesticides and herbicides have been dispelled by analyses which show that the concentrations of these

toxic elements in subsurface agricultural drain flows is so low as to be practically nonexistent.

Except for boron, no mention is made of any investigations regarding the potential for toxic elements such as the heavy metals or nonmetallic elements such as selenium.

The Task Force Report on the San Luis Unit of 1978 addresses drainage by discussing the salt management problem in the San Joaquin Valley, the chronology of events in the evolution of the San Luis Drain, and the environmental impacts of disposal of drainage water. It states that:

Pollutants expected in the drainage water . . . include: dissolved solids such as salts of sodium, calcium, and magnesium; nitrates; sulphates; suspended solids; and trace elements, such as boron.

No mention is made of selenium in the Task Force Report, nor do the Bureau's manual on land classification revisions of September 30 and November 10, 1982, contain any information in regard to the potential for leaching selenium from irrigated lands.

11. 1975 Drain Construction Halted

Construction of the San Luis Drain was halted at Kesterson in 1975 when it was only 40 percent complete to the Delta and the Kesterson Reservoir ponds were only 21 percent complete. The cost of these facilities amounted to approximately \$40 million at the close of Fiscal Year 1975. An outlet to the Delta never was constructed and the Drain terminated at Kesterson.

12. 1978 - 1981 Construction and Hookup of Westlands Collector Drains to San Luis Drain

Beginning in 1978 and continuing to 1981, collector drains were installed within about 42,000 acres in the northeast corner of Westlands and connected to the San Luis Drain. The 42,000 acres is only a portion of the total area of Westlands that the Drain was designed to serve. Within the 42,000 acres, only about 5,000 acres of grower-funded subsurface, on-farm drainage systems were allowed to be installed and connected to the collector system. No other collector drains were ever connected to the San Luis Drain in any of the Contractors' territories.

13. 1979 Bureau Notification of Drain Availability

In 1979, the Bureau notified the Contractors that the Drain was available for service. Each of them began paying the \$0.50 per acre-foot drainage service charge pursuant to their water service contracts beginning January 1, 1980.

14. 1980 Studies for Drain Discharge Permit

In 1980, the Bureau renewed technical studies needed to obtain a discharge permit from the State Water Resources Control Board ("SWRCB") for the San Luis Drain to discharge drainage effluent near Chipps Island in the western Delta.

15. 1981 Drain Hookup Moratorium

In 1981, the Bureau told the Contractors that completion of the San Luis Drain to the Delta would be required before any additional drainage effluent could be accepted. The Bureau imposed a moratorium on all on-farm drain hookups in 1981 because of the limited capacity of Kesterson Reservoir. That capacity was being utilized to accommodate drainage from 5,000 acres in Westlands that had grower-financed on-farm drainage systems, as well as some portion of the remaining land within the 42,000-acre area which received some limited benefit because of the existence of the drainage collector system. The remainder of Westlands and all of Panoche and SLWD thus were prohibited by the Bureau from receiving any drainage service from the San Luis Unit.

16. 1982 Reclamation Reform Act

In 1982, Congress enacted the Reclamation Reform Act ("1982 Act") to change the acreage limitation provisions under which Reclamation project beneficiaries could receive water and to change the basis for calculating water rates. 43 U.S.C. §§ 390cc, et seq. The 1982 Act mandated increased water rates, according to the amount of land held in a landholding, to reflect O&M or full cost pricing.

17. 1983 Discovery of Selenium Contamination at Kesterson

In 1983, FWS biologists discovered waterfowl mortalities and deformities at Kesterson Reservoir. Subsequently, the Bureau took action to minimize waterfowl attraction to Kesterson by reducing the number of ponds, providing additional water deliveries to neighboring wetland areas, and starting hazing activities intended to discourage waterfowl from using Kesterson as a refuge.

18. 1984 San Joaquin Valley Drainage Program

In 1984, the SJVDP was established as a cooperative state and federal effort to investigate drainage and drainage-related problems and to identify possible solutions in the western San Joaquin Valley. All federal funding for U.S. Geological Survey ("USGS"), FWS, and Bureau work came through the Bureau. The Bureau spent a total of approximately \$54.5 million on the SJVDP. The SJVDP activities resulted in a plan and recommendations for managing those problems for the period from 1990 to 2040, as set forth in a report entitled "A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley," dated September 1990. The management plan is described in the SJVDP report is as follows:

The recommended plan, which is regional in both scope and detail, takes account of uncertainties in information. The plan is not site-specific, and, without more detailed analysis, it is not a plan from which structures may be built. Rather, it should be considered as a framework that will permit the present level of agricultural development in the valley to continue, while protecting fish and wildlife and helping to restore their habitat to levels existing before direct impact by contaminated drainage water. Id. p.1. (Emphasis added).

19. 1984 - 1989 SWRCB Proceedings and Orders

In 1984, Robert James Claus petitioned the Central Valley Regional Water Quality Control Board ("Regional Board") to take enforcement actions against the Bureau and others regarding the discharge of agricultural drainage flows at Kesterson. After the Regional Board denied the petition, the SWRCB reviewed the denial and conducted an evidentiary hearing. In Order No. WQ 85-1, dated February 2, 1985, it held that the drainage flows created a hazardous condition and issued a Cleanup and Abatement Order ("CAO") to the Bureau.

The CAO required the Bureau to submit revised reports of waste discharge for Kesterson Reservoir and to undertake remedial measures. CAO at p.3. It prohibited further discharges into Kesterson and required the Bureau to formulate a Kesterson Cleanup Plan. Id. at p.4. Over the next few years, the SWRCB issued a series of revised cleanup orders culminating in Order No. WQ 89-16, dated September 21, 1989, which approved a final Cleanup Plan.

The approximately \$26.5 million spent by the Bureau as of September 30, 1990, for development and implementation of the Kesterson Cleanup Plan approved by the SWRCB in Order No. WQ 89-16, includes the costs of two activities completed prior to the approval: cessation of drainage water discharges into Kesterson and filling of low spots in Kesterson to prevent the formation of ephemeral pools and to minimize surface ponding.

The three ongoing activities of the plan are active site management, continued monitoring, and continued research.

20. 1985 Department of the Interior Announcement of Closure of Drain and Kesterson and Westlands - Interior Agreement

On March 14, 1985, the Secretary was advised by the Department of the Interior's Solicitor that, because the hazing program was not entirely effective, employees performing their official duties in connection with the operation of Kesterson could not be assured that their actions would not be found to violate the Migratory Bird Treaty Act if waterfowl died from selenium poisoning.

On March 15, 1985, the Secretary announced the closure of Kesterson Reservoir in testimony before the House Subcommittee on Water and Power Resources, stating in part as follows:

The Department believes strongly that in addressing the issue, it must act in full compliance with applicable State and Federal law. Policy-level officials in Washington have concluded that because the hazing program at Kesterson has not proven to be as effective as was hoped and because of the prohibitions of the Migratory Bird Treaty Act, immediate action must be taken. That act appears to create the possibility of violation of criminal laws without regard to intent or knowledge. Therefore, the Secretary has instructed the Bureau of Reclamation and the Fish and Wildlife Service to begin the process of shutting down the Kesterson Reservoir. This process will result in plugging the San Luis Drain and stopping the delivery

of irrigation water to the lands which drain into the reservoir.

Also, we will begin the process of cleaning up the water and soil in the Kesterson Reservoir. The hazing program will continue at Kesterson. The comprehensive study program initiated will continue. (Emphasis added).

After this announcement, Westlands acted immediately to protect its water users against the disastrous effects of the proposed actions. This finally resulted in an agreement with the United States dated April 3, 1985, ("1985 Agreement") that deferred plugging of the drainage collector system for a year, giving Westlands time to explore alternatives to that action, and assured the continued delivery of irrigation water. The 1985 Agreement did not provide for payment by Westlands for any cleanup, monitoring, or other costs associated with the closure of Kesterson or for SJVDP expenditures by the Bureau. The other Contractors were not parties to the 1985 Agreement.

One of the purposes stated specifically in the 1985 Agreement was to allow continued delivery of irrigation water to Westlands during 1985 for lands that at the time were draining into the San Luis Drain, "...while at the same time Westlands, in compliance with the mandate of the federal government, designs and installs alternative means for disposal of drain water in an efficient and environmentally sound manner." These "alternative means" could include, but were not limited to, evaporation ponds, irrigation of salt-tolerant crops, and recycling. If adequate alternative means were not installed by June 30, 1986, Westlands was required to plug the collector drains in the 42,000 acres so that they would no longer discharge into the San Luis Drain.

In an effort to implement alternative means, and thus to avoid plugging the collector drains, Westlands undertook the following measures between August 1985 and the June 30, 1986, deadline: (1) purchased a 366-acre site for land application of approximately 213 acre-feet of drainage water on bare soil; (2) started a pilot voluntary water conservation and management program for farmers in the 42,000 acres under which participants received \$8 per acre from Westlands (fees exceeding \$8 per acre were paid by the farmers) to hire an irrigation consultant to help them effectively reduce their drainage water (94 percent of these farmers participated in this program during the 1985-86 season); and (3) approved a voluntary drainage water recycling program under which participants were paid \$25 for each acre-foot of drainage water recycled by blending it with fresh irrigation water. For a variety of reasons, none of the alternatives examined allowed Westlands to meet the June 30, 1986, deadline for terminating all drainage flows to Kesterson and Westlands was forced to plug the drainage collector system. Since that time, Westlands has spent more than \$8 million in carrying out its obligations under the 1985 Agreement, as well as research, investigations, and prototype development designed to resolve the drainage problem.

Both Panoche and SLWD have also worked toward resolving the drainage problems in their respective areas. Since 1985, the two districts have spent approximately \$1,650,000 on drainage.

21. 1986 Westlands' Collector Drains Plugged and Drain and Kesterson Closed

In 1986, Westlands completed its performance of the 1985 Agreement with the installation of plugs shutting off the drainage collector system in the 42,000 acres from the San Luis Drain. Since then there has been no San Luis Unit drainage service. The

42,000 acres received partial service for only a few years, disposing of a total of 34,000 acre-feet of drainage water in the six years before the system had to be plugged. The remainder of Westlands and all the lands within the other two Contractors' districts were forbidden to hook up in 1981 and have never received any drainage service.

22. 1986 Stipulated Judgment in Barcellos Case

On December 30, 1986, the Barcellos litigation was settled by U.S. District Court approval of a stipulation for judgment by all of the parties, including Westlands and the United States. The other Contractors were not parties to the Barcellos litigation or its settlement. Paragraphs 4 through 7 of the Judgment state the basis for various rates to be paid by water users in Westlands for Bureau service and describe the conditions under which the San Luis Drain or alternative drainage service facilities providing drainage service to Westlands are to be completed by the Bureau and paid for in part by Westlands.

Under paragraphs 4 and 5 of the Judgment, rates are either those established in the 1963 Contract (a maximum of \$0.50 per acre-foot for drainage service) or those established pursuant to the 1982 Act and implemented by the 1987 CVP "Irrigation Ratesetting Policy" published by the Bureau Mid-Pacific Region ("1987 Policy"). 43 U.S.C. §§ 390aa, et seq., and Pub.L. No. 99-546, §§ 105, 106 (1986).

Paragraph 6 of the Judgment concerns drainage service facilities, and paragraph 7 establishes the Drainage Trust Fund. Under those provisions the Bureau is obligated to develop a Drainage Plan by December 31, 1991. Specifically, paragraph 6.1 requires the Bureau to develop, adopt, and submit to Westlands by December 31, 1991, a Drainage Plan which shall have at least the elements set forth in designated paragraphs of the Judgment. One of the paragraphs, 6.1.1, states that the drainage service facilities included in the Drainage Plan shall (a) in the aggregate have sufficient capacity and capability to transport, treat as necessary, and dispose of, the annual quantity of subsurface agricultural drainage water from Westlands (not less than 60,000 acre-feet and not more than 100,000 acre-feet) required to be disposed of by December 31, 2007, as projected in the Drainage Plan; (b) be cost effective and financially feasible; and (c) be capable of construction, acquisition, and operation in compliance with all applicable laws. The Bureau has not yet developed, adopted, and submitted the Drainage Plan.

Paragraph 7 of the Judgment establishes the Drainage Trust Fund to provide up-front cost-sharing by Westlands for future drainage service facilities constructed by the Bureau and to encourage and expedite Bureau construction or acquisition of such facilities. Westlands is required to levy assessments sufficient to pay into the trust fund \$5 million per year up to an aggregate of \$100 million including interest earned. The Westlands Treasurer is the trustee of the Drainage Trust Fund and is required to pay the Bureau progress payments from the Drainage Trust Fund amounting to 35 percent of the estimated costs of construction by the Bureau of drainage service facilities in any fiscal year.

"Costs of construction" are defined in paragraph 1.18 of the Judgment as "costs of design, preparation of plans and specifications, acquisition of real and personal property, and actual construction, excluding administrative, indirect and overhead costs." The 35 percent limitation is in paragraph 7.1.4. It further states that the required progress payments to the Bureau in any fiscal year shall not exceed \$500,000 per facility for design and preparation of plans and specifications and \$15 million for total costs of construction of all facilities. The progress payments in the aggregate

shall not exceed \$100 million. Westlands began levying and collecting the required assessments in 1988.

Inasmuch as the Bureau has not yet developed the Drainage Plan, no obligation of Westlands to make progress payments has yet arisen.

Paragraph 7.5 of the Judgment provides that, beginning upon completion of construction or acquisition by the United States of any drainage service facilities included in the Drainage Plan and continuing through December 31, 2007, Westlands shall pay the United States for drainage service, in addition to the \$0.50 per acre-foot drainage service charge under the 1963 Contract, a drainage service charge per acre-foot of CVP water delivered to Westlands sufficient, when combined with the \$0.50 per acre-foot charge, to cover its share of the O&M costs of such drainage service facilities. Paragraph 7.7 further states that the Bureau shall credit the total drainage service charges collected, first, to payment of Westlands' share of the O&M costs of the drainage service facilities and, second, to Westlands' share of their construction costs. Nothing in any of these provisions requires such payments in the absence of the construction or acquisition by the Bureau of drainage service facilities.

Nothing anywhere in the Judgment requires Westlands or its water users to pay for any of the expenditures discussed in this Memorandum.

23. 1986 Interior Solicitor's Opinion

The Solicitor of the Department of the Interior concluded in his Opinion M-36901, Supp. I, dated June 17, 1986, that the Secretary had "a full range of administrative options" available to implement the San Luis Unit legislation with regard to the issue of "the nature of the San Luis Interceptor Drain." The opinion stated further that "substantial Secretarial discretion must be found to exist with regard to . . . the provisions for financing and repayment of the San Luis Interceptor Drain." The opinion also affirmed the Secretary's authority to finance the construction of the San Luis Drain as well as the San Luis Reservoir and the San Luis Canal under the indexable cost ceiling of Section 8 of the 1960 San Luis Act, previously quoted.

24. 1986 Enactment of Coordinated Operations Agreement

In 1986, Congress enacted Public Law 99-546, the Coordinated Operations Agreement. The COA is significant because it allows for any deficit balances to accrue interest which, in effect, forces water users to pay actual O&M costs rather than contract rates and it fixes the repayment period to the year 2030 for federal contractors.

Sections 105 and 106 of the COA mandated the determination of individual contractor repayment of deficit balances and precludes options previously under consideration that would pool O&M deficits CVP-wide for repayment and provided that the Secretary of the Interior could adjust water rates such that repayment of federal facilities was completed by the year 2030. The law also provided for interest to be calculated on O&M deficits accruing on or after October 1, 1985.

The deficits referred to in the law describe the accumulation of annual O&M costs that exceed the annual water service payments made under a contract with a particular water agency. These unpaid amounts would then be added to the cost of water when a water agency's water service contract is renewed.

25. 1987 Bureau CVP Irrigation Ratesetting Policy

In 1987, the Bureau published its "Irrigation Ratesetting Policy" for the CVP. Its purpose was to establish the basis for rates of payment for water service from contracting districts and their water users sufficient to eliminate deficits created over the years by the type of fixed-rate contracts agreed to by the Contractors and the Bureau. Those contracts did not allow the Bureau to increase rates to meet increased CVP capital and O&M costs. The new rates were designed to correct this. Additionally, the policy allowed for repayment to commence once the plans for which the contracts were executed were placed in service.

The 1987 Policy was established under Section 9(e) of the Reclamation Project Act of 1939. This policy was affected by Sections 105 and 106 of Pub.L. No. 99-546. The 1987 Policy states:

These rate determinations include provisions for annual O&M costs, amortized rates for the applicable construction costs and rates to recover any accumulated O&M deficits (including interest pursuant to Section 106 of Pub.L. No. 99-546) or adjustments for individual repayments to date. The "full cost" rate also includes an interest charge. Id. at p.4.

The 1987 Policy provides for recovery of San Luis Drain costs from the Contractors as follows:

The San Luis Drain operation and maintenance expense component incorporates all San Luis Drain expenses including a pro rata share of the annual administrative and general expense. The San Luis Drain operation and maintenance expenses were pooled and allocated to the three contractors currently entitled to San Luis drainage service (the Panoche, San Luis and Westlands Water Districts) on the basis of each Contractor's San Luis Canal deliveries for the year involved. . . .

The San Luis Drain capital costs as of September 30, 1986, were allocated to the three contractors currently entitled to San Luis drainage service (the Panoche, San Luis, and Westlands Water Districts) on the ratio of each Contractor's projected 1987 through 2030 San Luis Canal deliveries to the total of all such deliveries. . . . Id. at p.8.

The San Luis Drain is listed in Schedule 4 of the 1987 Policy as an "unpaid irrigation capital cost" as of September 30, 1986, totalling \$40,991,103 (slightly higher than the fiscal year-end 1975 figure), or approximately \$41 million. Among the Contractors, the approximate \$41 million is allocated as follows: (1) Panoche, approximately \$1.5 million; (2) SLWD, approximately \$2.7 million; and (3) Westlands, approximately \$36.8 million. The calculated "unpaid capital rate per acre-foot" amounts to \$0.77 per acre-foot for each of the Contractors.

The application of the 1987 Policy to the Contractors is as follows:

1. Westlands: Rates for service under the 1963 Contract are not subject to the 1987 Policy except as to landowners and water users who have elected to come under the 1982 Act and are subject to the O&M or full cost rates. However, rates for provisional water service under paragraph 5 of the Judgment are controlled by the 1987 Policy even as to water users who have not elected; that is, they must pay at least cost-of-service.
 2. Panoche: Rates for service under its 1974 Contract are not subject to the 1987 Policy as to the water service component, except as to landowners and water users who have elected to come under the 1982 Act and are subject to O&M or full cost rates. In addition, rates for service for water from a new turnout to Panoche on the San Luis Canal are subject to the 1987 Policy as to the O&M or full cost rates because of the 1988 Amendment of its 1974 Contract. But the drainage service component is still limited by the original terms of its 1974 Contract, except as to water users who have elected to become subject to the 1982 Act. In 1996, approximately one half of the water supply will become subject to the cost-of-service rate.
 3. SLWD: Similar to Panoche, rates for service under its 1974 Contract are not subject to the 1987 Policy except as to landowners and water users who have elected, who then pay the O&M or full cost rate, as appropriate. In 1996, approximately 25 percent of the water supply will become subject to the cost-of-service rate.
25. 1987 Interior Solicitor's Opinion

The Solicitor issued another opinion, dated March 20, 1987, which responded to the Secretary's questions regarding (1) his authority to finance the Department of the Interior's participation in the SJVDP with funds appropriated under Section 8 of the 1960 San Luis Act, and (2) how and from whom he should seek reimbursement if such use of those funds is authorized and they are so used. The Solicitor stated his conclusions as follows:

- (1) the Secretary is authorized to finance SJVDP activities relating to the ultimate resolution of the drainage problems in the San Luis Unit with funds appropriated under the indexable cost ceiling in Section 8 of the San Luis Act; and
- (2) neither the San Luis Act nor any other provision of Federal Reclamation law, including the Reclamation Reform Act of 1982, 43 U.S.C. 390 *aa et seq.*, and the Act to implement the Coordinated Operations Agreement for the CVP, P.L. 99-546, prescribe specifically the manner in which such SJVDP costs are to be repaid or by whom.

In our consideration of the foregoing issues, we have reviewed for consistency the memorandum of the Associate Solicitor for Energy and Resources, dated November 25, 1986, on the related authority and repayment issues for the Kesterson Reservoir cleanup program.

We agree with the analysis and conclusions presented by the Associate Solicitor in the November 25th memorandum as they relate to the Secretary's authority to finance the Kesterson Reservoir cleanup program under Section 8 of the San Luis Act. However, for the repayment of the Kesterson Reservoir cleanup program costs, the analysis presented herein concerning the repayment of the Federal cost of the SJVDP clarifies that presented in the Associate Solicitor's November 25th memorandum. Id. at p.1. (Emphasis added.)

* * *

In summary, it is our opinion that because the SJVDP studies relate to the provision of authorized drainage service to the San Luis Unit of the CVP, additional authorization from Congress is not needed. The expenditures are for studies of the type for which appropriations normally are made to the "construction" account of the Bureau of Reclamation. Consequently, funds appropriated under Section 8 of the San Luis Act for "construction of the works of the San Luis Unit" lawfully may be used for the SJVDP (subject, of course, to any limiting provisions, such as the proviso in Pub. L. No. 99-591). Id. at p. 6.

* * *

Based on the foregoing, we conclude that the Secretary has broad discretion to determine the method of repayment and determine to whom the repayment obligation will be allocated for the SJVDP and Kesterson Reservoir cleanup program costs. Id. at p. 7.

Apparently following the advice of the Solicitor, the Bureau has been charging the San Luis Unit Construction-in-Progress Account for all costs associated with the Kesterson Cleanup Plan, the SJVDP, and other drainage-related expenditures.

According to the 1987 Policy, the Bureau has calculated the costs of partially constructing the Drain and Kesterson prior to their closure and has included them as components of the 1987 to 2030 water rates. This action suggests that these costs have already been transferred to a Plan-in-Service Account.

27. 1989 San Joaquin Valley Drainage Program Citizens Advisory Committee Policy Statement

On May 27, 1989, Chester McCorkle, Chair of the SJVDP Citizens Advisory Committee ("CAC") wrote Interior Secretary Donald P. Hodel advising him of the CAC's consensus position regarding repayment of federal expenditures on San Joaquin Valley agricultural drainage problems. Enclosed with the letter was the CAC's May 1988 "Policy Statement" on allocating repayment responsibility for Kesterson cleanup costs

and SJVDP costs. The CAC recommended that financial responsibility be apportioned as follows:

1. Kesterson Reservoir Cleanup. Principal responsibility should be borne by the Bureau without reimbursement by the water users because it (along with the FWS) chose Kesterson as a drainage disposal site and collected drainage fees from all San Luis Unit contractors for nearly a decade "without apparent benefit for those contractors," and because the contractors had relatively little influence over where their drainage was disposed of. Hence, the Bureau should "absorb the lion's share . . . without reimbursement from water users." Policy Statement at 2.
2. SJVDP Studies. The diverse beneficiaries should pay for costs fairly attributable to them. Hence, primary responsibility for costs of treatment and disposal research and development should be borne by the affected water districts and their water users; primary research generating baseline geological and environmental information should be a shared public/private responsibility. The public includes regional, state, and national interests concerned with the quality of water for drinking purposes and for fish and wildlife protection and affected by drainage problems. Research that benefits broader public interests should not be subject to reimbursement by the water users. Id. at 3.

The CAC further recommended that apportionment of financial responsibility for implementing solutions that arise out of the SJVDP and other sources "must ultimately await the actual development of those solutions" so that costs can be tied to benefits received and offset by any revenues generated by solutions to drainage problems.

28. 1990 Kesterson Monitoring Budget Item

The Bureau's February 1990 proposed FY 1991 O&M budget includes expenditures as "Kesterson monitoring and evaluation". As already stated, those expenditures, totalling approximately \$2.8 million for the 1990-91 federal FY were for Kesterson monitoring, specifically two cost components.

One component consists of biological monitoring, site management, and administrative overhead expenses associated with four full-time employees and one part-time employee at the Kesterson Field Station to implement the 1990 Kesterson Reservoir Site Management Plan as approved by the SWRCB in March of 1990.

The other component consists of approximately \$1.7 million for various external consultant services to provide biological monitoring, monitoring of selenium uptake in soil and groundwater, a study of long-term site management through alternative land use scenarios, ongoing management of a two-acre volatilization plot, monitoring and testing for potential sediment removal from the San Luis Drain, and coordination by the FWS of the overall management of the site and program development. Activities associated with these costs were characterized by the Bureau as the second phase of a multi-part plan to mitigate the long-term effects of drainage contamination at Kesterson. Bureau staff have indicated these activities will take place over the next five years, at least.

29. 1990 San Joaquin Valley Drainage Program - Phase II

The SJVDP officially ended on September 30, 1990. Prior to its conclusion, however, the SJVDP's Policy and Management Committee acknowledged that there was a need for certain activities to continue. At that time, the Policy and Management Committee pledged that sufficient resources from each of the five participating state and federal agencies would be made to accomplish the SJVDP's follow-up mission, which would terminate by December 31, 1991. To accomplish the follow-up portion of the program, the organization and general concept outlined in the SJVDP Managers' memoranda to the Committee, dated June 6, 1990, and August 3, 1990, would be used.

For the follow-up effort, the state and federal managers were retained in their positions to continue work. Additionally, the CAC became the "Drainage Oversight Committee for the San Joaquin Valley Drainage Program Followup."

In a draft work plan for the SJVDP Followup, dated November 1990, the purpose of the Follow-up program is described:

"The overall purpose of the San Joaquin Valley Drainage Program Followup is to develop a strategy for implementation of the plan and recommendations described in the SJVDP report. The strategy will promote action on the program's recommended plan to ensure that the recommendations do not languish in an unattended report. The strategy should define: (1) required actions and priorities, (2) agency responsibilities, (3) funding sources and amounts. (Emphasis added).

The Drainage Oversight Committee has been meeting and the followup efforts of the SJVDP are underway. To date, however, there has been no indication as to where the Bureau's portion of the funding is being budgeted or to whom those costs will be allocated.

30. 1990 FY 1991 Appropriations Act Statement of Managers

The proposed \$2.8 million item for Kesterson monitoring was included in the Bureau's O&M budget for the 1990-91 federal FY. The amount is a small part of the total \$221,516,000 for all Bureau project O&M costs that is appropriated, along with funds for all other Bureau activities, by the Energy and Water Development Appropriations Act of 1991, but it was not separately identified in that Act. The Statement of Managers accompanying the Act directs the Secretary in part to:

. . . review the Department's repayment policies with respect to Kesterson and other drainage related costs . . . and submit a report on this policy, no later than March 31, 1991, to the appropriate committees of the House and Senate. Recommendations on past and future allocations between Federal and non-Federal interests as well as recommendations on cost allocations between reimbursable and non-reimbursable functions shall be included in the report. Pub.L. No. 101-514, 104 Stat. 2074, 2085 (1990).

V.

COSTS EXPENDED TO DATE

The major expenditures in question are for the following activities:

O&M Expenditures

1. Kesterson monitoring and evaluation ("Kesterson monitoring"), approximately \$2.8 million for federal FY 1990-91. These are the anticipated annual expenditures for ongoing Bureau monitoring and evaluation of the contamination at Kesterson Reservoir in federal FY 1990-91 and the efforts to clean it up. Future costs to perform this activity are not included. The approximate costs to date are as follows: Monitoring -- \$1.1 million; Research -- \$930,000; Field Office -- \$420,000; Regional and Fresno Offices -- \$324,000.

Current Status. The Bureau has budgeted Kesterson monitoring expenditures as O&M costs of the San Luis Unit. It has stated its intention to include them as part of the O&M component of the rates to be collected in federal FY 1990-91 (and apparently in federal FY 1991-92 as well) from the Contractors' water users.

Capital Expenditures

2. San Luis Drain and Kesterson Reservoir construction costs ("construction costs"), approximately \$40 million when construction was halted in 1975 and ongoing operation and maintenance costs. The amount for construction costs includes approximately \$10 million for construction of Kesterson Reservoir as completed in 1971, which consisted of 1,200 acres with 12 ponds. In addition, O&M charges associated with Kesterson and the Drain have ranged from approximately \$50,000 to \$250,000 annually.

Current Status. The Bureau has included the costs incurred for partially constructing the Drain and Kesterson up to 1975, when construction was halted, in the San Luis Unit Plan-in-Service Account and, thus, in the capital components of the cost-of-service and full cost rates currently being charged to the Contractors' water users for San Luis Unit service. In addition, the costs for operating and maintaining the San Luis Drain are included in the O&M rates charged to the San Luis Unit Contractors.

3. Kesterson Cleanup Plan, approximately \$26.5 million as of September 30, 1990. These are Bureau expenditures for the actions required by the SWRCB and concurred by the Bureau to develop and implement an approved plan to clean up the Kesterson Reservoir contamination. The costs expended as of the end of the federal FY 1990 are detailed as follows: San Luis Drain Closure -- \$13.3 million; Kesterson On-site Disposal -- \$12.7 million; Capitalized Movable Equipment -- \$141,266.

Current Status. The Bureau has included these expenditures in the San Luis Unit Construction-in-Progress Account. The Contractors do not know where these costs ultimately will be placed for repayment, if, in fact, any repayment is appropriate.

4. SJVDP, approximately \$54.5 million as of September 30, 1990. These are expenditures for the Bureau's share of a cooperative federal and state program to study and investigate the causes of and potential solutions to westside San Joaquin Valley drainage and drainage-related problems. The costs are detailed as follows: Primary

Program Studies and Research – \$34.6 million; Drainage Monitoring and Analyses Activities – \$10.5 million; San Luis Drain Special Study – \$1.1 million; San Joaquin Drainage Implementation Program – \$1.1 million; San Luis Drain Discharge Study – \$5.1 million; Capitalized Movable Equipment – \$692,146.

Current Status. The Bureau has included these expenditures in the San Luis Unit Construction-in-Progress Account. The Contractors do not know where these costs ultimately will be placed for repayment, if, in fact, any repayment is appropriate.

5. Drainage Plan preparation ("Drainage Plan"), approximately \$1 million as of September 30, 1990. These are expenditures for Bureau preparation of the Drainage Plan required by the stipulated Judgment in the consolidated Barcellos and Wolfson, Inc. v. Westlands Water District and Westlands Water District v. United States litigation, U.S. District Court, E.D. California, Nos. CV 79-106-EDP and CV F-81-245-EP ("Barcellos litigation").

Current Status. The Contractors have not been able to determine how these costs are being currently accounted for by the Bureau.

6. Kesterson Mitigation, an unspecified amount. These are expenditures for the purchase by the Bureau of approximately 5,600 acres of land that will be transferred to the FWS to replace wildlife habitat no longer available at Kesterson due to its closure. The Bureau also will spend an unspecified amount annually to maintain the purchased acreage as a wetlands area, including costs associated with providing an annual water supply of approximately 12,000 acre-feet.

Current Status. The Contractors have not been able to determine how these costs are being currently accounted for by the Bureau.

VI.

ANALYSISA. Kesterson Monitoring Costs

The inclusion of the approximately \$2.8 million in expenditures for Kesterson monitoring in the Bureau's FY 1991 O&M budget raises an immediate concern regarding the Bureau's authority to collect those costs. At issue is whether the expenditures are properly classified as O&M costs based upon the type of activities for which they were spent. The classification of expenditures as O&M costs or as construction costs is initially decided by the Bureau, but its decision is not final.

There is an additional concern created because the Bureau has classified these costs as O&M expenditures as opposed to capital expenditures. The ratesetting policy established by the COA legislation allows for O&M expenditures to be interest-bearing. Not only do water users have to pay the O&M expenditures in present-day values, they will also be charged interest should a deficit occur.

The Contractors have been told by the Bureau that Kesterson monitoring costs are expected to continue for at least five years. What is not known is whether those costs will continue at \$2.8 million, or increase under present values, not to mention accumulated interest.

1. Distinguishing O&M Costs From Construction Costs

Nampa and Meridian Irrigation District v. Bond, 268 U.S. 50 (1925), the seminal case regarding the distinction between O&M and construction costs, stated the criteria as follows:

- (1) Proper O&M expenditures generally include those:
 - (a) made to maintain an irrigation system as an efficient going concern and to operate it effectively to the end for which it was designed; or
 - (b) made to overcome injurious effects resulting from the normal and ordinary operation of the completed plant, which was originally well constructed.
- (2) By contrast, proper construction expenditures generally include those:
 - (a) necessary to construct an irrigation system and put it in a condition to properly furnish and distribute a water supply; or
 - (b) necessary for extensions to new land or for changes in or additions to the system due to faulty original construction in violation of contractual or statutory obligations (citing Twin Falls Salmon River Land and Water Co. v. Caldwell, 266 U.S. 85 (1924)). Id. at 53-54.

Based on relevant case law, these criteria can be distilled into two key questions: (1) Was the facility completely constructed and operational when the expenditures became necessary? (2) Was the original construction properly done (i.e. not defective) and in conformance with the statutory authority and contractual requirements?

If the answer to both questions is "yes" the charges may properly be allocated to O&M. For the following reasons, these questions cannot be answered "yes" as to the Bureau monitoring work at Kesterson.

The answer to the first question is clearly "no" because the San Luis Drain and Kesterson Reservoir were never completely constructed. Further, the facilities were not operational when the Kesterson monitoring expenditures arose. Pursuant to the Bureau's decision to close Kesterson and the San Luis Drain, as well as the 1985 Agreement, Kesterson and the Drain (north of Mendota) were closed due to accumulated high selenium concentrations in the drainage water deposited into Kesterson. The accumulation of this concentrated selenium was due directly to the failure of the Bureau to provide an outlet for drainage flows to the Delta.

The answer to the second question is also "no" because construction of the Drain and related facilities was never completed in the manner authorized by the 1960 San Luis Act and contemplated by Westlands' 1963 Contract and Panoche's and SLWD's 1974 Contracts. As constructed, Kesterson could not be used as a regulating reservoir and the Drain could not discharge into the Delta at its terminus. These facts rendered the facilities defective, as shown in Twin Falls Salmon River Land and Water Co. v. Caldwell, 266 U.S. 85 (1924). In that case, the Supreme Court held that expenditures on irrigation facilities which did not measure up to the standard imposed by the statutes must be allocated to construction rather than O&M. The Court approved the findings of the Ninth Circuit Court of Appeals, which stated in pertinent part:

The state was not contracting with the promoting company for part of an adequate system, but for a completed adequate system. When the Land and Water Company got through there was to be nothing more to do -- there was to be a system up to the requirements of the law . . . Twin Falls, supra at 272 F. 356, 370 (1921) aff'd. 266 U.S. 85. (Emphasis added.)

Thus, charges for corrective actions on a defective check basin were disallowed as O&M costs in Twin Falls. In a similar vein, the partial construction of the San Luis Drain and Kesterson Reservoir, while in part useful to a small fraction of the lands in Westlands prior to their closure, failed to meet the requirements of the 1960 San Luis Act and the Contractors' 1960 and 1974 Contracts that anticipated the full use of a completed, adequate drainage system. Under the law, this makes the Kesterson monitoring expenditures construction costs and not O&M costs.

In addition, these expenditures did not add anything to make a completed system operate more effectively. On the contrary, the costs grew out of corrective actions needed to correct faulty original construction, the same sort of actions held chargeable to construction costs in U.S. v. Fort Belknap Irrigation District, 197 F. Supp. 812, at 819 (D. Montana 1961).

The provisos in the 1965 Appropriations Act and subsequent appropriations acts required completion of studies and plans for water quality compliance prior to determination of the final discharge point for the drain, but these acts did not convert the Kesterson Reservoir or the San Luis Drain into "completed facilities."

For example, the 1960 San Luis Act's capacity requirements for the completed facility were not changed by these subsequent congressional directives. Paragraph 1(d) of the 1963 Contract stated that the area intended to be served by the Drain when complete required a capacity of about 150,000 acre-feet per year at a maximum rate of flow of 250 cfs.

Further, the Bureau did not regard the post-1965 appropriations act provisos as congressional amendments to the 1960 San Luis Act's definition of authorized project facilities. The Bureau's renewal of technical studies in 1980 to obtain a discharge permit from the SWRCE for discharge of the drainage water at a point near Chipps Island in the western Delta demonstrates the Bureau's belief that the authorized Drain was still one that terminated at the Delta. In addition, a December 22, 1981, letter from Bureau Regional Director Mike Catino to Panoche Manager Raymond Ram stated:

You were advised that our capability to accept drainage effluent from your District is nonexistent at this time and will be severely limited until an ultimate point of disposal is available to us. Completion of the drain to the presently proposed discharge location near Chipps Island will provide that point of disposal. In the interim, it is possible that our capability to accept drainage flows can be increased by the addition of: (1) an expanded Kesterson Reservoir, and (2) construction of a marsh or marshes in the vicinity of Mendota or South Dos Palos. We anticipate that completion of an enlarged Kesterson or the marshes will require a minimum of five years. We do not anticipate that the discharge at Chipps Island will be completed prior to 1995. (Emphasis added).

The letter clearly states the Bureau's understanding of the law that the Drain was required to terminate at the Delta and that the provision of adequate capacity in the facilities was required before they would be considered complete.

While no lands in Panoche or SLWD received drainage service, a small portion of Westlands, approximately 5,000 acres, did receive some drainage service between 1979 and 1986, prior to the closure of the Drain and Kesterson. Also, some portion of the remaining land within the 42,000 acre area received some limited benefit because of the existence of the drainage collector system during that period. Nonetheless, the lack of adequate capacity to serve all of the drainage needs in Westlands prevents the Bureau from considering the facilities completed, operational, and not defective during that period.

The Drain was meant to serve about 300,000 acres in Westlands, not just the 42,000 acres. Water users in a large portion of Westlands need drainage service. Westlands contracted in the 1963 Contract for a system with adequate capacity when completed to serve those needs. Construction of only 40 percent of the Drain and 21 percent of the Kesterson ponds constituted only part of a system, not a "completed, adequate system." Twin Falls, supra, 272 Fed. at 370. Thus, construction of the facilities to the Kesterson terminal point, even if limited by the post-1965 appropriations act provisos, did not produce completed facilities in the absence of

sufficient capacity to serve all the lands needing drainage in the Contractors' service areas, as required by their contracts.

2. \$0.50/Acre-foot Drainage Service Charge

Under the stipulated Judgment, Westlands agreed and is required to continue to pay the \$0.50 per acre-foot drainage service charge in the 1963 Contract, even though the Drain including Kesterson is no longer serving any lands in Westlands. Paragraph 4 of the Judgment preserves the fixed drainage service charge of \$0.50 per acre-foot for those water users who have not elected to become subject to the 1982 Act. Those water users who have elected and those water users who receive provisional water service under the Judgment must pay the applicable rate established in the 1987 Policy. That rate includes an O&M expense component that "incorporates all San Luis Drain expenses" according to the 1987 Policy. However, as discussed above, the \$2.8 million is not an O&M expense because the Drain was not completed, adequate, and operational for lands in Westlands.

Panoche and SLWD have never had service from the Drain. While they were notified in 1979 that the Drain was available for service, two years later, before they built any collector drains to connect to the Drain, the Bureau imposed a moratorium on further connections. Their 1974 Contracts do not obligate them to pay for drainage service if it is not available. Therefore, they should have no obligation even to pay the \$0.50 per acre foot component for interceptor Drain service under their 1974 Contracts. For the same reason, to the extent these Contractors or their water users have elected to come under the 1982 Act, no drainage service costs should be included in their cost-of-service or full cost rates under the 1987 Policy.

As to both Panoche and SLWD, the same as to the bulk of Westlands, the drain has never been a completed, adequate, and operational facility. As discussed above, this fact precludes the treatment of the Kesterson monitoring expenditures as O&M costs.

3. Reimbursability of Kesterson Monitoring and Evaluation Costs As Construction Charges

As discussed above, the \$2.8 million is not an O&M cost because there are no completed, adequate, and operational drainage service facilities as required to meet the Contractors' drainage needs to which they could apply. The 1987 Policy does not currently incorporate such expenditures as a capital cost component of the San Luis Drain. Viewed as construction costs, to incorporate them as a capital component in San Luis Unit cost-of-service or full cost rates would, however, be premature at best.

The Secretary's March 15, 1985, order to close the San Luis Drain and Kesterson raised the question of whether the Department might ultimately play any role in the provision by the Bureau of drainage service to the Contractors. Thus, it is not possible to determine now whether the costs of Kesterson monitoring and evaluation will relate to any future construction of additional facilities or future extension of existing facilities by the Bureau to provide drainage service.

B. San Luis Drain and Kesterson Construction Costs

The expenditures incurred by the Bureau for construction of the San Luis Drain and Kesterson Reservoir up to the date of cessation of that activity in 1975 were

approximately \$40 million. As mentioned earlier, the 1987 Policy currently provides for recovery of San Luis Drain expenditures in the capital and O&M cost components of the cost-of-service or full-cost water rates applicable to the Contractors. Inclusion of these costs in the rates to be charged the Contractors over the period 1987 to 2030 under the 1987 Policy raises the question whether the Bureau has properly moved these costs from a Construction-in-Progress Account to a Plan-in-Service Account making them payable by the Contractors now.

The Bureau's standard accounting methodology is to allocate construction costs to a Construction-in-Progress Account until such time as facilities have been completed. Upon their completion, the costs are transferred to a Plan-in-Service Account for collection from the project beneficiaries as a capital component of the cost-of-service or full cost water rates.

Similar to the discussion of Kesterson monitoring costs, the issue is whether the construction of these facilities has been completed. If the answer is yes, it is appropriate to include their costs in the Bureau's Plan-in-Service Account for repayment by the Contractors to the extent that some of their water users are subject to the 1987 Policy. If the answer is no, these costs should be kept in the Bureau's Construction-in-Progress Account for a later determination of reimbursability when construction has been completed.

Under the analysis in Nampa and Meridian Irrigation District v. Bond, 268 U.S. 50, 53-54 (1925), construction expenditures include those necessary to construct an irrigation system and put it in a condition to properly furnish and distribute a water supply or those necessary for extensions to new land or for changes in or additions to the system due to faulty original construction in violation of contractual or statutory obligations. In that decision, the Supreme Court further stated that classification as construction costs depends on the facts of each case. In the instant case, unquestionably the expenditures for San Luis Drain and Kesterson construction up to 1975 are properly classified as construction costs. But they are costs for facilities that are not furnishing a service to the Contractors; they are not only incomplete, they are presently inoperable.

Although construction was halted in 1971 on the Kesterson ponds and in 1975 on the San Luis Drain, the Bureau notified the contractors that the facilities were available for drainage service in 1979. In 1981, however, the Bureau imposed a moratorium on collector drain hookups to the San Luis Drain and prohibited use of the facilities by all Contractors except those water users in the Westlands 42,000 acres who were already using the entire disposal capacity of the facilities. Finally, when the Secretary closed Kesterson in 1985 and, under the 1985 Agreement, Westlands installed plugs in the drainage collector system for the 42,000 acres by June 1986, the facilities were no longer available for use by any of the Contractors.

As a direct consequence of the Secretary's closure of Kesterson and termination of all drainage service, currently there is no constructed system in a condition to properly furnish drainage service to any of the Contractors. Moreover, the Bureau has not yet completed a Drainage Plan or constructed facilities required to meet its obligation under the 1960 San Luis Act and the 1963 and 1974 Contracts to provide drainage service. Since the needed facilities do not exist now and the facilities previously constructed are no longer in operation, construction expenditures for the closed and inaccessible facilities are not properly included in a Plan-in-Service Account for recovery by rates for service.

A fundamental premise of the Reclamation program since its inception in 1902 has been that benefits would be made available to people utilizing project facilities under the program consistent with the public good. As a corollary to bestowing these benefits, Congress gave the federal government the authority to impose reasonable conditions on the use of federal funds, property and privileges. Contracts executed between the federal government and project beneficiaries establish "debtor-creditor" relationships in which payment is expected under reasonable and necessary terms for benefits derived from the projects. See generally Ivanhoe Irrigation District v. McCracken, 357 U.S. 275, 292, 295-97 (1958). (CVP landowners held liable in challenge of application of excess lands provisions in California.)

Nothing in the Reclamation program contemplates payment by water users when they do not receive any benefits from a project or enjoy the privileges of using Reclamation facilities. To require payment when there is no benefit is not reasonable or necessary. Westlands' 1963 Contract and the other Contractors' 1974 Contracts clearly provide that payment for drainage service is tied to access to drainage service facilities. Most of the land within Westlands and all land within Panoche and SLWD has received no drainage service benefit; since the closure of Kesterson and termination of San Luis Drain access, the Bureau has not provided any drainage service benefits whatsoever to the Contractors.

The expenditures calculated as of September 30, 1986, should be held in the Construction-in-Progress Account until the Bureau has constructed facilities that furnish drainage service as needed to meet its statutory and contractual obligations to the Contractors. Only then would the Contractors receive a benefit for which they may be held liable under federal Reclamation law.

C. Reimbursability of Kesterson Cleanup and Related Costs

The Bureau currently has allocated to the Construction-in-Progress Account for the San Luis Unit approximately \$25 million spent for development and implementation of the Kesterson Cleanup Plan approved by the SWRCB in 1989. The costs associated with the Kesterson cleanup and general monitoring costs are not reimbursable and should not be included in the construction component of rates for service.

The expenditures associated with the Kesterson cleanup were made to correct environmental problems caused by the Bureau's failure to complete the San Luis Drain to the Delta, its decision to manage Kesterson for evaporation, and its unilateral determination to use Kesterson Reservoir as a wildlife refuge. The cleanup expenditures were needed to correct the impact of selenium in drainage water as recognized by state-of-the-art technology as of 1983, whereas the decision to store drainage at Kesterson was based on prior state-of-the-art technology which failed to recognize the potential adverse impacts of selenium in such waters. Under similar circumstances, where unforeseen soil characteristics and/or drainage impacts have resulted in unanticipated expenditures for corrective actions, Congress has been consistent in not holding contractors liable for repayment. The following are examples where unforeseen soil characteristics of the lands irrigated by the authorized project have led to problems requiring subsequent major expenditures:

The Wellton-Mohawk Division, Gila Project, Arizona. One statute concerning this project, which was enacted to improve water quality of the Wellton-Mohawk drainage waters, determined that costs for certain tile drainage systems should be nonreimbursable (78 Stat. 682). A second statute, regarding a desalting complex and

implementation of salinity control measures, provided that 75 percent of such costs should be nonreimbursable (88 Stat. 266).

Leadville Mine Drainage Tunnel, Colorado. To assist in controlling the quality of drainage waters, a federal Act authorized appropriations for rehabilitation of the tunnel and provided that the funds expended for the works shall be nonreimbursable (90 Stat. 1324).

Farwell Unit, Nebraska. To address drainage problems associated with this project, the Bureau and the Farwell Irrigation District entered into a contract for the construction of additional drainage facilities. The contract provided that the costs of the project shall not be reimbursable and payments already made under the contract shall be credited against the overall payments due the U.S. (101 Stat. 1329).

The expenditures required because of design errors and changes in state-of-the-art criteria at Kesterson can also be compared to expenditures at the Teton Dam and Reservoir, main features of the Lower Teton Division, Teton Basin Project, in Idaho. The dam failed on June 5, 1976, because of inadequate design criteria. A Department of Interior Teton Dam Failure Review Group Report, dated April, 1977, stated the following:

"Recognition of the potential for occurrence of hydraulic fracturing was not in the general state of the art of dam design at the time the Teton Dam was designed."

Following the dam failure, Congress authorized the use of nonreimbursable funds to pay claims and repair facilities [Appropriation Act of July 12, 1976 (90 Stat. 889); Teton Dam Disaster Assistance Act of September 7, 1976 (90 Stat. 1211); Act of September 30, 1976 (P.L. 94-438)]. Further, the Department of Interior has not sought repayment for the project from project contractors. This example is applicable to the present issue not only because it involved changes in state-of-the-art criteria, but also because project facilities were taken out of service. In many other situations where water users were not required to make repayment, the projects at least had completed facilities in service, contrary to the present circumstances.

D. SJVDP and Drainage Plan Costs as Construction Costs

Relying upon the March 20, 1987, Solicitor's opinion concluding that the Secretary had authority to finance the SJVDP activities with appropriations authorized under the indexable cost ceiling in Section 8 of the 1960 San Luis Act, the Bureau currently has allocated approximately \$54.5 million from the SJVDP to the Construction-in-Progress Account of the San Luis Unit. An additional conclusion of the opinion was that activities are properly funded under Section 8 only as "activities relating to the ultimate resolution of the drainage problems in the San Luis Unit." *Id.* at p. 1. Thus, expenditures charged to the San Luis Unit accounts for recovery from the water users should be limited to those spent on activities that contribute to the construction of adequate drainage service facilities as required by the 1960 San Luis Act and the Contractors' 1963 and 1974 Contracts. A decision on what activities qualify must await the selection and construction of such facilities.

After the closure of Kesterson and the drain, Westlands executed the stipulation for Judgment in the Barcellos litigation. As previously noted, the other Contractors were not parties to the Judgment. Paragraphs 6 and 7 of the Judgment recognize that, under the changed circumstances resulting from termination of access to the drain, a

new plan for drainage service facilities is required. The Drainage Plan required by the Judgment is supposed to be completed by the Bureau by December 31, 1991. The Bureau has spent approximately \$1 million toward preparation of this Drainage Plan. Its purpose is to assess the options for providing drainage service facilities in lieu of Kesterson. In the event the Drainage Plan results in drainage service facilities that are complete and operable, such expenditures will be reimbursable when transferred to the Plan-in-Service Account.

E. Nonreimbursability of Costs by Statute and Otherwise

Bureau investigation costs on projects constructed under federal Reclamation law are generally reimbursable by project beneficiaries unless there is statutory authority making them nonreimbursable. See H.R. No. 92-557, Report from the Committee on Interior and Insular Affairs on the Act of October 29, 1971, Pub. L. No. 92-149, 85 Stat. 416. Such specific statutory authority is found in the Act of October 29, 1971: "All costs heretofore or hereafter incurred from funds appropriated to the Bureau of Reclamation and costs transferred to it for . . . (5) general engineering and research studies shall be nonreimbursable." Id. Subsection O of the Fact-Finders Act of December 5, 1924, as amended in 1945, also contains specific statutory authority that the costs of investigations of a general, area-wide or basin-wide nature that are not attributable to specific projects are nonreimbursable. 43 U.S.C. § 377. Conversely, all investigation costs attributable to a particular project must be reimbursed by appropriate charges to the project beneficiaries. S.R. No. 92-315, Report from the Committee on Interior and Insular Affairs, on Pub. L. No. 92-149, supra.

Under the foregoing statutes, the costs for the Bureau's current investigations may be reimbursable at least to the extent they lead to drainage service. This is not true for federal SJVDP costs. All or most of the SJVDP expenditures should be nonreimbursable. They were spent to investigate drainage problems of the entire western San Joaquin Valley, and perhaps other areas of the nation as well, and not simply the San Luis Unit service area. As such, they would be properly classified as general engineering or area-wide or basin-wide costs not attributable to a particular project. Much of the SJVDP work had such broad application, it cannot be identified with any Reclamation project or projects. The cost for such work should be made non-reimbursable immediately. The remaining costs may or may not be properly reimbursable. The decision on how to classify them must be delayed until a specific project to provide drainage service for the San Luis Unit has been formulated, authorized, financed and constructed. Then it can be seen whether and to what extent those SJVDP expenditures may have contributed to the project and, therefore, should be reimbursable by the districts and water users that contract for its benefits.

The following are illustrations of how certain SJVDP expenditures provided national benefits, San Joaquin Valley-wide benefits, or both: The National Academy of Sciences was commissioned to perform an oversight role to "bring a national perspective to the disposal program." From 1986 to 1990, a total of \$848,557 was expended for this study. Because the nature of the project was nationally-oriented, these costs can be appropriately described as "general and investigative" and are, therefore, nonreimbursable.

Another example is a study commissioned to examine desalting technology. In 1985 and 1986, the engineering firm of CH2M Hill was commissioned to perform the study, which was nonspecific to the San Joaquin Valley and has a national value when salinization is a problem. The costs for the study, which totaled \$141,974, should be nonreimbursable.

The Contractors also recognize that where costs were expended for investigations that might lead to direct benefits for the San Luis Unit water users, those costs may be considered reimbursable. Such an example is found in the Brown and Caldwell contracts commissioned from 1986 to 1989. A portion of those contracts was for a study examining out-of-valley disposal options such as the Mojave Desert, areas of the San Francisco Bay, and Central Coast. Costs expended on the study were more than \$200,000 and are attributable to the San Joaquin Valley.

Another example is for expenditures associated with an economic evaluation specific to the San Joaquin Valley. Those costs, which totaled \$67,881, could be attributable to the Contractors and other beneficiaries.

In addition to specific beneficiaries, many of the studies conducted on behalf of the SJVDP benefit more than one entity. One such example is a contract with Boyle Engineering. The contract was for building an experimental anaerobic treatment plant for selenium removal and cost \$677,857. The results are of considerable value to every selenium-contaminated area in the world. Consequently, those study costs could be attributed on a pro rata basis to the nation and San Joaquin Valley. Likewise, there were numerous studies conducted by the USGS which have numerous beneficiaries. More than \$1 million was expended in these contracts.

The Bureau expenditures for Kesterson cleanup, Kesterson monitoring and Drainage Plan preparation are not for general engineering and research studies or investigations of an area-wide or basin-wide nature. Consequently, the foregoing statutes do not apply.

The expenditures for Bureau preparation of the Drainage Plan might turn out to be reimbursable. They could become reimbursable in the future if the Drainage Plan required by the Judgment is developed and implemented by United States' authorization, financing, and construction of facilities that provide drainage service to the Contractors and their water users.

Another point relating to the future determination of the reimbursability of the questioned expenditures is that some of them could be nonreimbursable as being for the benefit of fish and wildlife. Federal Reclamation project costs allocated to fish and wildlife are generally nonreimbursable under federal law.

F. Reimbursability of Kesterson Mitigation Costs

There is no plausible argument for requiring the Contractors to pay for the Bureau's cost of acquiring 5,600 acres of land as mitigation to replace wildlife refuge lands that are no longer available at Kesterson or its cost of a water supply to serve wildlife needs on the acquired land.

The 1960 San Luis Act did not authorize the creation and use of Kesterson as a wildlife refuge; this was a decision made by the Bureau and the FWS apparently under some other statutory authority and without input from the Contractors. Although Section 1 of the 1960 San Luis Act mentions recreation and fish and wildlife benefits as incidents of providing irrigation service from the San Luis Unit, this does not amount to authorization for a wildlife refuge at Kesterson. While Section 7 of the 1960 San Luis Act specifically authorizes construction of "minimum basic public recreation facilities," nowhere does the statute specifically authorize the creation or use of a wildlife refuge. If Congress had intended the latter, it would have stated this in the statute.

Nothing in their 1963 and 1974 Contracts or the Barcellos Judgment obligates the Contractors or their water users to pay the costs of creating, maintaining, or replacing wildlife refuge lands as part of the San Luis Unit.

Moreover, the Contractors derived no benefits from the existence of wildlife refuge lands at Kesterson prior to its closure and they will derive no benefits from the acquisition and operation of mitigation lands. To the contrary, the fact that the United States focused its efforts on developing Kesterson as a wildlife refuge and did not expedite the completion of the Drain beyond Kesterson to a discharge point in the Delta was detrimental to the Contractors. If the Bureau had completed the drainage service facilities in accordance with the 1960 San Luis Act and its contractual commitments to the Contractors, the bioaccumulation of selenium at Kesterson could have been avoided, as could the waterfowl deaths. Further, the Secretary would not have ordered the closure of Kesterson and there would be no need to purchase and operate the 5,600 acres as a mitigation wildlife refuge.



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**COMMENTS OF THE
 ENVIRONMENTAL DEFENSE FUND
 ON THE SAN LUIS UNIT DRAINAGE PROGRAM
 DRAFT ENVIRONMENTAL IMPACT STATEMENT**

By

TERRY F. YOUNG, Ph.D.
 Senior Consulting Scientist

March 25, 1992

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Summary

The San Luis Unit Drainage Program Draft Environmental Impact Statement (DEIS) was produced in direct response to the requirements of a judicial settlement. As a result, its analysis is skewed and will require substantial alteration before it can be used as the foundation for the Bureau of Reclamation's (Bureau's) long-term drainage plans. As a case in point, the proposals considered in the DEIS rest on the assumption that the drainage problem is appropriately solved by federal action. The Environmental Defense Fund (EDF) disagrees with this fundamental assumption. Instead, the responsibility for solving the drainage problem rests with the farmers producing the drainage, assisted in appropriate circumstances by regional, state and federal efforts.

In addition, several components of the DEIS are wholly inappropriate as a matter of policy, and sometimes of law, and should be dropped from the Bureau's long-term plans without further study. For example, high-quality water from the Delta-Mendota Canal should not be used simply to dilute polluted farm drainage. Similarly, operating large "holding ponds" for highly contaminated drainwater begs another ecological disaster, at worst, or extensive exposure of the federal government to liability claims, at best.

On the other hand, many of the components of the DEIS are worthy of consideration for the Bureau's long-term program, and were already included in the recommendations of the joint federal-state San Joaquin Valley Drainage Program. The development of a targeted (and entirely voluntary) land retirement program is a case in point.

Several of the DEIS components are appropriate for the Bureau's long-term plan, but require substantial adjustments in order to provide optimum benefits. Plans to promote water marketing, for example, should be undertaken, but not in the highly constrained and artificial manner assumed in the DEIS. Similarly, "source control" in the form of irrigation efficiency improvements can be designed by individual farmers (preferably in response to incentives to conserve), rather than being prescribed by district audits of farm practices.

Perhaps because the DEIS was written in response to specific settlement requirements, it omitted the fish and wildlife provisions recommended by the San Joaquin Valley Drainage Program. We refer to the provision of high-quality Central Valley Project water to the regional wetlands and to the augmentation of Merced River flows in order to attract salmon now drawn to spawn in runoff from cotton fields. We recommend that the Bureau incorporate these provisions into its plans.

Overview

The San Luis Unit Drainage Program Draft Environmental Impact Statement (DEIS) is currently fulfilling two functions: responding to the requirements of the Barcellos judgement and providing advance planning for the Bureau's drainage program, regardless of the fate of the Barcellos settlement. The Environmental Defense Fund (EDF), with these comments, addresses only the latter purpose.

Unfortunately, the narrow confines of the Barcellos judgement appear to prejudice the scope and objectives of the drainage plan. The entire analysis is skewed due to the assumption that management of the drainwater currently being produced is the federal government's responsibility. In addition, many of the components appear to have been designed in a vacuum, ignoring the ongoing efforts of growers, water and drainage districts, and the State of California to decrease the amount of problem drainage in the westside of the San Joaquin Valley, regardless of Bureau activities. As a result, the source reduction programs already in place, rather than forming the foundation of the Bureau's proposed program, are largely ignored.

For these reasons, the DEIS analysis tends to assume the worst possible drainage problem, then assume that the federal government should fix all of it. The Bureau, the federal taxpayers, the environment, and (we suspect) the farmers would be better served if the long-term drainage program developed by the Bureau were based on fundamentally different assumptions. Primary responsibility for solving the drainage problem rests not with the federal government, but with the growers. The Bureau's involvement may reasonably be limited to providing only those services still necessary after the drainage problem has been ameliorated by onfarm source reduction, and after the drainage reduction benefits of local programs such as tiered water pricing have been realized.

As a management plan, the DEIS can further be faulted for arbitrarily including elements (such as water marketing) in some plans, but not in others. As written, the bottom-line cost projections are misleading. It is EDF's view that the Bureau could devise a "least environmentally-damaging" and "least-cost" combination of source control and disposal alternatives, or at least come close to it, if unfettered by the artificial constraints imposed by its own analysis. The preferred alternative would maximize farmer and district-level source control efforts. It would also take full advantage of economic incentive programs such as water marketing and water pricing adjustments, as well as local cost-sharing programs such as tradable discharge permits or locally-controlled effluent fees¹. Central to an acceptable plan, of course, is the assumption that the overall costs of the program would be distributed primarily among those who

¹ Many of these components were specifically excluded from consideration in the DEIS.

are directly responsible for the problem, rather than the federal government.

In short, while the DEIS contains some valuable proposals and background analyses, it also contains several elements which are simply a by-product of the dual purpose of the document and would be inadvisable to include in the Bureau's long-term drainage plan. Comments on specific components of the plan follow.

Use of High-Quality Water to Dilute Pollutant Discharges

Included in most alternatives in the DEIS is a proposal to take high-quality water out of the Bureau's Delta-Mendota Canal and spill it into the San Joaquin River in precisely the amount necessary to dilute the farmers' pollution discharges to the level required by water quality standards. This proposal would be inappropriate at any time, but is particularly onerous in the sixth year of drought, in the midst of battles raging over scarce water supplies, and at a time when valuable species such as the winter-run salmon are facing extinction.

The proposal should be rejected as bad public policy. It is also contrary to California's sanctions against the "waste and unreasonable use of water". Furthermore, it is unnecessary. Almost a decade worth of federal, state, academic and local study of the drainage problem has generated cogent proposals for meeting water quality standards in the San Joaquin River without resorting to this practice.

Construction of Regulating Reservoirs

Another component of the DEIS which we recommend omitting from further consideration is government-financed construction of large-capacity "regulating reservoirs" to store polluted farm drainage until it can be dumped into the San Joaquin River. The temptation to compare the proposed ponds to a re-enactment of the Kesterson disaster has been irresistible in the press, and understandably so.

The DEIS correctly identifies the reservoirs' potential for causing bird mortalities and deformities. It provides inadequate analysis of the additional potential for selenium accumulation from algal growth and detritus deposition as occurred at Kesterson, and the potential for further concentration and wildlife exposure due to the cyclical wet/dry conditions and associated capillary rise.

In sum, the proposal poses unnecessary risks. Should thorough study show that regulating reservoirs can be managed safely (which we doubt), then we recommend that they be considered only if other alternatives for managing drainwater are unavailable; and with the proviso that local drainage districts bear full financial responsibility, assume full liability, and post a performance bond for operation of these facilities.

Groundwater Pumping

Central to the "success" of the DEIS' preferred alternative is the deliberate and accelerated pollution of the region's semiconfined aquifer. While manipulation of the aquifer was proposed in earlier studies, such as the San Joaquin Valley Drainage Program, the pumping program was viewed as a potentially necessary, but largely "last-resort" technique to manage the drainage problem. The DEIS, in contrast, appears to plan the pollution of the aquifer more as a first resort, and encourages aquifer pumping by tying it to water marketing, as well as by providing technical assistance for well-drilling. EDF opposes this emphasis on polluting the aquifer, and recommends instead that the aquifer be used to store drainwater only to the extent that no other reasonable alternatives are available.

Voluntary Land Retirement

Among the potentially beneficial elements of the proposed program is the provision for land retirement. Retiring the most contaminated lands is one of the most direct methods of ameliorating the drainage problem. At the same time, providing for fair compensation of landowners will minimize the extent to which growers suffer from having unknowingly invested in contaminated lands. EDF supports this and other provisions which attempt to make maximum use of economic incentives to solve pollution and resource allocation problems through voluntary and compensated approaches.

Designing the land buyout program will not be straightforward. Among the questions which must be addressed are:

- what should the "selection criteria and procedures" be;
- how are the water rights allocated;
- is some of the retired land appropriate for use as habitat;
- to what extent must the retired land be managed to avoid nuisance species and dust, and by whom; and
- how should the program be financed?

One of the potential benefits of a centralized buyout program is the ability to minimize transaction costs. By addressing the above questions now, the Bureau will make individual transactions smoother and, we suspect, more attractive to the growers in the long-run.

Water Marketing

The rules under which water marketing will be allowed within the boundaries of the San Luis Unit have been the subject of discussion and disagreement in a number of state and federal forums. The DEIS presents a peculiar formula for water marketing which is highly constrained, limiting the quantity of water eligible for marketing, assigning water marketed from Westlands to other users within Westlands until the "unmet demand" is satisfied, and limiting the duration of the transfers. This formula is unlikely to be acceptable to a broad range of parties, including EDF, who have vigorously supported the development of an active water market in California.

In addition, the potential benefits to be derived from water marketing are misused by encouraging the use of groundwater in place of the marketed CVP water. The DEIS argues that increased groundwater pumping helps to solve the drainage problem by lowering the water table, thereby creating more storage space for the polluted drainage; we suggest that this approach simply trades one environmental problem for another. It also does little to encourage more efficient use of irrigation water. In short, the DEIS uses the powerful economic incentives provided by water marketing to accelerate the destruction of an aquifer rather than to accomplish environmental goals and facilitate better use of limited water supplies. A far superior use of the incentives created by a water market is to encourage irrigation efficiency and occasional land fallowing in order to decrease the amount of drainage produced in the first place.

Further, the inclusion of water marketing only in Alternative 4 appears to be arbitrary. Excluding water marketing from the other alternatives skews the comparisons of cost and efficiency among the four alternatives.

In short, EDF supports the Bureau's efforts to use water marketing as an economic incentive to alleviate the drainage problem, but recommends that the proposed rules for marketing be changed significantly.

Conclusion

The DEIS proposes a set of solutions for the westside drainage problem which arguably may make sense within the narrow confines of the Barcellos settlement, but do not make sense as a matter of public policy and should not form the basis of the Bureau's long-term plans for drainage management in the west San Joaquin Valley. Driven by the specific requirements for the use of the "drainage fund" under the settlement, the Bureau has constructed a proposal for drainage management which is not cost-effective and lays considerable financial responsibility on the Federal government. Still, the DEIS contains many valuable components which can be extracted and reformulated into an environmentally-friendly and cost-effective plan.

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September 30, 1991

Mr. Roger Patterson, Director
Bureau of Reclamation, Mid-Pacific Region
U.S. Department of Interior
2800 Cottage Way, MP-405
Sacramento, CA 95825-1898

BY FAX AND MAIL

Dear Mr. Patterson,

In our telephone conversation last Friday, we offered to set down our concerns and suggestions regarding the proposal, now pending, to re-open the San Luis Drain for the conveyance and disposal of agricultural drainage to the San Joaquin River. We appreciate your interest and willingness to discuss this proposal, and its environmental and political implications. As should be clear from the record of our correspondence with the Drainers, the Bureau and other parties, we strongly believe that the proposal can, and must, be improved before it can rightly be viewed as a project to benefit wetlands and improve drainage management in the Grasslands subbasin.

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We have briefly reviewed the revisions to the draft Final Finding of No Significant Impact (FONSI), dated 9/25/91. The section titled "Environmental Commitments" (pp. 3-8) has been improved over the Draft version in the following ways: the project performance will be reviewed at the end of two years, with extension to five years contingent on compliance with water quality objectives; the beginnings of a timetable for the formation of a Regional Drainage District; and, the formation of an Advisory Committee. It is our opinion, however, that the commitments still fall short of the meeting the minimum conditions necessary for assuring that damage to the environment will be avoided.

We refer you to our letter of May 9, 1991 (see attached) which presents our comments and recommendations on the Draft FONSI. In that letter, we discuss two categories of concern: first, specific instances where the language in the Draft FONSI does not

Mr. Roger Patterson, Director
 September 30, 1991
 Page 2

ensure that commitments will be achieved; and second, fundamental issues which must be resolved, in some way, to make the proposed plan acceptable. The comments in the first category pertained to points of agreement negotiated with project proponents, and which we consider essential (i.e., not optional) to any agreement for use of the Drain. These points are as follows:

- 1) use of the Drain must be tied to meeting water quality standards in the San Joaquin River (we provided substitute language in Attachment 1);
- 2) use of the Drain must be linked to drainage reduction;
- 3) formation of a Regional Drainage District with appropriate legal authority, including the ability to enforce drainage cuts and levy fees.

The revised 9/25/91 version of the FONSI represents some progress on these points, but is disappointingly vague and/or confusing in key areas. For example, item 1c on page 4 requires that "annual discharges of selenium, boron, and total dissolved solids do not exceed pre-project levels delivered to the San Joaquin River via Mud and Salt Sloughs." Does the term "discharges" refer to loads or concentrations of contaminants? Is this criterion tied to a particular baseline year or a 5-year historical average of loads discharged to the River? The specifics make all the difference. Similarly, what legal and regulatory authority would the Regional District have under item 1b?

The issues of potential liability and performance guarantees enumerated in our second category can be accomplished through a variety of means which we are happy to explore. The current version of the FONSI does address some of these issues. The language in item 3 on the top of page 6 satisfactorily spells out the responsibility of the Drainers to pay for mitigation and clean-up. Similarly, we believe that the formation of an Advisory Committee which includes environmental agencies (item 1, bottom of page 5) could suffice as a mechanism or process for determining compliance provided the Drainers do not serve on the Committee. Finally, the issue of drainage reduction milestones is central to an acceptable plan for the use of the Drain. We have provided several ideas for a system of financial incentives/penalties as an appropriate means for ensuring progress towards drainage reduction. We remain quite willing to discuss any alternative proposal to a performance bond or fee system.¹ The adoption of this type of "insurance" program might be timed with the two-year compliance review if project-related drainage reduction milestones and/or applicable water quality standards have not been met at that time.

¹ See letter from Environmental Defense Fund to Mike Delamore, Water Quality and Environmental Branch, Bureau of Reclamation, July 2, 1991.

Mr. Roger Patterson, Director
 September 30, 1991
 Page 3

In our telephone conversation, you raised the possibility of removing references to a long-term use agreement following the termination of this proposed 5-year project. While this would simplify the current project documentation, it does not change the fact that this short-term project is viewed by its proponents as part of a longer term drainage management plan involving use of the Drain. If the 5-year use agreement is de-coupled from any future long-term use of the Drain, what other mechanism besides the proposed use agreement would you propose to tie future use to current performance?

Finally, when we spoke with you, we were pleased to hear you endorse strongly what we have long thought the most promising approach to drainage management, namely source reduction. Indeed, this is one of the principal findings and recommendations of the San Joaquin Valley Drainage Program. In our judgement, in addition to benefits of pollution reduction and to the environment which result from better drainage management practices, a positive incentive exists for those who engage in those practices if they can in turn be assured that water can be sold to other users in the state. In the past, there has been considerable uncertainty as to whether the Mid-Pacific Region of the Bureau would support or oppose this approach to water conservation and marketing. If, in your position on this project, you would indicate the Bureau's support for conservation-based transfers, the result would likely be more timely compliance with water quality standards in the San Joaquin River and tributary sloughs, while providing financial benefits to the Drainers and making water available to other users in the state. If you would like to discuss this idea at greater length, please do not hesitate to contact me or Tom Graff.

We appreciate your deliberation and willingness to discuss the issues inherent in this proposed plan for use of the San Luis Drain. We have provided detailed comments on this project in the past and believe that those concerns and recommendations provide the appropriate basis for our review of the revised draft Final version of the FONSI. We hope this letter is responsive to your questions. Please feel free to contact us with any questions.

Sincerely yours,

Chelsea Congdon

Chelsea Congdon
 Resource Analyst

for Thomas J. Graff, Senior Attorney
 Terry F. Young, Ph.D., Consulting Scientist

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July 2, 1991

Mr. Mike Delamore
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Dear Mike:

When we spoke last week, you expressed interest in "revisiting" the idea of a performance bond as a means of addressing issues of financial liability associated with the proposed use of the San Luis Drain in the event that environmental clean-up is required. As you know, we have made numerous suggestions, both in our written comments and in negotiations with the Drainers, regarding how such a performance bond or liability fund might work. We hope that this letter can help to further clarify and advance this concept.

We have used the terms performance bond and liability fund interchangeably in describing a financial mechanism to provide two essential guarantees: 1) a dedicated source of funding available for any mitigation or cleanup made necessary by project operations, and 2) an incentive for improving environmental performance (i.e., drainage reduction).

In theory, a performance bond places the responsibility for the costs of pollution with the polluters by internalizing these costs up front. This "internalization" of heretofore external environmental costs is accomplished by requiring the polluters to allocate, at the outset of the project, enough money to pay for the potential environmental damage caused by the project. If a standard commercial bond is unavailable, the bond fund can be financed by fees which are based on the amount of effluent produced. The total amount in the fund is reserved (held in an interest-earning account) to cover, in total or in part, the actual costs of clean-up or mitigation. The bond is totally refundable once the polluters have demonstrated that

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Mr. Mike Delamore
 July 2, 1991
 Page 2

damage has not occurred (and/or that other agreed upon measures of performance have been met).

A performance bond offers an attractive regulatory alternative because it encourages voluntary compliance. Polluters have a strong incentive to improve environmental performance in order to reduce their liability. The public benefits from the increased certainty that performance standards (e.g., water quality standards or drainage reduction milestones) will be met and environmental damage will be avoided.

In our proposals for a performance bond for the San Luis Drain, we have incorporated some of these standard characteristics of performance bonds and altered or eliminated others, in an attempt to tailor the approach to the particular needs of the situation at hand. The following discussion is intended both to clarify our reasoning, and to present options for further refining this proposal to better meet the needs of all parties.

A Performance Bond for the Proposed Use of the San Luis Drain

A standard performance bond is in some ways analogous to an insurance policy; it ideally seeks to create a fund large enough to cover the worst-case potential outcome. Our proposals do not anticipate a fund this large. Instead, we are willing to accept a smaller fund if the payments into the fund provide sufficient incentives for the farmers to reduce the amount of drainage which they produce, and if the project is of limited duration.

Our proposal also differs from other performance bonds because we do not intend that the farming districts should be required to show that environmental damage has not occurred. We are instead offering the compromise that an oversight group composed of appropriate agency representatives will be empowered to make this assessment. Thus, the burden of proof will not, strictly speaking, be shifted to the farming districts.

The performance bond which we have proposed is a standard one in the sense that the money will be made available to pay for mitigation or cleanup measures, should they be required. If appropriate mitigation measures cost more than the amount of money available from the fund, then the Bureau would have to fall back on other methods for requiring the Drainers to pay for mitigation. In other words, we do not intend that the size of the performance bond fund should de facto limit the Drainers' liability for damages; it simply makes the financing of a portion of the expenses immediately available.

If the performance bond fund does not have to be used for mitigation or cleanup measures, all or part of the fund may still be forfeited if water quality standards (or some equivalent measure of performance) are not met. Should this occur, we suggest that the money be dedicated to funding

Mr. Mike Delamore
July 2, 1991
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drainage reduction investments within the "problem" districts. We are assuming that the districts will want to work out a system based on drainage reduction milestones so that each district can demonstrate that it has met or failed to meet its respective requirements. In this way, only those districts which have failed to meet their milestones will forfeit their shares of the fund; all of the districts are not penalized if only a few districts are unable to meet the goals.

If the money is not required for cleanup or mitigation, and if specified performance requirements are met (in this case, water quality standards in the San Joaquin River and/or drainage reduction milestones for achieving Mud Slough standards), then the bond fund will be returned to the districts with interest.

Creation of the Bond Fund

We are open to considering payments into the fund based on water inputs, subsurface drainage outputs, weighted selenium plus boron loads, or some combination of the three. Each system has its advantages and disadvantages.

With regard to water inputs, the advantage is that the payments can be spread among all who are contributing to the problem, not just those who happen to have drainage systems. On the other hand, it does not distinguish among areas with differing concentrations of selenium or boron. In order to correct this problem, we could use the maps developed by the San Joaquin Valley Drainage Program (SJVDP) which show areas with high concentrations of selenium and boron. Assessments could then be tiered so that a lower rate per acre-foot of delivered water is charged to those without severe boron or selenium concentrations.

If payments are made according to the amount of drainage produced, then we recommend considering subsurface drainage only. In this way, decreases in surface tailwater will not be credited and fees can be directly correlated with the decreases in subsurface drainage quantity which are required to meet water quality standards. Weighted selenium and boron loads would accomplish much the same purpose.

Regardless of the assessment method chosen, we recommend that a tiered fee structure be used. The first increment of water inputs or drainage outputs should be assessed at the base rate, and higher amounts should be assessed at progressively higher rates. In our view, the tiered fee structure will further enhance the incentive to reduce drainage. As the Drainers invest in source control and other drainage reduction measures, these improvements would translate into lower fees.

Mr. Mike Delamore
 July 2, 1991
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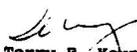
Size of the Fund

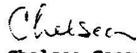
As mentioned above, our initial purposes in suggesting the performance bond were to address issues of environmental risk and liability, and to create an additional incentive, and fund, for drainage reduction at the district and/or farm level. For these reasons, we suggested basing payments into the fund on drainage outputs, and sizing the fund according to the estimates developed by the SJVDP of the costs of drainage reduction (or "source control") measures in the Grasslands Subarea. According to the SJVDP, these measures involve existing and available technology and are economically realistic for the Drainers. We also note that the costs of these measures are well within the range of those deemed acceptable by the State Water Resources Control Board's 85-1 Technical Committee.

In earlier comments, we suggested a rate of \$15-20/af of drainage generated (a figure derived from the one-time source control costs developed by the SJVDP) that would yield a total of \$780,000 to \$1,040,000 per year, based on our own estimates of the total amount of drainage generated from the affected area in 1989. We note that this amount is actually only about half of the total annualized cost of source control (considering both one-time and ongoing expenses) quoted by the San Joaquin Valley Drainage Program for the geographical area encompassed by this project. It is also approximately one-third of the Drainage Program's estimates of the costs to minimize risks to fish and wildlife in this region. (Lacking better information, the fish and wildlife costs could be considered a surrogate for the minimum mitigation or clean-up costs which might be required.) Finally, the size of our suggested fund is far smaller than what the Drainers seem ready to pay for the anticipated San Luis Drain-San Joaquin River connection. Nonetheless, we are willing to accept this amount for purposes of the short-term (two to five year) project contemplated in the Drainers' proposal because of the incentives the fund would provide for drainage reduction.

We hope this information is helpful. We continue to believe the adoption of a performance bond as outlined in this letter, and in earlier communication, will go a long way towards resolving the remaining critical issues surrounding the proposed temporary use of the San Luis Drain. Please feel free to contact us if you would like to discuss this in more detail.

Sincerely yours,


 Terry F. Young, Ph.D.
 Senior Consulting Scientist


 Chelsea Congdon
 Resource Analyst

ENVIRONMENTAL DEFENSE FUND

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May 9, 1991

Mr. Lawrence F. Hancock, Director
Bureau of Reclamation, Mid-Pacific Region
U.S. Department of Interior
2800 Cottage Way, MP-405
Sacramento, CA 95825-1898

Re: Supplemental Environmental Assessment and
Draft Finding of No Significant Impact for
the Proposed Use Agreement Allowing Use of
the San Luis Drain

Dear Mr. Hancock:

The Environmental Defense Fund urges you not to adopt the Supplemental Environmental Assessment (EA) and Draft Finding of No Significant Impact (FONSI) for the use of the San Luis Drain. Consistent with our discussions with you during the past year, we continue to consider the use of the San Luis Drain to be feasible under carefully defined circumstances; the conditions described in the draft FONSI, EA and associated Use Agreement, however, are not acceptable. Moreover, the EA and draft FONSI are inadequate in their own right because they do not fulfill the requirements of the National Environmental Policy Act. Among our concerns are the following:

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Richmond, VA 23219
(804) 780-1297

128 East Hargett Street
Raleigh, NC 27601
(919) 821-7793

1800 Guadalupe
Austin, TX 78701
(512) 478-5161

-The use of the San Luis Drain is not directly tied to meeting water quality standards, despite rhetorical promises.

-Progress towards controlling the underlying pollution problem (i.e., meaningful drainage reduction) is not linked to the use of the Drain.

-The EA promises benefits which may or may not actually occur.

-The potential liability associated with the use of the Drain has not been properly addressed.

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We are also concerned that this project has been fundamentally misrepresented as a project whose primary purpose is to benefit wetlands. In our view, the wetlands do --desperately-- need access to a reliable supply of good-quality water. That is not the purpose of this project, however. No serious consideration has been given to actually providing water to the wetlands. This project simply moves polluted agricultural drainage to a new location without addressing the crux of the problem: agricultural drainage is polluting the wetlands and rivers of the San Joaquin Valley.

Accordingly, the Environmental Defense Fund has attempted to persuade you and the project proponents that it is necessary to tie the use of the Drain to significant pollution reduction. Drainage reduction (reducing the amount of polluted drainage which is produced) is not controversial; rather it is the cornerstone of both the Federal-State San Joaquin Valley Drainage Program and the California Technical Committee Report which preceded it. We see no reason why the use of a federally-subsidized facility, made possible by a state-subsidized loan fund, should not be contingent upon furthering the drainage reduction goals of the Federal-State Program. The Program, as you know, represents the culmination of nearly eight years of in-depth technical analysis and public policy debate, supported by \$50 million of taxpayer money. While the program included the possible use of the San Luis Drain, this use was coupled with an extensive array of drainage reduction actions. Use of the Drain should continue to be linked to substantial drainage reduction, in our view.

EDF's earlier comments on the Panoche Water District's draft Environmental Assessment and Initial Study indicated our willingness to meet with the concerned parties and attempt to design a satisfactory Use Agreement. We were pleased when, albeit at the eleventh hour, serious negotiations ensued and substantial progress was achieved on several important issues. These include: 1) linking the continued use of the Drain to compliance with water quality standards; 2) the formation of a regional drainage district with the authority to undertake actions necessary to meet the requirements for use of the Drain; and 3) the use of defined milestones for drainage reduction as necessary to meet water quality standards. Unfortunately, we find that the language now included in the draft FOWSI and associated Use Agreement does not adequately reflect our understanding of these points of agreement and will not accomplish the intended goals.

Moreover, there are additional significant issues where no agreement has been reached. Among these are: 1) the need to determine, prior to the start of the project, appropriate "triggers" which will define unacceptable environmental impacts, and the need to provide a clear process or set of

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criteria for determining when additional mitigation or enforcement measures are required; 2) the creation of a liability fund, performance bond or other similar mechanism to assure the availability of adequate resources for any clean-up or mitigation which may be required; and 3) measures to guarantee that potential project benefits associated with the removal of drainage from Salt Slough are actually realized.

Finally, we recognize that legitimate issues raised by other parties also have not been resolved. The following comments describe some of these concerns in greater detail.

THE LANGUAGE IN THE DRAFT FONSI DOES NOT ENSURE THAT THE COMMITMENTS WHICH HAVE BEEN PROMISED ACTUALLY WILL BE ACHIEVED.

1. The cornerstone of Reclamation's justification for allowing the use of the San Luis Drain is that it "is contingent upon compliance with all applicable laws and regulations" (draft FONSI, p. 2). However, the actual language contained in the Environmental Commitments section, which will be an enforceable component of the Use Agreement, fails to deliver on this assurance.

First, the language does not actually require that water quality standards for the San Joaquin River which become effective in October 1991 will be met. We assume that this was an oversight; Attachment 1 provides specific language to correct this problem.

Second, the project will not comply with federal or state antidegradation requirements, either in Mud Slough, or (according to the analysis in the Supplemental EA) in the San Joaquin River itself. The draft FONSI asserts (p. 5, referencing Appendix 1, Table 24) that the project will not cause a significant change in the number of times that water quality objectives are exceeded in the San Joaquin River. However, the Table shows that, in every year and every scenario analyzed, the project would cause significant increases in the number of times that selenium standards are exceeded. According to this analysis, therefore, the only way that the project can be undertaken without further degrading the San Joaquin River is to formally link the use of the Drain to a substantial decrease in drainage load, as well as to tie continued use of the Drain explicitly to meeting water quality standards. This formal linkage is not accomplished by the current language.

2. The Drainers, Reclamation and other interested parties (including Fish and Wildlife Service representatives, NRDC and EDF) agreed in principle that drainage reduction milestones are appropriate for inclusion in the Use Agreement. The provisions in the draft FONSI, however, do not accomplish the intended purpose.

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The draft FONSI should clearly require that the milestones: a) are adequate to meet applicable standards in the San Joaquin River; b) require consistent progress towards meeting standards in Mud Slough; and c) assure significant annual reductions in pollutant loads. Further, milestones for drainage reduction should be developed and agreed-upon prior to the start of construction of the project. We recommend that an Oversight Committee composed of representatives from Reclamation, Fish and Wildlife Service, California Department of Fish and Game, and California State Water Resources Control Board (or its delegate, the Regional Board) be established to approve the milestones, and to review the monitoring results during the course of the project. The specific language to be added to the draft FONSI to accomplish these purposes appears in Attachment 1.

3. The Drainers have also agreed to form a Regional Drainage District during the period covered by the Use Agreement. The draft FONSI needs to be more specific in defining the minimum acceptable legal authority of the Regional Drainage District.
4. An updated revision of the Use Agreement incorporating the assurances set forth in the draft FONSI should be made available to interested parties for comment prior to the start of construction.

THE DRAFT FONSI DOES NOT RESOLVE ISSUES WHICH ARE FUNDAMENTAL TO AN ACCEPTABLE PLAN FOR USE OF THE DRAIN.

1. Given Reclamation's recent experience at Kesterson Reservoir, we are convinced that both Reclamation and the taxpayers should seek protection from liability in the event that the proposed use of the Drain results in contamination requiring clean-up or expensive mitigation. The draft FONSI provides no such protection, nor does the draft Use Agreement dated January 21, 1991. Notable shortcomings include the following:

- the draft FONSI is silent regarding who will pay for additional mitigation, should it be required;
- the draft FONSI provides no formal mechanism for determining whether (or when) adverse impacts justify termination of the Use Agreement;
- the draft Use Agreement, while it clearly identifies the Drainers as liable for potential damages, does not shield Reclamation from claims by third parties if the damages exceed the ability of the Drainers to pay.

The language included in Attachment 1 partially rectifies the first two problems, appears consistent with the Drainers' stated position, and can easily be inserted into the draft FONSI. However, the remaining concerns are still unresolved. For example, our recent discussions with

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the Drainers have led to an impasse regarding the use of pre-defined "triggers" and the designation of a formal entity to review monitoring data. Similarly, with regard to third-party claims, EDF has recommended the use of a drainage fee/performance bond similar to the trust fund used in the Barcellos settlement (see Attachments 2 and 3). This proposal was rejected, but an alternative mechanism was not forthcoming and the issue remains unresolved.

2. The draft FONSI does not include an appropriate incentive structure for the Drainers to meet drainage reduction milestones or comply with the other requirements stipulated in the "Environmental Commitments".

The draft FONSI now prohibits the renewal of the license for use of the San Luis Drain beyond the five-year term if the "Environmental Commitments" are not met; we consider this an improvement over the previous proposal. However, if the Drainers fail to meet these commitments during the five-year period, Reclamation should have recourse to an enforcement mechanism short of revoking the license and closing the Drain. In our view, relying solely on the "all-or-nothing" approach virtually guarantees that "minor" infractions will be overlooked.

In order to rectify this problem, EDF has recommended that Reclamation charge drainage fees. As proposed, the fee system would provide several benefits: give Reclamation the flexible enforcement option it needs; create a monetary incentive for drainage reduction; and finance a refundable performance bond. We continue to advocate this approach because it provides tangible incentives for progress in drainage reduction. If drainage fees or their equivalent are not used, Reclamation will, in our view, lack a realistic enforcement mechanism during the five-year project term.¹

3. The Supplemental EA continues to assert benefits of the project which are not, in fact, a part of the project.

The Supplemental EA promises that use of the Drain will eliminate contaminated drainwater from 70 miles of channels, including channels that can be used to supply water to public and private wetlands. No guarantees have been provided, however, that all contaminated drainage will be diverted into the Drain.

¹Alternatively, Reclamation could adopt a more traditional enforcement mechanism -- a system of financial penalties which would be analogous to the standard fines imposed when waste discharge permits are violated. If an approach involving refundable drainage fees/performance bond is not implemented, then a system of penalties is a logical alternative.

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Just as important, there is no guarantee that any usable water will be left in these channels once they are "cleaned up". The Supplemental EA somewhat disingenuously provides an extensive analysis which presumes that good quality tailwater will be available for use in the wetlands (see p. 11 and subsequent analysis). EDF has been directly informed, however, that the Drainers cannot and will not guarantee that water is made available for wetlands. Reclamation has also declined to commit to actions which would facilitate the provision of water to the wetlands. Moreover, the Supplemental EA does not analyze any alternative options for delivery of water to the wetlands. In short, since little water may be available, cleaning up water supply channels does not qualify as a project-related benefit to offset other impacts, as is assumed in the draft FONSI.

THE DRAFT FONSI AND SUPPLEMENTAL EA FAIL TO ADDRESS ADEQUATELY OTHER
FEASIBLE ALTERNATIVES AND MITIGATION MEASURES.

One of the benefits of the process required by the National Environmental Policy Act is that fundamental shortcomings, such as those discussed above, can be remedied via a thorough evaluation of reasonable alternatives. For this project, however, 1) fundamental issues remain unresolved; 2) reasonable options are available to resolve these issues; and 3) these options were not evaluated in the Supplemental EA. Accordingly, we conclude that the Supplemental EA did not adequately analyze alternatives to the project.

In addition, the Supplemental EA still purports to provide mitigation measures which are not mitigation measures at all. (See the above discussion regarding availability of water supply channels; see also EDF's comments regarding the misrepresentation of monitoring as mitigation in Attachment 2.)

Finally, the Supplemental EA incorrectly asserts that a FONSI is appropriate because the Use Agreement would be of limited duration. The legal analysis presented by NRDC (Comments on Draft EA, December 11, 1990) refutes this assertion. The proposed project is clearly the first stage of a longer-term program that is currently being evaluated. In fact, almost concurrent with this draft FONSI, Reclamation issued an "Alternatives Analysis" (preceding a full EIS) for the same drainage problem in the same region which includes the long-term use of the San Luis Drain in four out of five alternative scenarios.

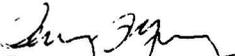
CONCLUSION

The design of the proposed project was flawed at the outset, and has not been sufficiently modified to address the fundamental concerns raised by EDF and other interested parties. Because the Supplemental EA and draft

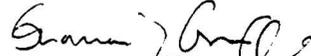
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FONSI still do not satisfactorily address these concerns, the draft FONSI cannot be construed as satisfying the requirements of federal law. Proceeding with the project on the basis of the FONSI as drafted will make any consensus-based solutions to the San Joaquin Valley's drainage problems even more unlikely than they already are.

Sincerely,


Terry F. Young, Ph.D.
Consulting Scientist


Chelsea Congdon
Resource Analyst


Thomas J. Graff
Senior Attorney

cc: Marvin L. Plenert
Dennis Falaschi

Attachment 1

We acknowledge that the "Environmental Commitments" stipulated in the FONSI for incorporation into the Use Agreement represent progress towards addressing the numerous environmental concerns associated with this project. However, these "Environmental Commitments" do not adequately reflect all of the changes to which the Drainers recently have agreed, at least in principle. In addition, the language in the draft FONSI, and therefore the Use Agreement, require further refinement to provide even the minimal environmental mitigations and guarantees already asserted in the document. Accordingly, we suggest the following specific changes to the language in the FONSI in order to rectify, at least partially, these problems.

ENVIRONMENTAL COMMITMENTS

p.4. Item #2 should conclude with the following:

The contents of the Joint Exercise of Powers Agreement will, pursuant to Government Code provisions, state: the nature and purpose of the Agreement; the duration of the Agreement; work to be performed; limitations; service charges or fees to be assessed, or other financing arrangements; administration; personnel; procedures for amendment.

p.4. Item #3 should be amended as follows:

3. Drainage and constituent load reduction goals are specified in Appendix to this agreement. The goals will assure that 1) Water Quality Objectives in the San Joaquin River are met consistently throughout the agreement period; 2) consistent progress is made towards achieving the Water Quality Objectives for Mud Slough prior to the implementation date for those objectives; and 3) in no case shall the monthly constituent loads exceed the average loads for the same month during the 1986 through 1989 period of record. The Drainers, in consultation with the Regional Board, will establish drainage and constituent load reduction goals to meet Water Quality Objectives per the Basin Plan Amendment and to minimize negative impacts associated with agricultural drainage water. These goals will identify monthly flow and load targets for discharges from the Drain based on the type of water year, and on an annual basis, will demonstrate significant reductions in discharges to Mud Slough and the River. Reduction goals will be established and presented no later than at the time of submittal of the Drainers' Drainage Operation Plans to the Regional Board in December, 1991. Discharge and load will be measured monthly. Achievement of goals will be evaluated on a quarterly basis by Reclamation and the Service and made available to interested parties, and, at a minimum, reported annually in the Drainage Operation Plans during operation of the project.

p.4. Item #4 should be amended as follows:

a) All discharge of toxic constituents in toxic amounts to Salt Slough are terminated ~~when the project commences.~~

c) Demonstration that applicable ~~monthly and instantaneous~~ water quality objectives in Salt Slough and the San Joaquin River can consistently be met ~~throughout the~~ operation of the project.

d) Demonstration that the applicable implementation schedule for meeting objectives in Mud Slough ~~can and~~ will be met.

p.5. Item #2 under "To ensure that significant adverse effects to fish and wildlife in affected channels do not occur" should be amended as follows:

2. Results of the monitoring program will be reviewed quarterly with ~~these agencies and if by an advisory committee composed of one representative from each of these agencies.~~ If unacceptable problems or impacts are identified, appropriate mitigative actions to address the problems will be developed by the advisory committee, and implemented The definition and identification of "unacceptable" problems or impacts and need for mitigative action will consider applicable laws (i.e., Migratory Bird Treaty Act, Endangered Species Act) as well as the impacts in all channels affected by implementation of the project. Appropriate mitigative actions, depending on the situation, would include, but not necessarily be limited to, for example: interruption of a specific identified contamination pathway through hazing or habitat manipulation; increased management, enhancement, and recovery activities directed at impacted species in channels cleaned up as a result of the project; and/or, establishment and attainment of more stringent contaminant load reductions. The costs of mitigation, as well as any required clean-up, shall be borne by the Drainers.

p.5. Insert a new item #1 under "To ensure that there are no significant adverse effects to other environmental resources or public health" as follows and renumber subsequent items:

1. Section 404 permitting requirements of the Corps of Engineers will be completed prior to any construction in Mud Slough or modifications of retainer dikes or other measures to protect habitat or fish populations from drainage contamination.

p.6. Item #1 under "To ensure that the above listed Commitments are implemented and adhered to as part of the project" should be amended as follows:

1. "The Environmental Commitments set forth in FONSI No. _____, dated _____, are hereby incorporated and made an integral, binding component of this License."

Attachment 2

ENVIRONMENTAL DEFENSE FUND

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December 11, 1990

VIA FAX AND MAIL

Lawrence F. Hancock, Director
Bureau of Reclamation, Mid-Pacific Region
U.S. Department of the Interior
2800 Cottage Way, MP-720,
Sacramento, CA 95825-1898

Re: Proposed Use of the San Luis Drain

Dear Larry:

Thank you for our good meeting last week. As you know, the Environmental Defense Fund (EDF) has many specific concerns regarding the proposed use of the San Luis Drain as described in the Panoche Drainage District's Environmental Assessment, Initial Study, and Proposed Negative Declaration dated November, 1990. (See comments, attached.) We recognize, of course, that the Panoche proposal offers at least the potential of "clean" conveyance channels in the North Grasslands area, as well as the possibility that Salt Slough will once again be usable for the benefit of area wetlands. Prospective benefits do not, however, change the fact that significant drainage reduction will be part of any meaningful effort to address the Valley's irrigation drainage problems, whatever the short- or long-term prospects for use of the San Luis Drain might be.¹

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Currently missing from the Panoche proposal are two important elements: firm assurances that the benefits promised will, in fact, be realized during the five-year interim use period; and firm assurances that concurrent progress will be made towards meaningful drainage

¹ "Improvement in the application of irrigation water to reduce the source of deep percolation has been shown to be the most effective and least costly means of reducing the amount of potential drainage problem water." (San Joaquin Valley Drainage Program Final Report, September 1990.) Drainage reduction is wholly consistent with the applicants' promise to meet applicable water quality standards; can be undertaken on a "for-profit" basis through the compensated reallocation of waters conserved; and will be needed to avoid the unnecessary commitment of scarce water supplies to the mere dilution of agricultural wastes.

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reduction. Considering the Bureau's liabilities, obligations, and interests in the post-Kesterson era, it is imperative that any agreement for interim use of the Drain address both of these elements; it should also be available for public review and comment.² Considering these points, and following on last week's discussion, we suggest that the following elements be incorporated into any such interim-use agreement:

First, it should be guaranteed that waters which are available for diversion in Salt Slough and the North Grasslands area will either be usable for wetlands purposes or, if not usable, will be fully mitigated. At a minimum, waters with selenium concentrations in excess of 1.0 ug/l should be considered unusable for wetlands purposes. Mitigation should be provided in the form of "in-kind" replacements (i.e., equivalent reductions in next-month deliveries among the participating entities, and reallocation of those waters to area wetlands), or in the form of "in-lieu" payments for the acquisition of equivalent replacement supplies.

Second, ceilings should be established on consolidated drainage discharges and mass pollutant loadings.³ Monitoring data (1989) suggest that reasonable interim-use caps would amount to approximately 50,000 acre-feet (AF) per year of combined drainage inflow, 9,000 pounds selenium (averaging 66 ug/l), and 900,000 pounds boron (averaging 6.6 mg/l). Substantial reductions in drainage volume and loadings should also be required during the interim-use period.⁴

² It is our understanding that a draft interim-use agreement between the Bureau, Panoche, and possibly others has been under discussion and development since March of 1990 (if not before). We have asked for and have been promised, but have not yet received, a copy of this agreement.

³ Ceilings and reduction targets are needed for satisfactory completion of the environmental review process and to address legitimate environmental concerns. It would also be unwise for the Bureau to rely on the tacit assumption that the Regional Water Quality Control Board's regulatory program for agricultural drainage in any way guarantees that water quality objectives will, in fact, be attained, much less that significant new wildlife or habitat contamination will be avoided. Even a cursory review of the current Basin Plan and most of the associated Drainage Operations Plans will confirm that this program cannot reasonably be relied upon to lead to full compliance with applicable water quality objectives.

⁴ According to the State Water Resources Control Board's Technical Committee Report (August 1987), "deep percolation...could be reduced by about 40 percent with better water management of existing furrow systems. It could probably be reduced by more than 70 percent if the best available technology in irrigation systems were employed..." The Drainage Program's Final Report undercores this finding: "target reductions in deep percolation believed to be attainable through on-farm water conservation measures...and sustainable

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Third, a system of fees should be established for consolidated drainage inflows on a per-AF or per-pound basis, with revenues used to establish a liability/clean-up reserve.⁵ At the end of the interim-use period, these funds would be returned, with interest, to the participating entities unless otherwise needed for liability/clean-up purposes. Unless interim drainage-reduction targets have been achieved, however, subsequent use of these funds should be restricted, by prior agreement, to drainage reduction investments and/or associated O&M expenses. Fees of \$15-20 per AF of consolidated drainage inflow would be appropriate based on the one-time source reduction investment costs described in the Final Report of the San Joaquin Valley Drainage Program.

Fourth, progress towards the attainment of "Level 4" refuge water supplies should be assured. Here, many options are possible: the Bureau could "officially" forswear the marketing of such unallocated CVP yield as may exist during the interim use period (or permanently) and make such water available to the U.S. Fish and Wildlife Service for fishery/wetland enhancement purposes. Also, assurances could be given that a Grasslands turnout on the Delta-Mendota Canal would be completed by the end of the interim-use period, and certainly prior to any subsequent use of the Drain. In all cases, however, the most appropriate permanent source of enhanced refuge water supplies will come not from unallocated CVP yield but from the compensated reallocation of waters indigenous to the San Joaquin River basin, or from some portion of the water conserved for drainage-reduction purposes through reduced applications and/or land fallowing. To this end, the Bureau should act expeditiously to clarify its policies in support of long-term water transfers, particularly with regard to any discriminatory treatment that might be applied to waters under contract that are voluntarily transferred to non-irrigation uses.

Fifth, and finally, the Bureau, or the Panoche consortium, must agree to initiate a request to the State Water Resources Control Board for a permit for

beyond [2000]" amount to 0.35 AF per acre annually--approximately 47 percent of the reported drainwater average in the Grasslands subarea, and about 11 percent of total applied water. Additional reductions will be needed to meet the U.S. Environmental Protection Agency's objections regarding disapproved state-based objectives for water quality in Mud Slough. Finally, bona-fide load reductions will be needed if Drainage Operation Plans are to result in compliance with the drainage-reduction milestones referenced in the Regional Water Quality Control Board's Basin Plan (as amended).

⁵ The Bureau negotiated a similar reserve in the Barcellos litigation.

Lawrence F. Hancock, Regional Director
 December 11, 1990
 Page 4

the consolidated discharge of drainage from the San Luis Drain.⁶ An interim-use permit should be in place within one year of the date on which the interim-use agreement takes effect, and should incorporate all of the terms and conditions of that agreement. The interim-use permit and associated agreement also should clarify that use of the Drain beyond the five-year interim-use period will not be allowed in the absence of (1) a permit which regulates the discharge of selenium, boron, and other constituents of concern; and (2) formal organization of a regional entity (or entities) with appropriate contracting, financing, liability, and drainage-management authority.

We recognize that the above list of conditions may prove daunting at first blush, particularly to proponents of the proposed interim use of the San Luis Drain. Anticipating such a response, we can only underscore the fact that our proposals involve little more than firm assurances that the promised mitigations and benefits will materialize; provide a material means of resolving the Bureau's, the Drainers', and most of all the public's concerns over liability for, and the potential adverse impacts of, such interim use; and offer complementary mechanisms for the concurrent implementation of a program of drainage reduction that leaves operational and investment details to the participating districts' discretion.

We urge your careful consideration of the above suggestions, which we will forward to the Panoche Drainage District along with our comments on the Environmental Assessment/Initial Study. We are, as you know, prepared to work hard and cooperatively to assure that a satisfactory and comprehensive interim-use agreement is in place on or before May 1, 1991. Please let us know how you wish to proceed.

Sincerely yours,

David Yardas

David Yardas
 Economic Analyst

for Thomas J. Graff, Senior Attorney
 Terry F. Young, Ph.D., Consulting Scientist

cc: Dennis Falaschi, Panoche Drainage District

⁶ Permits have previously been required for the intermittent discharge of lower-volume and higher-quality groundwater seepage from the Drain. Planned use of the Drain in the early 1980's also was to have required an NPDES permit; see Interim Guidance on Possible Waste Discharge Requirements for the Proposed San Luis Drain, State Water Resources Control Board, May 1981.

Attachment 3

ENVIRONMENTAL DEFENSE FUND

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December 11, 1990

VIA FAX AND MAIL

Mr. Dennis Falaschi
Panoche Drainage District
52027 West Althea
Firebaugh, CA 93622

Re: Proposed Use of the San Luis Drain

Dear Dennis:

This letter, with attachments, constitutes the comments of the Environmental Defense Fund (EDF) on the Environmental Assessment and Initial Study for Proposed Use of the San Luis Drain (Panoche Drainage District, Lead Agency, November, 1990).

Notwithstanding the considerable effort that Panoche and other participating entities have expended on this proposal, we regret to say that the Environmental Assessment remains deficient in areas that raise major environmental concerns. Our concerns, which we will discuss in more detail below, represent not simply documentation problems, but also serious reservations about the design of the project itself. As currently structured, we do not believe that the project, or the subject study and assessment, warrant the proposed "negative declaration" or deserve a "finding of no significant impact" by the U.S. Bureau of Reclamation.

We do, however, wish to emphasize that it appears possible to resolve these concerns within a reasonable period of time, and thus it should still be possible to accommodate a May 1, 1991 construction date. A more detailed description of the changes that we propose is provided in the attached letter to Mr. Lawrence Hancock, Regional Director of the Bureau.

The areas in which the Assessment/Initial Study is deficient fall into three major categories:

- inaccurate characterization of mitigation measures;
- inadequate analysis of alternatives that may render the project more environmentally benign; and

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Mr. Dennis Falaschi
December 11, 1990
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- insufficient documentation of the proposed alternative.

With respect to the inaccurate characterization of mitigation measures, we note that monitoring of the potential contamination of Mud Slough and the associated environment cannot be equated with the mitigation of adverse effects. If mitigation is to be claimed, there must be a more solid provision for follow-up than vague promises to consult with interested parties. For example, in case contamination exceeds an acceptable threshold, the plans for apportioning responsibilities for clean-up should be explicitly discussed. (Following on the experience at Kesterson Reservoir, both state and federal taxpayers deserve a clear discussion of the legal recourse available against the federal government should a worst-case scenario develop.) At the very least, a refundable contingency reserve should be created that will be available during the interim use period to assist, as needed, in paying for the actual costs of clean-up. (See attachment.)

The cornerstone of the proposed "mitigation" for this project is the elimination of contaminated drainwater from 70 miles of channels in the north Grasslands area (including Salt Slough) and the presumed availability of these channels for delivery of usable water for wildlife refuges and private wetland habitat. We dispute, however, the validity of this claim of mitigation unless the water that remains in these channels is, in fact, usable. In other words, removal of contaminated drainwater must be explicitly guaranteed by the plan, and use of the San Luis Drain must be formally linked to the maintenance of adequate water quality in those 70 miles of channels. This requirement sounds more formidable in the abstract than it need be in fact; a suggested method for accomplishing this formal linkage is explained in the attachment to these comments.

With regard to the inadequate analysis of alternatives, the Assessment has overlooked an obvious set of alternatives which would be environmentally preferable to the proposed project. These alternatives would still allow the use of the San Luis Drain, but would provide additional assurance that the five-year interim use period would be accompanied by progress towards meeting the goals that have already been established by state water quality regulatory agencies and the federal-state San Joaquin Valley Drainage Program. In other words, the use of the San Luis Drain should be tied formally to interim drainage reduction goals and/or to progress towards meeting water quality standards.

The most obvious method for achieving this linkage is to apply for a waste discharge permit for use of the Drain. In fact, given the previous judgment of the State Water Resources Control Board that the San Luis Drain required an NPDES permit, it is odd that the Regional Board has not specifically required a permit as a result of the current proposal. Also, drainage reduction milestones, or other guarantees of progress towards the attainment of water quality standards, should be part of the contractual agreement that is to be signed with the Bureau of Reclamation for use of the

Mr. Dennis Falaschi
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San Luis Drain. As currently described, the project does not provide this linkage: the management of contaminated drainwater will be governed only through compliance with Drainage Operation Plans, which make no formal commitments to achieving any such milestones. Use of the Drain, even on an interim basis, simply cannot be an excuse for further delay.

As regards inadequate documentation of anticipated effects, we have four principal comments:

o First, underlying data should be provided in appendices in support of all figures and tables, enabling independent analyses of effects based on a common set of assumptions, as well as comparisons against other available data.

o Second, analyses should be provided with regard to expected flows and water quality in Salt Slough during the proposed interim use period (i.e., "Estimated Salt Slough without Drain Discharge"). Other constituents of concern (e.g., organic pesticides) should also be addressed.

o Third, the proposed diking of Mud Slough and associated channel realignments are important features of the proposal that should help to avoid inundation of at least two impoundment areas. They will, however, require dredge-and-fill permits from the U.S. Army Corps of Engineers, and raise numerous questions with regard to on-site impacts, wet-season flooding of refuge lands, etc. Has sufficient time been left for this process? Also cited is the U.S. Fish and Wildlife Service's intention "to create a positive flow with usable water towards Mud Slough in the side channel areas [south of Highway 140 ... thus eliminating] the need for blocking these backwater areas" (p. 22). What is the source of this water? How much will be needed? Will it always be available when needed? At what impact (or benefit) to other needs in the wetlands/refuge complex?

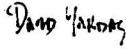
o Fourth, and finally, the proposed monitoring program should be expanded to include at least three monitoring sites in the San Luis Drain: one at the point of entry; one approximately mid-Drain; and one just above the point of exit. Only this way can the ultimate fate of selenium, boron, and other problem constituents be accurately accounted for.

We conclude that neither the proposed "negative declaration" nor a subsequent "finding of no significant impact" are justified at this point in time with regard to the proposed interim use of the San Luis Drain. Our analysis suggests, however, that opportunities exist for you and the other project proponents, together with the U.S. Bureau of Reclamation, to remedy the aforementioned shortcomings in a reasonably short time frame. To this

Mr. Dennis Falaschi
December 11, 1990
Page 4

end, we will do our part to help structure the assurances that can make interim use of the Drain a step in the right direction for all concerned.

Sincerely yours,



David Yardas
Economic Analyst

for Thomas J. Graff, Senior Attorney
Terry F. Young, Ph.D., Consulting Scientist

cc: Larry Hancock, U.S. Bureau of Reclamation

**THE WILDLIFE SOCIETY**

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5 October 1993

Honorable George Miller, Chairman
Subcommittee on Oversight and Investigations
U.S. House of Representatives
1324 Longworth House Office Building
Washington, DC 20515

Dear Chairman Miller:

The Wildlife Society wishes to submit the attached testimony concerning your Committee's 26 October 1993 hearing on the San Luis Unit drain. The Wildlife Society is the international organization of wildlife professionals dedicated to excellence in wildlife stewardship through science and education. This testimony was prepared in collaboration with our San Joaquin Valley Chapter.

We urge you to also consider holding hearings relative to the broader issue of agricultural drainage water impacts on wildlife associated with evaporation ponds. The Wildlife Society would like to offer the input of scientists with research and management experience in this problem area.

Thank you for your consideration.

Sincerely,

Thomas M. Franklin
Wildlife Policy Director



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**Statement of
The Wildlife Society**

**Oversight Hearing on
Drainage Problems in the Central Valley Project
Before the
Subcommittee on Oversight and Investigations
Committee on Natural Resources
U.S. House of Representatives
October 26, 1993**

Mr. Chairman and respected subcommittee members, The Wildlife Society (TWS) appreciates this opportunity to present written testimony before the subcommittee on the issue of agricultural drainage water problems in the San Joaquin Valley, California. TWS is a nonprofit scientific and educational organization of over 8600 professionals active in wildlife research, management, education, and administration. Through our Western Section and San Joaquin Valley Chapter, TWS has been an active participant in the debate over agricultural drainage waters and related environmental impacts in California's San Joaquin Valley and throughout the Western United States. We believe that equitable solutions to the problems caused by agricultural drainage waters are available. However, these solutions will be costly and no single group will endorse the entire package of solutions necessary to cope with the problems.

A hearing on this and related issues is long overdue. We note, however, that the original announcement of this hearing included the topic of San Joaquin Valley evaporation ponds, an item omitted from the final agenda. We strongly urge this subcommittee to convene field hearings focusing solely on evaporation ponds and San Joaquin Valley drainage issues as soon as possible. Given the completion of the San Joaquin Valley Drainage Program in 1990, enactment of the Central Valley Project Improvement Act in 1992, recent court decisions, and pending actions relating to evaporation ponds in the San Joaquin Valley, such hearings should be convened.

This subcommittee is aware of the significant environmental, social and economic problems caused by excessive salts and trace elements such as selenium in agricultural drainage water in the San Joaquin Valley and many other parts of the Western United States. In California alone, subsurface agricultural drainage water is discharged to surface waters of the state at a rate of 150 billion gallons per year; enough to fill a lake of 100 square miles to a depth of over 7 feet. Salts imported to the San Joaquin Valley with irrigation waters amount to over 2 million tons per year. The subcommittee should

also be aware that severe environmental damages are associated with agricultural drainage waters throughout the United States and elsewhere in the world where irrigated agriculture is practiced.

The issues of concern to the subcommittee today cannot and should not be separated from the larger issues mentioned above. Much of this hearing is focused on the reopening of the San Luis Drain and implementation of the recommendations of the San Joaquin Valley Drainage program (Rainbow Report). We would first like to point out that the Rainbow Report explicitly recognizes that even if every one of its recommendations were enacted immediately (beginning in 1990), the drainage crisis might be managed, not solved, within the San Joaquin Valley for perhaps 50 years; the Rainbow Report does not offer solutions. Sometime around the year 2040 drainage will no longer be controlled by "in-valley" methods and drainage export will be a necessity despite efforts which will include substantial retirement of agricultural lands. This is the "best-case scenario" because the Rainbow Report recommendations rely on multiple unproven technologies to achieve results. During this intervening 50-year period the shallow ground-water table would be saturated with a net gain of over 3 million tons of salt per year (in a strategy termed "planned groundwater degradation"), drainage waters will continue to be discharged to the San Joaquin River (a defacto Master Drain) ultimately ending up in the San Francisco Bay Estuary, and evaporation ponds with concentrations of selenium known to be toxic to migratory waterfowl and shorebirds will continue to cause embryo, juvenile, and adult bird deaths. Furthermore, absent a drainage water management solution, agricultural lands will still be forced out of production by increasing salinization and land retirement will not be a voluntary program. TWS seriously questions the wisdom of a plan advocating the potential demise of entire ecosystems in order to maintain agricultural productivity over a relatively short period of time.

The National Academy of Sciences harshly criticized the San Joaquin Valley Drainage Program for not considering all potential solutions to the drainage crisis. The San Joaquin Valley Drainage Program was constrained to consider a limited set of "in-valley" solutions. Prime among these constraints was the assumption that the status quo must be maintained with respect to agricultural crop productions. TWS would like to see an independent economic evaluation of land retirement and water redistribution with resulting effects on water price, highest beneficial use, crop support price reductions and the effects of terminating water subsidies.

Nevertheless, in general TWS supports the Rainbow Report because it forms a viable framework for future planning involving all sectors of the San Joaquin Valley community. The Rainbow Report will serve as a model for future multi-agency task forces addressing similar problems elsewhere provided this report receives the congressional support necessary for implementation. Without this necessary congressional support, the Rainbow Report will have served as just another testament to the inability of regulatory and policy setting agencies to make decisions based on sound science and the best available information. It is a simple matter to delay a difficult decision and call for more meetings, more research, and more committees to evaluate

the problems. This has been called cognitive dissonance, whereby public officials faced with difficult decisions fail to adequately protect the public interests in the exercise of their duties because of political expediency. TWS recommends a heavy reliance on source control, especially land retirement, as the most promising short term management strategy for reducing agricultural drainage impacts on the environment. Recommendations found in the Rainbow Report should be strengthened and expanded with respect to source control. TWS also supports the Rainbow Report recommendations with respect to institutional changes as necessary to implement a modernized water policy in the Western United States.

Recently the US Bureau of Reclamation (BuRec) attempted to apply the Rainbow Report recommendations to resolve longstanding drainage problems in the Westlands Water District left unresolved after the closure of Kesterson Reservoir. BuRec's effort failed because it was not a genuine attempt to apply all of the recommendations found in the Rainbow Report. In fact, BuRec's preferred alternative for managing agricultural drainage waters was rightfully rejected by all parties because the plan disingenuously relied on the creation of 17,000 acres of new evaporation ponds.

TWS does not have a position on the reopening of the San Luis Drain. However, if the decision is made to not reopen the drain, then the subcommittee should be aware that no progress will be made on how to resolve wetlands water quality issues in the Grasslands area. Left unresolved, this means that federal laws will continue to be broken, water quality objectives will remain unmet, selenium contamination will continue to spread throughout the area, and water conveyance structures servicing the Grasslands and wildlife areas remain unavailable to meet the goals of the Central Valley Project Improvement Act. Again, source control emphasizing land retirement seems to be the most viable option for managing agricultural drainage water.

Mr. Chairman, TWS members are among the foremost experts on the issues of agricultural drainage, selenium contamination, and environmental impacts in the Western US. These members are also scientists and others employed by federal or state agencies. Agencies can thus restrain these individuals from testifying before you because their findings may be politically troublesome. The Wildlife Society strongly encourages this subcommittee to convene hearings in California focused on evaporation ponds and environmental impacts. The Wildlife Society also encourages this subcommittee to call field level scientists and others as witnesses to provide testimony and respond directly to questions without interference from any specific agency policy objectives. We appreciate this opportunity to provide written testimony.

**A Management Plan
for
Agricultural Subsurface Drainage
and Related Problems on the Westside
San Joaquin Valley**

Final Report
of the
San Joaquin Valley Drainage Program

September 1990

U.S. DEPARTMENT OF THE INTERIOR
Bureau of Reclamation
Fish and Wildlife Service
Geological Survey

CALIFORNIA RESOURCES AGENCY
Department of Fish and Game
Department of Water Resources

PREFACE

A comprehensive study of agricultural drainage and drainage-related problems on the westside San Joaquin Valley has resulted in the management plan presented in this final report of the Federal-State interagency San Joaquin Valley Drainage Program.

Understandably, some may be disappointed that no single, sure, and lasting solution to the drainage problem has been put forward. Rather, the management plan presented is complex and includes risks that could be costly. Moreover, it may be only the first step in solving the salt accumulation problem. Virtually everyone involved in examination of the drainage problem agrees, however, that there is no single solution and no easy answer to the problem.

But it is also generally agreed that the drainage problem is manageable and that this management logically begins in the valley with a broadly shared effort to reduce the amount of drainage water, to place the remaining water under control, and to contain and isolate toxicants such as selenium. Such actions would largely correct present problems of waterlogging of farmlands and could greatly reduce adverse impacts on fish and wildlife.

The in-valley actions recommended in the plan would also be necessary for any eventual export of salt from the San Joaquin Valley. The recommended actions would provide a regional drainage infrastructure that now exists only in scattered pieces. If the plan proposed here is implemented, a salt export decision need not be made for several decades.

A review of the history of the drainage problem suggests that some of the reasons the problem has grown to nearly 500,000 acres and is adversely affecting the environment include: (1) Continued hopes for a master drain, (2) expectations of a technological breakthrough in drainage water treatment, (3) the need for more information, and (4) a lack of cooperation among parties affected. Viewed as an accumulation of years of piecemeal efforts and neglect, the problem appears overwhelming. It is not. Systematic, shared work begun now can manage the problem and contribute to its eventual solution.



Edgar A. Imhoff, Program Manager
San Joaquin Valley Drainage Program

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SAN JOAQUIN VALLEY DRAINAGE PROGRAM COMMITTEE AND TEAM MEMBERSHIP

The San Joaquin Valley Drainage Program is a Federal/State interagency program that was established in August 1984 by then Secretary of the Interior William Clark and California Governor George Deukmejian.

INTERGOVERNMENTAL COORDINATION TEAM

<p>Peter Bontadelli, CA Department of Fish and Game Constance Harriman, US Department of the Interior David Kennedy, CA Department of Water Resources W. Don Maughan, CA State Water Resources Control Board Dallas Peck, US Geological Survey</p>	<p>John Sayre, US Department of the Interior Jananne Sharpless, CA Environmental Affairs Agency John Turner, US Fish and Wildlife Service Dennis Underwood, US Bureau of Reclamation</p>
--	---

Gordon Van Vleck, CA Resources Agency

POLICY AND MANAGEMENT COMMITTEE

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Chapter 1. SUMMARY OF THE PLAN AND RECOMMENDATIONS FOR ACTION

This report summarizes the results of an intensive study of the subsurface agricultural drainage problems of the western side of the San Joaquin Valley, and presents a plan and recommendations for managing those problems from 1990 to 2040. The study has led to a much better understanding of the causes and effects of the drainage and drainage-related problems, although much is yet to be learned and long-term monitoring of the problem will be necessary.

The study and resulting plan focus on in-valley management of the drainage and drainage-related problems. It appears that in-valley actions can manage the problems for several decades without a means of exporting drainage-related salts to the ocean. Ultimately, it may become necessary to remove salt from the valley.

The recommended plan, which is regional in both scope and detail, takes account of uncertainties in information. The plan is not site-specific, and, without more detailed analysis, it is not a plan from which structures may be built. Rather, it should be considered as a framework that will permit the present level of agricultural development in the valley to continue, while protecting fish and wildlife and helping to restore their habitat to levels existing before direct impact by contaminated drainage water. It is noteworthy that many of the valley's water and drainage districts and individual growers have already begun to take actions similar to those recommended in this report.

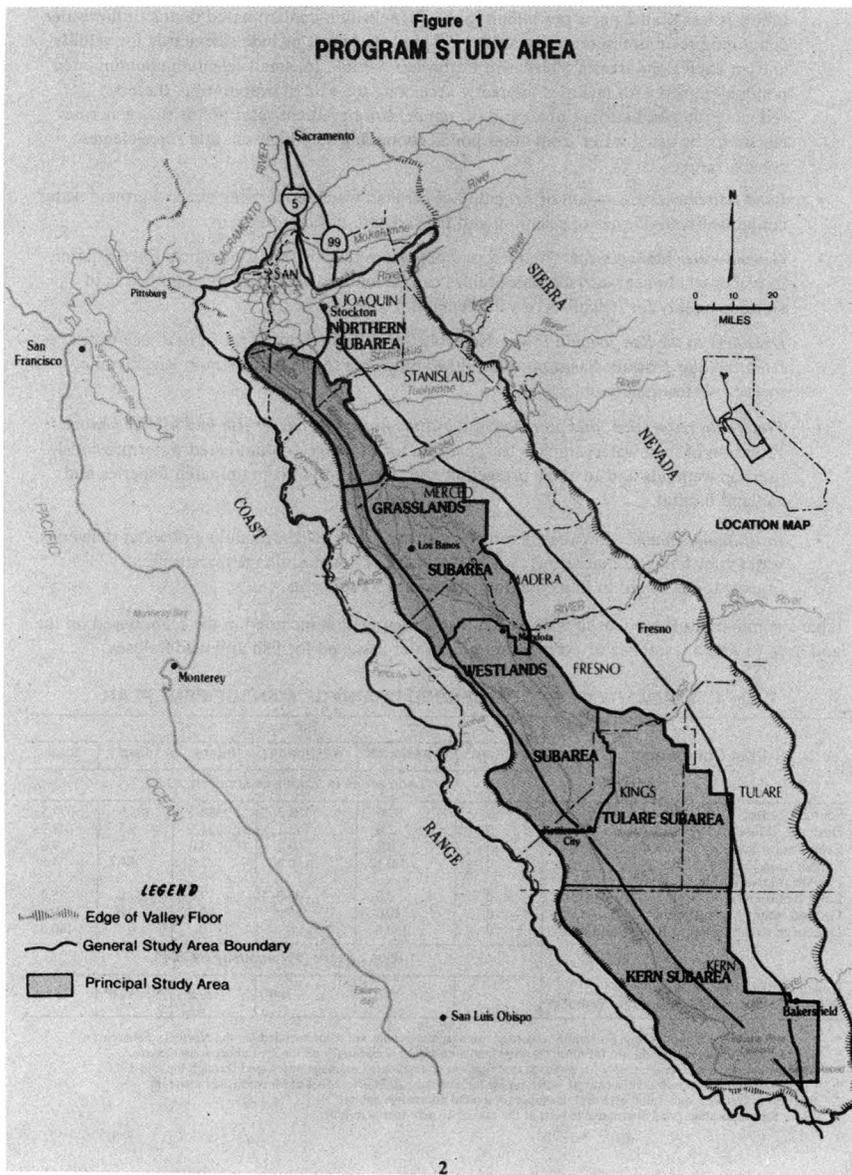
Figure 1 shows the San Joaquin Valley, the principal study area, and the five subareas used for planning.

SUMMARY OF THE PLAN

The plan recommended for management of subsurface drainage and drainage-related problems on the western side of the San Joaquin Valley contains the following major components:

- **Source control.** Consisting mainly of on-farm improvements in the application of irrigation water to reduce the source of deep percolation. This in turn will reduce the amount of potential drainage problem water.
- **Drainage reuse.** A planned system of drainage-water reuse on progressively more salt-tolerant plants. This will reduce the volume of drainage water and concentrate salts and trace elements for easier containment and safe disposal.
- **Evaporation system.** Drainage-water evaporation ponds planned for storage and evaporation of drainage water remaining after reuse on salt-tolerant plants. Four types of ponds are included: (a) Nontoxic ponds in which selenium in drainage-water

Figure 1
PROGRAM STUDY AREA



inflow is less than 2 parts per billion (ppb); (b) selenium-contaminated ponds (inflowwater containing selenium in the range of 2 to 50 ppb) that must include safeguards for wildlife and an equivalent area of alternative freshwater habitat; (c) small selenium-contaminated ponds designed with facilities to greatly accelerate the rate of evaporation, thereby reducing the pond surface area; and (d) temperature-gradient solar ponds that generate electricity by using water from other ponds containing very high salt and trace-element concentrations.

- **Land retirement.** Cessation of irrigation of areas in which underlying shallow ground water contains elevated levels of selenium and the soils are difficult to drain.
- **Ground-water management.** Planned pumping from deep within the semiconfined aquifer, in places where near-surface water tables can be lowered and the water pumped is of suitable quality for irrigation or wildlife habitat.
- **Discharge to the San Joaquin River.** Controlled and limited discharge of drainage water from the San Joaquin Basin portion of the study area to the San Joaquin River, while meeting water-quality objectives.
- **Protection, restoration, and provision of substitute water supplies for fish and wildlife habitat.** Provision of freshwater supplies to substitute for drainage-contaminated water previously used on wetlands and to allow protection and restoration of contaminated fisheries and wetland habitat.
- **Institutional change.** Includes tiered water pricing, improved scheduling of water deliveries, water transfers and marketing, and formation of regional drainage management organizations to aid in implementing other plan components.

Table 1 summarizes the extent to which each plan component is included in the plan, based on the land area to which it applies or occupies and the water assigned for fish and wildlife uses.

Table 1. SUMMARY OF RECOMMENDED DRAINAGE MANAGEMENT PLAN

Plan Component	Subarea					
	Northern ^a	Grasslands	Westlands	Tulare	Kern	Total
	Land areas in 1,000s of acres by 2040					
Source Control	0	93.6	159.3	316.7	105.9	675.5
Drainage Reuse ^b	0	2.6	12.1	24.5	9.7	48.9
Evaporation System ^b	0	0.2	2.1	3.0	2.3	7.6
Evaporation Pond ^b	0	0.12	0.40	2.9	1.07	4.5
Alternative Habitat						
Land Retirement	0	3.0	33.0	7.0	32.0	75.0
Ground Water Management	0	10.0	19.0	40.0	0.0	69.0
Discharge to San Joaquin River (land area)	0	160.6	0	0	0	160.6
	1,000s of acre-feet annually by 2040					
Increased Water for Fish and Wildlife Uses, Including Substitute Water ^c	0	150.0 ^d	4.0 ^e	29.0 ^e	11.0 ^e	194.0

^a Except for study and monitoring, no planned drainage management actions are recommended for the Northern Subarea.

^b The acreages shown are for on-site facilities; the total land area served is essentially all the area under source control.

^c Substitute water is that water supply for wetlands that replaces contaminated drainage water used through the mid-1980s.

^d Consists of 129,000 acre-feet of substitute water supply for wetlands, 20,000 acre-feet of Merced River instream fish flow in October, and 1,000 acre-feet of evaporation pond alternative habitat.

^e Water for evaporation pond alternative habitat at the rate of 10 acre-feet/acre/year.

No planned drainage management actions other than those being carried out currently are recommended for the Northern Subarea. However, drainage water from this area now flows to the Sari Joaquin River. In the event that water-quality objectives for the river become more restrictive, actions that would aid in meeting the objectives are discussed in the subarea plan.

Problem water is a term introduced in this report to describe the volume of near-surface ground water that, if reduced by source control or removed from plant root zones each year, would eliminate the drainage-related impediment to agricultural productivity. When placed in streams or open basins, some problem water is potentially hazardous to fish and wildlife and therefore must be managed to prevent environmental degradation. Drainage water that causes unacceptable levels of environmental degradation is viewed also as problem water for agriculture because it must be remedied — even if retirement of irrigated land is required. Table 2 shows the estimated reduction of problem water to be achieved by each plan component in each subarea. If the targets are met, agricultural production could be maintained for at least the duration of the planning period, without removal of salt from the valley. If salt export becomes necessary in the future, the actions recommended in this plan could create prerequisite conditions by providing collection facilities, by reducing drainage water volumes, and by isolating and controlling contaminants.

Table 2. PROBLEM WATER REDUCTION, 2040

Plan Component	Subarea								
	Northern	Grasslands		Westlands		Tulare		Kern	
		Acre-feet	Percent of Total	Acre-feet	Percent of Total	Acre-feet	Percent of Total	Acre-feet	Percent of Total
Source Control	0	32.7 (21)	55.8 (36)	63.2 (30)	37.1 (34)				
Drainage Reuse	0	13.6 (9)	61.0 (40)	113.3 (54)	43.6 (39)				
Evaporation System	0	0.7 —	4.0 (3)	12.3 (6)	6.0 (5)				
Land Retirement	0	2.3 (1)	24.8 (16)	4.2 (2)	24.0 (22)				
Ground-water Management	0	4.0 (3)	7.6 (5)	16.0 (8)	0 (0)				
Discharge to San Joaquin River	0	102.1 (66)	0 (0)	0 (0)	0 (0)				
TOTAL		155.4 (100)	153.2 (100)	209.0 (100)	110.7 (100)				

a Except for study and monitoring, no planned drainage management actions are recommended for the Northern Subarea.

The costs of the recommended plan have been annualized over the 50-year planning period, 1990-2040, at an interest rate of 10 percent (Table 3). One-time costs include those for installation of facilities and purchase (as in the case of land retirement) of plan components. The category "Agricultural Drainage" includes all drainage-related components of the recommended plan, except on-farm drainage systems. "On-Farm Drains" includes new on-farm drainage systems expected to be installed between 1991 and 2040 and the annual operation of those drains during that period, as well as those already operating in 1990. "Fish and Wildlife" includes the costs of constructing and operating facilities and purchasing water so that clean water could be delivered to wetland habitat formerly supplied with contaminated drainage water.

The economic value of the direct benefits or regional economic impacts of implementing the recommended plan was not estimated, and no allocation of costs among beneficiaries has been

performed. For drainage reuse, an estimate of the value of wood produced has been reflected as a cost offset. However, for source control and land retirement, any economic surplus that might result from the possible transfer of conserved water to other uses has not been included as a cost offset.

Table 3. ANNUALIZED COSTS OF THE RECOMMENDED PLAN
In \$1,000s

Agricultural Drainage	
One-time	
Source control	2,940
Drainage reuse	6,194
Evaporation system	3,043
Land retirement	2,818
Ground-water management	962
San Luis Drain	2,300
Subtotal	18,257
Operation, maintenance, and replacement	
Source control	5,444
Drainage reuse	2,291
Evaporation system	1,915
Land retirement	300
Ground-water management	2,694
San Luis Drain	390
Subtotal	13,034
TOTAL	31,291
On-Farm Drains	
Installation	6,473
Operation, maintenance, and replacement	1,536
TOTAL	8,009
Fish and Wildlife	
Installation	153
Operation, maintenance, and replacement	18
Water supply	2,548
TOTAL	2,719
GRAND TOTAL	42,019

CONCLUSIONS AND RECOMMENDATIONS FOR ACTION

During this study, a massive amount of data has been collected; many reports have been published; and much analysis, planning, and public review have been completed. This has led to the plan for drainage management presented in Chapter 6. However, a plan alone will not manage or solve the drainage and drainage-related problems of the western side of the San Joaquin Valley; actions are required on many fronts to make the plan a reality. These actions can be grouped under implementation, planning, monitoring, additional study, and funding proposed actions. The conclusions and recommendations for action that follow are presented in each of those groups.

Implementation

Local initiatives need to be recognized, supported, and enhanced by coordinated, comprehensive Federal and State actions undertaken to manage drainage problems. Several components in the management plan are either being studied preparatory to action or are actually being carried out by organizations and private interests in the problem area. Those activities that meet the criteria and objectives of the long-term drainage management plan should be carried out as rapidly as possible. Generally, these activities will require approval or assistance from local, State, or Federal agencies. They should receive high priority.

Some changes in law and policy by local, State, and Federal agencies would provide the impetus or remove roadblocks for implementing some plan components. Policy actions by agencies supplying, distributing, and regulating irrigation water and managing drainage facilities are needed now and in the future. Institutional changes are also a part of the management plan, which requires concerted action by both the California Legislature and the U.S. Congress.

Because unattended plans often do not materialize, the efforts reported here will be followed by a short, new Federal-State effort between October 1990 and December 1991 that will develop a strategy for implementation of the plan.

Recommendation 1 – Implementation of Recommended Plan; Priority Activities

Local, State, and Federal water organizations and authorities should consider the recommended plan and explicitly adopt those parts appropriate for their long-term strategy of contributing to the management or solution of the drainage problems of the west side San Joaquin Valley.

The following plan components should be implemented as soon as final planning is complete, funding and applicable clearances can be obtained, and agreement can be reached. An asterisk (*) following a plan component indicates there is a related current local initiative that should become part of the plan component.

Northern Subarea

- Investigate, in detail, measures that may be needed if stricter salt standards are established for the San Joaquin River/Delta.

Grasslands Subarea

- Use the Grassland Task Force water districts as the nucleus of a regional drainage entity to coordinate and jointly manage subarea-wide drainage problems. *
- Provide the facilities required to intercept contaminated subsurface drainage water now being discharged into open channels within the grasslands wildlife habitat, and convey these to the San Luis Drain.
- Renovate and extend the San Luis Drain, bypassing 20,000 acre-feet of contaminated drainage water around wetlands (similar to the Zahm-Sansoni-Nelson plan). *
- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.35 acre-feet per acre per year (on the average) as soon as possible. *
- Intensify and complete local demonstration projects on source control and treatment of drainage water. (Work already under way in Broadview, Panoche, and Pacheco water districts.) *
- The U.S. Bureau of Reclamation should actively seek authority to reallocate 74,000 acre-feet of water annually from the Central Valley Project to replace drainage water used on wetlands before 1985.
- Restore drainage-contaminated wetlands.
- Provide 20,000 acre-feet of water to the Merced River each October to attract migrating fish from drainage water discharging to the San Joaquin River.

Westlands Subarea

- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.35 acre-feet per acre per year (on the average) as soon as possible. *
- Accelerate the pace and increase the number of field demonstrations of source control measures and drainage water treatment research, including especially reuse of drainage water on trees and removal of selenium from drainage water. *
- Develop guidelines for retirement of irrigated lands that have high selenium concentrations in shallow ground water and that are difficult to drain.
- Design and develop a 5,000-acre demonstration unit of closely-spaced, low-volume wells in the semiconfined aquifer for planned drawdown of the high water table.

Tulare Subarea

- Develop a formal association of water districts (built around the existing Tulare Lake Drainage District) for coordinated and joint management of subarea-wide drainage problems. *
- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.2 acre-feet per acre per year (on the average) as soon as possible. *

- Accelerate the pace and increase the number of field demonstrations of source control measures and evaporation pond experiments, including especially the reuse of water on trees and modification of pond systems and their management to make ponds bird-free or bird-safe. *
- Demonstrate in the field the use of alternative safe-water habitat near an existing evaporation pond containing elevated levels of selenium.
- Design and develop a 5,000-acre demonstration unit of closely-spaced, low-volume wells in the semiconfined aquifer for planned drawdown of the high water table in the area of good quality ground water in the Kings River Delta (Tulare Subarea water quality zone E).

Kern Subarea

- Kern County Water Agency and local water districts should form a drainage management entity responsible for coordination and joint management of subarea-wide drainage problems.
- Improve on-farm water conservation and source control on all irrigated lands and reduce deep percolation on lands having drainage problems by 0.35 acre-feet per acre per year (on the average) as soon as possible. *
- Initiate intensive studies of the ground-water resources of the old Buena Vista and Kern lakebeds.

Recommendation 2 – Source Control

The agencies with major responsibility for delivery of water to the study area (U.S. Bureau of Reclamation and California Department of Water Resources) should increase their work with the university extension systems and water districts to demonstrate ways to improve the efficiency of irrigation water application and thereby reduce potential drainage-water volumes.

Each water district should, by 1992, set objectives in their operation plans that would reduce deep percolation by the amounts stated in Recommendation 1 (preceding). State and Federal agencies should help local water districts accomplish their water conservation improvement plans.

Recommendation 3 – Financing Source Control Measures

Both the Federal and State governments should explore ways of providing a portion of the financing needed to implement irrigator source-control actions and to invigorate existing programs. The U.S. Soil Conservation Service and U.S. Bureau of Reclamation both have programs that could aid in financing irrigator actions. The State of California, through the Department of Water Resources, the Department of Food and Agriculture, and the State Water Resources Control Board, could provide loans and grants for source-control actions, if funds were made available.

Recommendation 4 – Joint Technical Assistance

The U.S. Department of the Interior and the State of California should jointly develop a technical assistance program to ameliorate the drainage problem, by providing water districts with geohydrologic and economic information and analytical techniques useful in investigating local areas for possible conjunctive surface- and ground-water use, land retirement, on-farm drainage, source control, and reuse. Technical assistance is also needed in environmental impact assessment, toxicity assessment, and habitat restoration.

Recommendation 5 – State of California Lead in Water Conservation

The State of California should expand and intensify its program of on-farm water conservation to focus especially on demonstrating alternative source control measures on drainage-problem lands.

Recommendation 6 – Federal and State Programs' Adjustment

The State of California and the U.S. Department of the Interior should jointly consider the findings, forecasts, and plans of the Drainage Program with respect to drainage problems, and should look for opportunities to encourage amelioration and resolution of these problems. This should be achieved through ongoing operations, planning, construction, and — if considered necessary — new legislation, promulgation of rules and regulations, and appropriate language in contracts and administrative reviews.

Recommendation 7 – Western U.S. Applications

The U.S. Department of the Interior should consider the information, techniques, and experience accumulated in the Drainage Program and extend appropriate aspects of the knowledge base to other land areas in the western United States that are experiencing similar agricultural drainage and drainage-related problems.

Planning

The general plan for reducing or solving drainage and drainage-related problems outlined in this report provides a framework into which many actions can be fitted. However, before many of the actions can move forward, additional work is needed to refine estimates of their scope and effects. Generally, this additional planning will occur at local, State, and Federal levels, and at combinations of each.

Recommendation 1 – Water District Plans

With financial and technical assistance from State and Federal agencies, water districts should lead in developing plans to:

- Identify lands in drainage problem areas in which the combined characteristics of high concentrations of selenium and difficult-to-drain soils would make these lands candidates for retirement from irrigation.
- Identify locations in drainage problem areas where there may be an opportunity to lower the high water table by pumping from deep in the semiconfined aquifer (above the Corcoran Clay), and design the facilities, reach agreements, and obtain policy approvals required to carry out pumping.

Recommendation 2 – State Water Project Area

Within the State Water Project service area, the State of California should lead in planning for the regional drainage-water treatment and disposal needs that will arise from management and reuse of drainage water within local water districts.

Recommendation 3 – Federal Water Service Area

Within the Federal water service area, the Department of the Interior should lead in planning for the regional drainage-water treatment and disposal needs that will arise from management and reuse of drainage water within local water districts.

Recommendation 4 – Joint Planning for Ground-Water Management

Plans for installation and operation of well fields designed to pump from the semiconfined aquifer to lower the high water table should be completed cooperatively by Federal and State agencies and water districts. In the Federal service area, the Bureau of Reclamation should work with Westlands, Broadview, Panoche, San Luis, and Firebaugh Canal water districts to design well fields for areas identified in this report. In the State service area, the Department of Water Resources should work with Kern County Water Agency and Empire Westside, Riverside, Stratford, and Laguna irrigation districts, Lakeside Irrigation Water District, Kings County Water District, and Kings River Conservation District for the same purpose. Services of the U.S. Geological Survey should be used in locating favorable areas and in developing plans.

Recommendation 5 – Joint Planning for Water Delivery

Federal and State fish and wildlife agencies, in cooperation with private wetland owners, and Federal and State water development agencies should jointly plan the facilities required for delivery of water to wildlife areas affected by subsurface drainage water.

Monitoring

To properly implement management of drainage and drainage-related problems, both the problems and the progress in solving them must be monitored. This is especially important because of the changing nature of the drainage problem and the flexible array of measures required for management. Monitoring all aspects of the problem and the effects of management will be critical to using the plan as a flexible guide to remedial actions.

Recommendation 1 – Local Water Agencies

All local water supply and drainage agencies should participate in joint, coordinated programs to monitor the volume and quality of drainage water in the collection, treatment, and/or disposal systems.

Recommendation 2 – Joint State/Federal

The U.S. Department of the Interior and the State of California should jointly design a scientifically reliable and cost-effective network of physical and biological monitoring stations that will detect change in the environment caused by subsurface agricultural drainage problems and attempts to solve these problems. Areas expected to experience expansion of high water tables should be included.

Additional Study

During the six-year life of the Drainage Program, the absence of reliable information made it necessary for the Program to fund basic research, as well as to fund investigations directly relevant to solving drainage problems. Some additional study is needed to provide detailed information for feasibility determinations.

Recommendation 1 – Study Needs

Water and land managers, universities, agencies, and individuals should emphasize the following study categories and subjects, and support the development of information transfer programs to extend study results to appropriate user groups.

Drainage Management

- Develop measures to renovate or close aged or toxic evaporation ponds.
- Develop a cost-effective treatment method to remove selenium from drainage water.
- Perform field tests of tolerance of agricultural crops, halophytes, and salt-tolerant trees to constituents in drainage water.
- Develop effective training programs for personnel involved in drainage management.
- Investigate the propagation and marketing of salt-tolerant crops that use saline drainage water as an irrigation supply.
- Demonstrate the use of an accelerated evaporation system, using a sprinkler system similar to the University of Texas at El Paso's experimental system and the use of a temperature-gradient solar pond system for salt disposal and generation of electricity.

Geohydrology

The following studies are interrelated by the nature of the geohydrologic system. The objective is to better understand the surface- and ground-water system's chemical and physical characteristics that will allow better management of the natural resources.

- Evaluate, in detail, the areal and vertical variability of ground-water quality in the Tulare Subarea and in all water-quality zones considered for the ground-water management component in the plan.
- Investigate solubility controls for specific elements of concern (selenium, arsenic, molybdenum, and uranium) in various geologic conditions. Specifically, expand studies to include basin and lacustrine environments that dominate the Tulare Basin where drain water disposal options are severely limited and conditions are highly varied.

- Develop reliable, consistent methods for estimating ground water pumping.
- Complete investigation of surface water and ground water interaction in the San Joaquin River so that the quantity, quality and timing of ground-water contributions to river flows can be evaluated.
- Complete development of a streamflow and solute transport model for the San Joaquin River and couple it with reservoir operations models so that management alternatives can be evaluated.
- Determine the capacity of geochemically reduced Sierra Nevada sediments to remove selenium.
- Determine the hydraulic and water-quality feasibility of controlling the water table by pumping from wells in selected areas.
- Continue development of quantitative analyses of ground water flow systems.

Economics

- Use the surface and subsurface conjunctive-use model of the San Joaquin Valley (as developed for the Drainage Program) to evaluate water transfers and marketing scenarios.

Fish and Wildlife

Contamination. Continue the effort initiated by the Program to determine the nature, geographic extent, and severity of contamination of fish, wildlife, and their habitats by subsurface drainage water. Special attention should be given to: evaporation ponds and neighboring public and private wildlife areas; agroforestry plantations; the San Joaquin River, Delta, and San Francisco Bay; and the six substances of concern discussed in this report (arsenic, boron, chromium, molybdenum, selenium, and total dissolved solids) and ten additional trace elements and metals: cadmium, copper, lithium, manganese, mercury, nickel, strontium, uranium, vanadium, and zinc.

Toxicity. Continue the effort initiated by the Program to define, for fish and wildlife, safe and toxic concentrations (and associated biological effects) of subsurface drainage water substances of concern in water and food. Special attention should be given to: independent toxicity of trace elements other than arsenic, boron, and selenium (for example, cadmium, chromium, copper, lithium, manganese, mercury, molybdenum, nickel, strontium, total dissolved solids, uranium, vanadium, and zinc); interactive effects of trace elements in drainage water; effects of water chemistry (for example, pH and salinity) on independent and interactive toxicity; and site-specific toxicity (for example, in valley aquatic and wetland habitats, evaporation ponds, and agroforestry plantations).

Protection, restoration, substitute water supply, and improvement. Continue the effort initiated by the Program to identify and evaluate measures to: protect remaining fish and wildlife resources of the San Joaquin Valley from drainage-related impacts; restore drainage water contaminated habitats; provide water supplies to substitute for drainage water previously used by fish and wildlife; and improve fish and wildlife resources.

Out-of-valley drainage water disposal. In the event that out-of-valley disposal is pursued in the future, develop information to assess the potential effects on fish and wildlife habitats and

populations, and public uses of those resources in the receiving waters and lands. In light of recommendations for consideration of disposal in these areas, special attention should be given to the Sacramento–San Joaquin Delta, San Francisco Bay, and the Pacific Ocean (CVRWQCB, 1988a; NRC, 1989).

Public Health

To adequately quantify the risks of environmental chemical exposures, substantial information is necessary on the environmental fate of the chemicals, the toxicity of specific forms, and the degree to which humans are exposed to them. Although site- and organism-specific data are always preferred, surrogate data are used frequently to fill data gaps (for example, animal studies are extrapolated to assess likely human toxicity resulting from a chemical exposure). The following summarizes information needed to best assess the probability of adverse human health effects related to drainage contaminant exposures.

Environmental fate

- Further identify chemical forms of substances of concern in different environmental media (air, water, soil, sediment, biota).
- Further identify environmental conditions (pH, oxidation-reduction, etc.) in which different chemical forms of substances of concern occur in different environmental media.
- Continue studies conducted by the University of California to assess the uptake of substances of concern into edible biota related to specific environmental conditions.
- Place research emphasis on the environmental fate of substances of concern via typical routes of human exposure (for example, food-chain transfer of organic forms of trace elements).

Toxicology

- Perform additional chronic toxicity testing on specific chemical forms of substances clearly associated with the drainage problem.

Exposure assessment

- Further identify contaminant threshold concentrations in edible animals in tissues used for human consumption.
- Further identify contaminant threshold concentrations in edible plants in tissues used for human consumption.
- Characterize consumption patterns of populations at risk.

Risk quantification

- Quantify option- and site-specific public health risks.

Funding Proposed Actions

There has been no formal discussion or analysis of the way in which components of the plan and the various actions recommended would be funded. Undoubtedly the costs would be shared by

the private and public sectors and it is essential that discussion begin soon of distribution of plan costs.

Recommendation 1 – Cost Allocation Principles

The following principles should be considered in discussing allocation of the costs of implementing the plan.

- All areas contributing to a problem of subsurface agricultural drainage water should share in the costs of resolution and management of that problem.
- With respect to contributing areas, the cost-sharing formulas should be based on best available scientific information, and they should be re-evaluated and updated periodically in light of new information.
- Both direct indicators (upslope–downslope hydraulic relationships, for example) and indirect indicators (water supply received, for example) should be considered for inclusion in cost-sharing formulas.
- All beneficiaries should pay for drainage-management costs in proportion to benefits received.
- There are both market and nonmarket national, State, and local benefits to be realized from the management of drainage problems. All beneficiaries should be identified.
- Because of the widespread occurrence of the drainage problem on the western side of the valley and the lack of scientific data on specific sites, costs should be distributed over the largest practicable land area — a whole service area or an association of water districts, for example — rather than one small water district.

Recommendation 2 – Study Plan Benefits

The U.S. Department of the Interior and the State of California should jointly study the benefits of implementation of the plan.

Recommendation 3 – Study Legislative Needs

The State of California should examine the need for new legislation to remove obstacles or to create opportunities for water marketing so that funds from water sales may be used for payment of drainage costs.

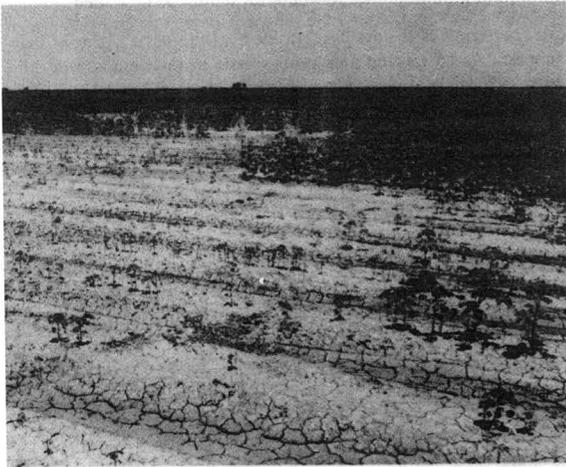
Chapter 2. THE PROBLEM

The San Joaquin Valley, which forms the southern portion of California's Central Valley, is bounded on the east by the Sierra Nevada and on the west by the Coast Ranges (Figure 1). It is made up of two geologic features — the San Joaquin Basin, drained by the San Joaquin River, and the Tulare Basin, a hydrologically closed basin that is drained by the river only in extremely wet years. The two basins divide the San Joaquin Valley roughly into its northern and southern halves.

The general study area includes the entire San Joaquin Valley, from the drainage divide of the coastal mountains to the 1,000-foot elevation of the Sierra Nevada foothills. The principal study area comprises lands that are now directly affected by or contribute to agricultural sub-surface drainage problems, as well as lands likely to be directly affected in the future. Most of these lands are on the western side of the valley and at its southern end.

A BRIEF HISTORY

The conditions associated with agricultural drainage in the San Joaquin Valley are not new to the region. Inadequate drainage and accumulating salts have been persistent problems in parts of the valley for more than a century, making some cultivated land unusable as far



Agricultural land south of Los Banos damaged by salt deposits caused by evaporation from ground water lying only a few feet below the land surface.

back as the 1880s and 1890s (Ogden, 1988). Widespread acreages of grain, first planted on the western side of the valley in the 1870s and 1880s, were irrigated with water from the San Joaquin and Kings rivers. This type of farming spread until, by the 1890s, the rivers' natural flows were no longer adequate to meet the growing agricultural demand for water. Poor natural drainage conditions, coupled with rising ground-water levels and increasing soil salinity, meant that land had to be removed from production and some farms ultimately abandoned.

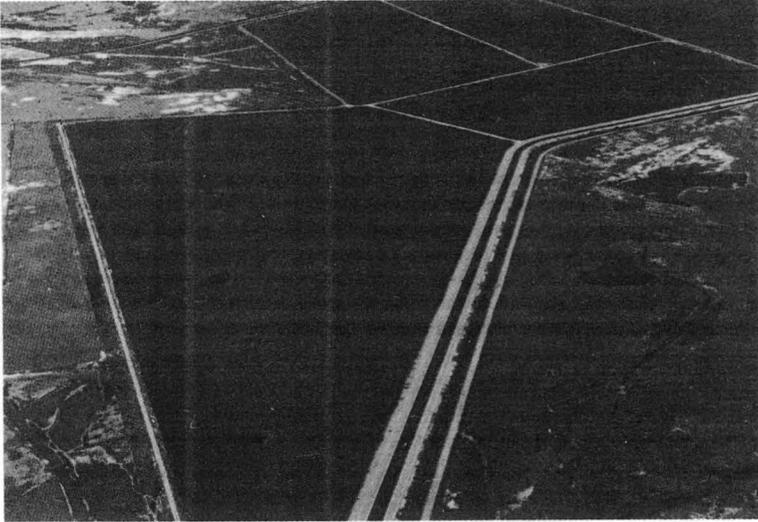
The development of irrigated agriculture in the San Joaquin Valley since 1900 owes a great deal to the improvements in pump technology that took place in the 1930s. These achievements led to the development of large turbine pumps that could lift water hundreds of feet from below ground. In time, heavy pumping triggered severe ground water overdraft because more water was being extracted than was being replaced naturally. Ground water levels and hydraulic pressure fell rapidly, and widespread land subsidence began to occur. By the late 1950s, estimated overdraft in Kern County had reached 750,000 acre-feet per year.

Initial facilities of the Federal Central Valley Project transported water from Northern California through the Sacramento-San Joaquin Delta and the Delta-Mendota Canal in 1951 to irrigate 600,000 acres of land in the northern part of the San Joaquin Valley. This water primarily replaced and supplemented San Joaquin River water that was diverted at Friant Dam to the southern San Joaquin Valley.

The CVP's San Luis Unit and the State Water Project, each authorized in 1960, began delivering Northern California water to agricultural lands in the southern San Joaquin Valley in 1968. Together they provide water to irrigate about 1 million acres. Authorization of the San Luis Unit also mandated construction of an interceptor drain to collect irrigation drainage water from its service area and carry it to the Delta for disposal. The Bureau of Reclamation's 1955 feasibility report for the San Luis Unit described the drain as an earthen ditch that would drain 96,000 acres. By 1962, Reclamation's plans had changed to a concrete-lined canal to drain 300,000 acres. In 1964, alternative plans added a regulating reservoir to temporarily retain drainage (USBR, 1964). A decision was made in the mid-1970s to use the reservoir to store and evaporate drainage water until the drainage canal to the Delta could be completed.

At this same time, questions were raised about the potential effects of untreated agricultural drainage on the quality of water in the Delta and San Francisco Bay. This concern was reflected in a rider added to the CVP appropriations act by Congress in 1965, which stated that "... the final point of discharge for the interceptor drain for the San Luis Unit shall not be determined until development by the Secretary of the Interior and the State of California of a plan which shall conform with the water quality standards of the State of California as approved by the Administrator of the Environmental Protection Agency." This proviso remains in effect today.

Initially, the San Luis Drain was conceived as a State/Federal facility, but the State twice declined to participate. The Bureau of Reclamation began construction in 1968 and, by 1975, had completed 85 miles of the main drain, 120 miles of collector drains, and the first phase of the regulating reservoir (Kesterson). In 1970, Kesterson Reservoir became part of a new national wildlife refuge managed jointly by Reclamation and the U.S. Fish and Wildlife Service.



Federal budget constraints and growing environmental concern about releasing irrigation runoff into the Delta halted work on the reservoir and the drain.

In 1975, the Bureau of Reclamation, the California Department of Water Resources, and the State Water Resources Control Board formed the San Joaquin Valley Interagency Drainage Program to find a solution to valley drainage problems that would be economically, environmentally, and politically acceptable. This group's recommendation was to complete the drain to a discharge point in the Delta near Chipps Island (IDP, 1979). In 1981, Reclamation began a special study to fulfill requirements for a discharge permit from the State Water Resources Control Board.

The 1983 discovery of deformities and deaths of aquatic birds at Kesterson Reservoir altered the perception of drainage problems on the western side of the valley. Selenium poisoning was determined to be the probable culprit. In 1984 the San Joaquin Valley Drainage Program was established as a joint Federal and State effort to investigate drainage and drainage-related problems and to identify possible solutions.

In 1985, the Secretary of the Interior ordered that discharge of subsurface drainage to Kesterson be halted, and the feeder drains leading to the San Luis Drain and the reservoir were plugged in 1986. The reservoir is now closed. The vegetation has been plowed under, and low-lying areas were filled in 1988.

Contamination-related problems similar to those identified at Kesterson are now appearing in parts of the Tulare Basin, which receives irrigation water from the State Water Project, in addition to other surface and ground water supplies. Wildlife deformities and deaths have been observed at several agricultural drainage evaporation ponds.

THE AREA OF CONCERN

The chief area of concern in this study is the western side of the San Joaquin Valley from the Sacramento-San Joaquin Delta on the north to the Tehachapi Mountains south of Bakersfield. This area coincides generally with the Federal Delta-Mendota Canal and San Luis Unit irrigation service areas and the State Water Project service area. Figure 2 shows those service areas, the Friant-Kern Service area on the eastern side of the valley, and the general study area boundary. Lands now directly affected by, contributing to, or likely to be directly affected by agricultural drainage problems make up the principal study area shown on Figure 1. To aid planning and analysis, the principal study area has been divided into the Northern, Grasslands, Westlands, Tulare, and Kern subareas. Subarea boundaries are based on hydrologic considerations, political boundaries, current drainage practices, and/or the nature of the drainage-related problems.

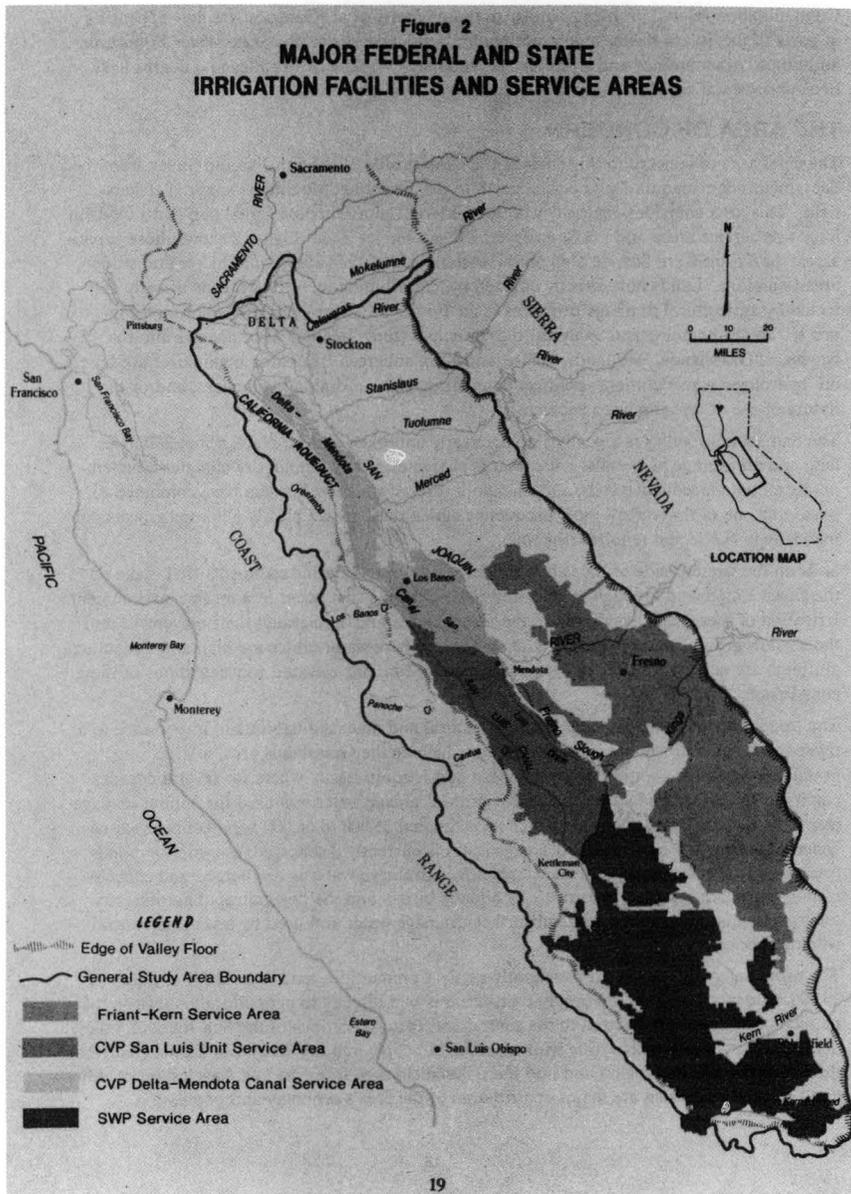
The San Joaquin Valley is a gently sloping, nearly unbroken alluvial plain, about 250 miles long and an average of 45 miles wide, that is characterized by a mild, dry climate. The temperate climate, productive soils, and the application of water by farmers have combined to make this one of the world's most productive agricultural areas. Nearly all crops grown commercially in the region require irrigation.

Soils on the western side of the valley are derived from the marine sediments that make up the Coast Range and are high in salts and trace elements that occur in a marine environment. Irrigation of these soils has dissolved these substances and accelerated their movement into the shallow ground water (Gilliom, et al., 1989a). Where water tables are high and agricultural drains are necessary, drainage water frequently contains elevated concentrations of these constituents.

The principal study area includes remnant natural and managed habitats of importance to a diversity of fish and wildlife species. Habitats include the Grasslands area, a large grasslands/wetlands complex in the southern San Joaquin Basin, where for several decades commingled surface and subsurface agricultural drainage water was used for habitat management; the San Joaquin River, into which an estimated 35,000 to 56,000 acre-feet per year of collected subsurface agricultural drainage water is currently discharged; evaporation ponds (primarily in the Tulare Basin), where subsurface drainage water is discharged and concentrated and which are used extensively by aquatic birds; and the beginnings of agroforestry plantations that are watered with subsurface drainage water and used by several terrestrial wildlife species.

The principal study area is predominantly rural. Communities tend to have fewer than 10,000 residents whose main economic existence is tied directly to agriculture. Although the population is sparse, compared to the central and eastern portions of the San Joaquin Valley, demographic shifts are occurring with an influx of people into the Tracy-Los Banos area from the San Francisco Bay region and into the Bakersfield area from the Los Angeles basin. Migrant farm workers also are major contributors to the area's economy and population.

Figure 2
MAJOR FEDERAL AND STATE
IRRIGATION FACILITIES AND SERVICE AREAS



INTERESTS AFFECTED BY DRAINAGE PROBLEMS

Agriculture

Agriculture provides the economic base of the western side of the San Joaquin Valley (Archibald, 1990). About 90 percent of the 2,544,000 irrigable acres in the principal study area are in irrigated crop production at any one time. A diverse range of crops is grown there. Fruits and nuts are important in the Northern, Grasslands, and Kern Subareas, while the predominant crops in the Tulare and Westlands Subareas are field crops and cereal grains. Cotton is the leading field crop in both subareas.

Irrigation practices, methods, and efficiencies vary subarea by subarea. In 1980, the predominant method in the San Joaquin Valley was surface irrigation. The methods chosen depend on many factors — types of crops cultivated, cost of water, soil types, and current irrigation and drainage management practices. Farming practices and irrigation efficiencies are influenced by variations in soil type, climate, slope of the terrain, crops grown, and a grower's experience.

If current irrigation practices continue, areas in which ground-water levels are 5 feet or less from the surface of irrigated lands will continue to expand in the Westlands, Tulare, and Kern subareas. Such areas in the Northern and Grasslands subareas are unlikely to increase as long as they can be drained to the San Joaquin River. The total area in the western side at that level now is about 847,000 acres, of which 90,000 acres are managed as wetlands. By



Melons are an important crop in both the Grasslands and Westlands subareas.

2000, high ground-water levels may be adversely affecting about 1 million acres of irrigated land (W.C. Swain, 1990a and 1990b), or about 40 percent of irrigable farmland in the principal study area. This will reduce crop productivity, cause loss of farm income through conversion from salt-sensitive to salt-tolerant crops, increase costs of drainage management, and force land out of production.

Fish and Wildlife

[The following section is supported by information in the Drainage Program's Technical Report, Fish and Wildlife Resources and Agricultural Drainage in the San Joaquin Valley, California, October 1990.]

Before settlement of the San Joaquin Valley began in the 19th century, the richly diverse landscape supported large populations of both resident and migratory species of fish and wildlife. Today, most of these aquatic, wetland, riparian forest, and valley oak savannah habitats have been converted to agricultural, municipal, and other uses. Less than 1 percent of the fresh-water lakes, only about 7 percent of the riparian forests, and less than 15 percent of the original wetlands remain. As a result, some native plants and animals have vanished from the landscape, and the continued existence of many others is in serious jeopardy. The populations of birds that once lived in or visited the valley as migrants have been greatly reduced, and the grizzly bear, the pronghorn antelope, and the gray wolf have disappeared entirely.

Impoundments on and diversions from the San Joaquin River and its tributaries have dramatically reduced the valley's fisheries. Native fish have declined drastically and introduced species are now dominant. Chinook salmon, once sufficiently abundant to have at least a spring run and a fall run, have been greatly reduced in population.

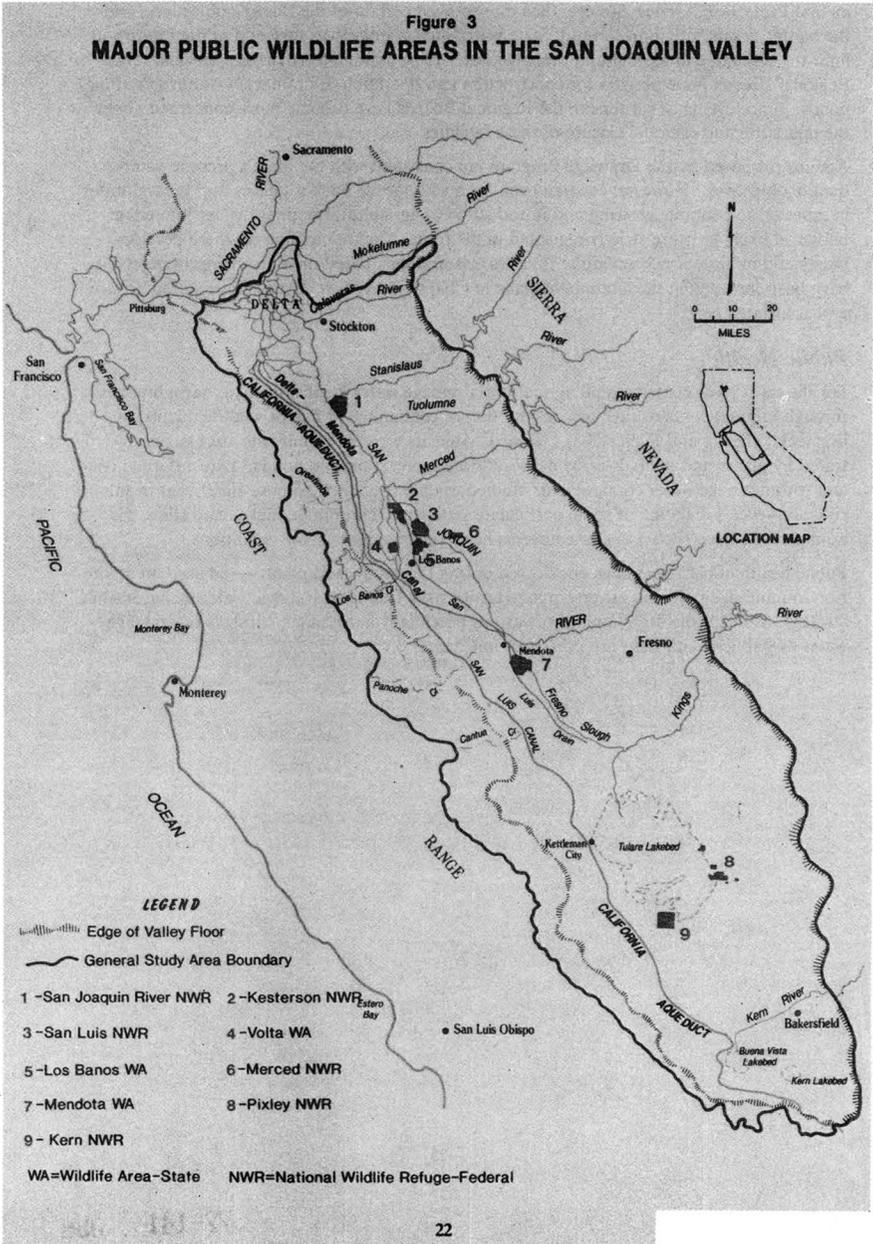
About 200,000 acres of private and public land and water in the San Joaquin Valley are presently managed as parks, refuges, and preserves, primarily for the benefit of fish and wildlife. These areas, which protect the surviving native habitats, include State and Federal wildlife areas, State fishery facilities, private duck clubs, special management areas, and private nature preserves. Until recently, about half the water supplies used in these areas was provided by agricultural drainage, but use of drainage water for such purposes has been discontinued on almost all wildlife areas because it may endanger the health of fish and wildlife. The location of major public wildlife areas in the San Joaquin Valley is shown in Figure 3.

Laboratory research has demonstrated that elevated waterborne and/or dietary concentrations of several trace elements in some San Joaquin Valley drainage waters are toxic to fish and wildlife. Selenium is the most prominent of these; other constituents of concern include arsenic, boron, chromium, molybdenum, and salts.

Water Quality

The State of California, through the State Water Resources Control Board (State Board) and the nine Regional Water Quality Control Boards (Regional Boards), is responsible for protecting the quality of the State's water for beneficial uses. Regulation of deleterious waste discharges into both surface and ground water of the State is their responsibility. The Central Valley Regional Water Quality Control Board has adopted and the State Board has approved objectives for allowable concentrations of selenium, boron, and molybdenum at various sites on the San Joaquin River and tributaries (CVRWQCB, 1988a). [The U.S. Environ-

Figure 3
MAJOR PUBLIC WILDLIFE AREAS IN THE SAN JOAQUIN VALLEY



mental Protection Agency, however, has disapproved certain of the Board's objectives, and the matter is presently unresolved.] State water-quality objectives now and in the future will limit the discharge of agricultural drainage water to be assimilated by these streams. The Regional Boards issue permits for construction and operation of drainage-water evaporation ponds. Since events at Kesterson, the Regional Boards have become more concerned about the operation and eventual closure of these facilities.

Actions proposed by the Drainage Program are consistent with the State's present water-quality objectives. However, concern over the quality of the State's surface and ground water is expected to continue growing and introduction of agricultural drainage water into either body will likely be more strictly regulated in the future. In anticipation of these developments and in view of new scientific findings, assumptions based on more stringent objectives have been included in the alternative plans in Chapter 5 to show changes in required actions and associated costs.

Public Health

For the most part, contaminated agricultural drainage water is most likely to harm humans through indirect contact, such as consumption of contaminated fish or wildlife, plants, or livestock (Klasing and Pilch, 1988). Hazards intensify when contaminants are bioconcentrated by plants and animals or by evaporation, as in evaporation ponds. Direct dermal contact with drainage water contaminants studied to date is unlikely to pose significant health risks; however, inhalation of some particulate sediments (chromium, nickel, and silica, for example) has been shown to cause adverse health effects under some conditions.

Public health effects have been considered during this study, and plans were based on a criterion to minimize potential adverse public health risks from any drainage-water management strategy. Conclusions from studies of various potentially harmful constituents of drainage water as public health risks are presented in Chapter 3.

Chapter 3. WHAT THE STUDY HAS REVEALED OR CONFIRMED

When the San Joaquin Valley Drainage Program was initiated in late 1984, there were many questions and conflicting opinions about westside San Joaquin Valley drainage and drainage-related problems. Through Program-supported studies from 1985 to 1990, some questions have been answered, some myths discredited, and some controversy resolved; but other questions and issues remain. The drainage problem was a long time developing. It will likely be solved only through the diligence and cooperation of many individuals and organizations over a considerable period. Further study will undoubtedly be essential to these efforts.

A common base of knowledge is paramount to understanding the causes and for developing potential solutions to drainage problems. This chapter describes major advancements in knowledge of various aspects of the drainage problem.

GEOHYDROLOGY

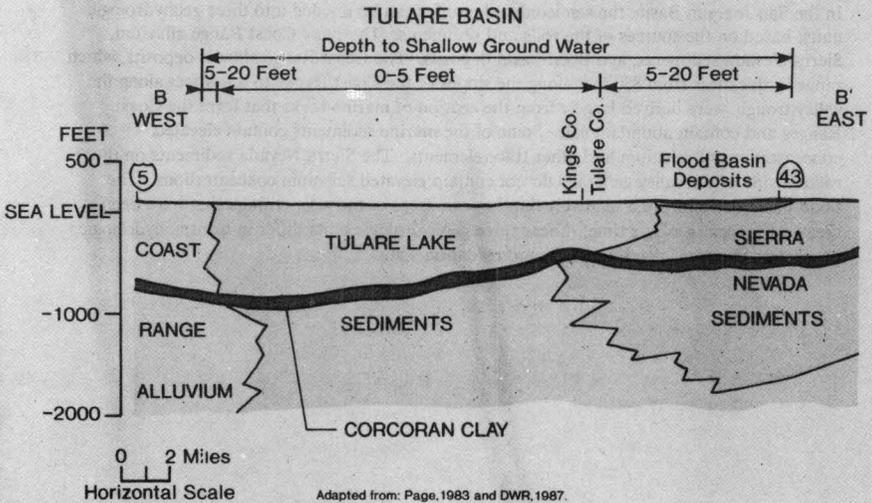
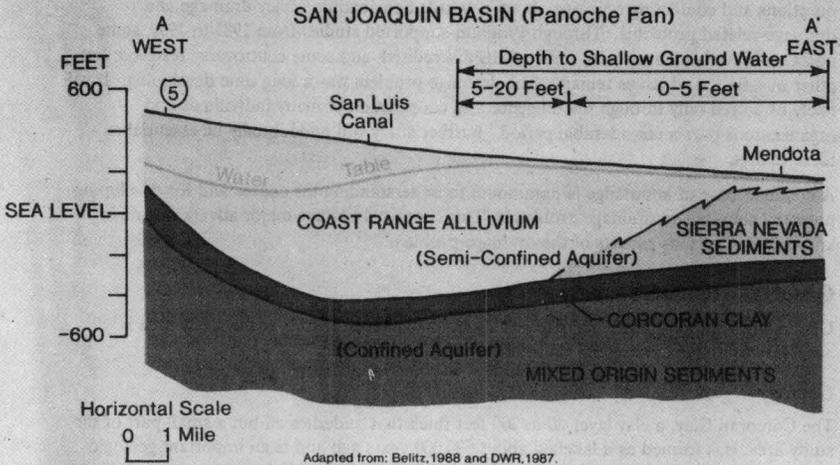
Understanding the geologic makeup and hydrologic characteristics of the study area is necessary to understanding the cause of the drainage problem.

Geology

The Corcoran Clay, a clay layer 20 to 200 feet thick that underlies all but a small part of the study area, was formed as a lakebed about 600,000 years ago and is an important geologic feature of the San Joaquin Valley (Figure 4). Lying as much as 850 feet deep along the Coast Ranges and 200 to 500 feet deep in the valley trough, the Corcoran Clay effectively divides the ground-water system into two major aquifers — a confined aquifer below it and a semiconfined aquifer above it (Page, 1986).

In the San Joaquin Basin, the semiconfined aquifer can be divided into three geohydrologic units, based on the sources of the soils and sediments. These are Coast Range alluvium, Sierra Nevada sediments, and flood-basin deposits. The Coast Range alluvial deposits, which range in thickness from 850 feet along the slopes of the Coast Range to a few feet along the valley trough, were derived largely from the erosion of marine rocks that form the Coast Ranges and contain abundant salt. Some of the marine sediments contain elevated concentrations of selenium and other trace elements. The Sierra Nevada sediments on the eastern side of the valley generally do not contain elevated selenium concentrations. The flood-basin deposits are a relatively thin layer in areas of the valley trough that have been created in recent geologic time. These three geohydrologic units differ in texture, hydrologic properties, chemical characteristics, and oxidation state.

Figure 4
**GENERALIZED GEOHYDROLOGICAL CROSS-SECTIONS
 IN THE SAN JOAQUIN AND TULARE BASINS**
 (Locations Shown in Figure 6)

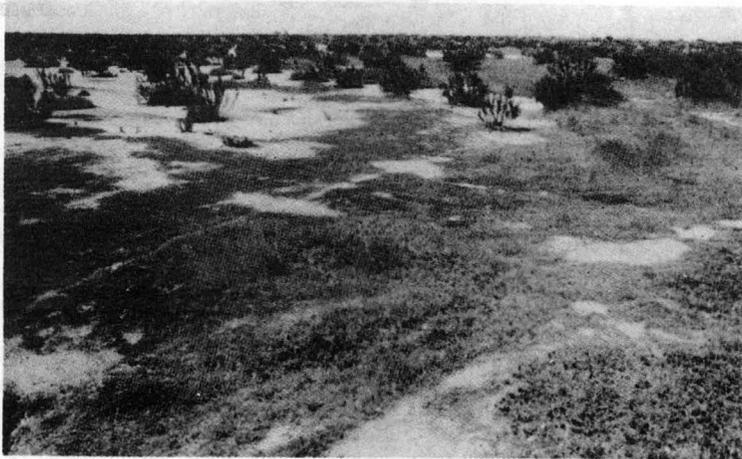


In the Tulare Basin, the semiconfined aquifer consists of the same three geohydrologic units found in the San Joaquin Basin, plus one additional unit, Tulare Lake sediments. The Tulare Basin is characterized by the presence of several dry lakebeds, including Tulare, Buena Vista, and Kern.

The marine sediments from which most soils in the study area are derived contain salts and potentially toxic trace elements, such as arsenic, boron, molybdenum, and selenium. When these soils are irrigated, the substances dissolve and leach into the shallow ground water (Gilliom, et al., 1989a). Selenium is largely a westside phenomenon. Soils derived from Coast Range sediments are generally far saltier than soils formed from Sierran sediments. In fact, selenium in livestock feed grown in some areas of the eastern side of the valley is so low that it must be added to the livestock diet. Figure 5 shows selenium in the top 12 inches of soil, as determined by a survey in the mid-1980s. Most soluble selenium has been leached from the soils over the past 30 to 40 years, and it now occurs in solution in the shallow ground water. It is drained from there when growers attempt to protect crop roots from salts and a high water table. Generally, growers need not be concerned about protecting crops from selenium.

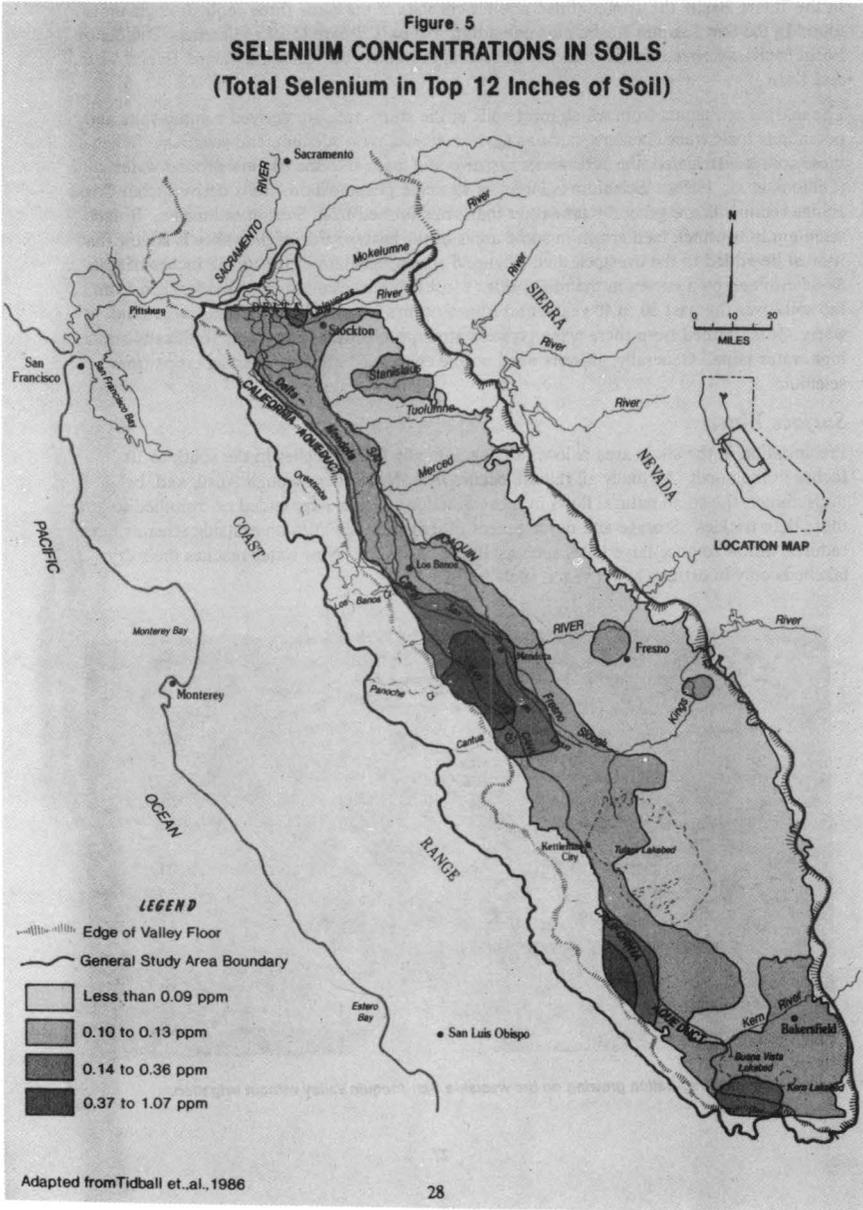
Surface Water

Precipitation in the study area is low, ranging annually from 5 inches in the south to 10 inches in the north. Virtually all rainfall occurs from November through April, and, by midsummer, the small natural flows in most westside streams have ended or dwindled to little more than trickles. Storage and development of irrigation facilities on eastside streams have reduced inflow to once-large lakes such as Tulare and Kern. Now water reaches their dry lakebeds only in extremely wet years, such as 1983.

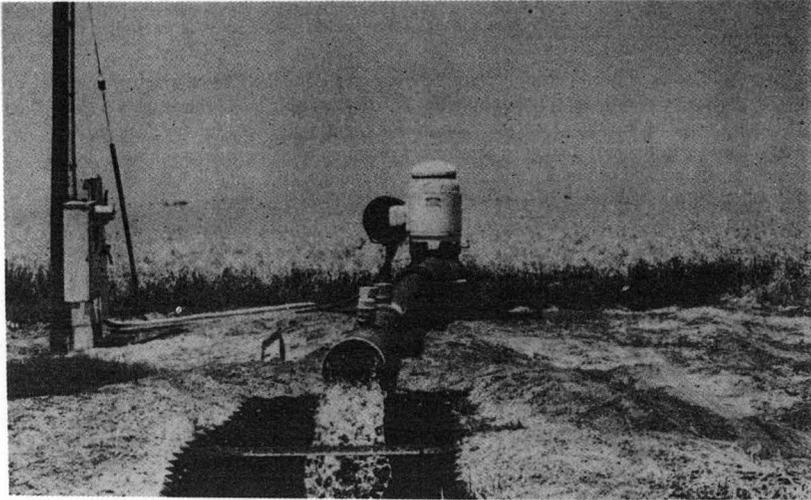


Natural vegetation growing on the westside San Joaquin Valley without irrigation.

Figure 5
SELENIUM CONCENTRATIONS IN SOILS
 (Total Selenium in Top 12 Inches of Soil)



The San Joaquin River and its major westside tributaries, Salt Slough and Mud Slough, are important to the study area because they convey drainage water away from the Northern and Grasslands subareas. San Joaquin River flows are controlled by dams on tributaries and on the main stem upstream from Fresno. Water stored in Millerton Reservoir is diverted through the Friant-Kern and Madera canals. Irrigation water historically diverted from the lower reaches of the San Joaquin River was replaced with Central Valley Project water provided through the Delta-Mendota Canal, beginning in 1951. Now, the San Joaquin River is essentially dry much of the year from below Gravelly Ford to the point at which irrigation return flow and local runoff replenish the river. Development on major eastside tributaries has also reduced the flow of the San Joaquin River. The combination of these actions causes problems in water quantity and quality, both for fish and for other downstream river users, especially in the South Delta area.



Irrigation water is still pumped from both above and below the Corcoran Clay, especially during drought periods when surface water supplies are short.

Ground Water

Pumping of ground water for irrigation from 1920 to 1950 drew ground-water levels down as much as 200 feet in large portions of the study area (Belitz, 1988). High pumping costs, land subsidence, and declining water quality created a need for new water supplies. By 1951, Federal Central Valley Project water was being pumped from the Delta and delivered to the Northern and Grasslands subareas through the Delta-Mendota Canal. By 1968, water was being delivered to the Westlands, Tulare, and Kern subareas through facilities of the CVP's San Luis Unit and the State Water Project.

With a reliable supply of surface water, ground-water pumping for irrigation lessened and the ground-water reservoir gradually began to refill. The semiconfined aquifer above the Corcoran Clay is now fully saturated in much of the westside area. Water tables continue to rise, and the waterlogged area is expanding. During the period 1977-1987, the 0-to-5-foot area expanded from 533,000 acres to 817,000 acres (W.C. Swain, 1990a). Figure 6 shows areas in which the water table was less than 5 feet deep, 5 to 10 feet deep, and 10 to 20 feet deep during part of 1987.

Irrigation-induced leaching of the soil and accumulation of salts from both the leaching and from imported water have concentrated dissolved salts in the upper portion of the semiconfined aquifer. Most of these salts are now located in a zone 20 to 150 feet below the ground surface (DuBrovsky and Neil, 1990). Ground-water quality is generally better above and below this zone. Figures 7 through 11 show concentrations of salinity, selenium, boron, molybdenum, and arsenic in shallow ground water (less than 20 feet below the land surface). This shallow ground water, and, in some places, water located even deeper, is the source of subsurface drainage water.

There are still zones in the semiconfined aquifer above the Corcoran Clay in which ground water is present in quality and quantity suitable for irrigation. Figure 12 shows the location of zones with salinity less than 1,250 parts per million (ppm) for several aquifer thicknesses saturated with water of that quality. The map was prepared by using a geographic information system and combining and evaluating water quality data and well construction information for the study area, as obtained from the U.S. Geological Survey, the U.S. Bureau of Reclamation, the Department of Water Resources, the Central Valley Regional Water Quality Control Board, and local water agencies. The procedures used were designed to produce a conservative estimate of the total depth of ground water that meets the specific water quality criterion of 1,250 parts per million total dissolved solids. Lenses of good quality water (less than 1,250 ppm TDS) overlying poor quality water (more than 1,250 ppm TDS) were not included in the total depth calculations. In some areas, notably in the southern Westlands Subarea, data from studies conducted in the 1960s were used in the absence of more recent data. Elsewhere, data from 1970 to 1989 predominated (Quinn, 1990).

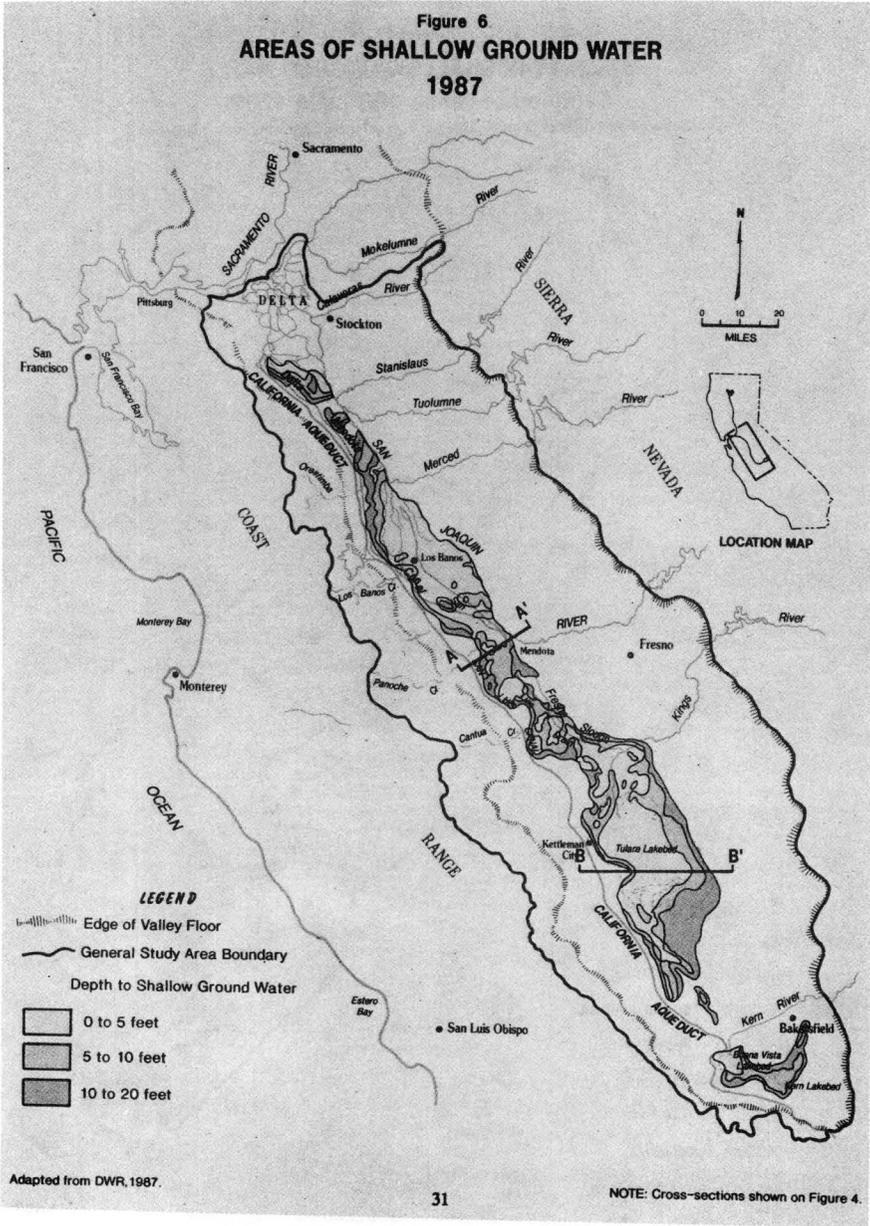
DRAINAGE-WATER CONSTITUENTS

Salinity

Drainage water contains dissolved mineral substances often referred to as "salts." These salts include sulfates, chlorides, carbonates, and bicarbonates of the elements sodium, calcium, magnesium, and potassium. The term "salinity" refers to the salt content of solutions containing dissolved mineral salts, which is commonly measured as either total dissolved solids (TDS) in parts per million (ppm) or electrical conductivity (EC) in microsiemens per centimeter ($\mu\text{S}/\text{cm}$). There are three sources of salts in the study area: (1) Water imported from the Sacramento-San Joaquin Delta; (2) soils; and (3) ground water. The imported water is of generally good quality; that is, its average salinity is less than 350 ppm. But because of the large volume of such water, about 1,600,000 tons¹ of salts are imported per year (D.G. Swain, 1990).

¹ Calculated by: Firm water supply imported annually (3,400,000 acre-feet) x salinity (350 ppm TDS) x conversion factor (0.00136) = 1,620,000 tons.

Figure 6
AREAS OF SHALLOW GROUND WATER
 1987



Adapted from DWR, 1987.

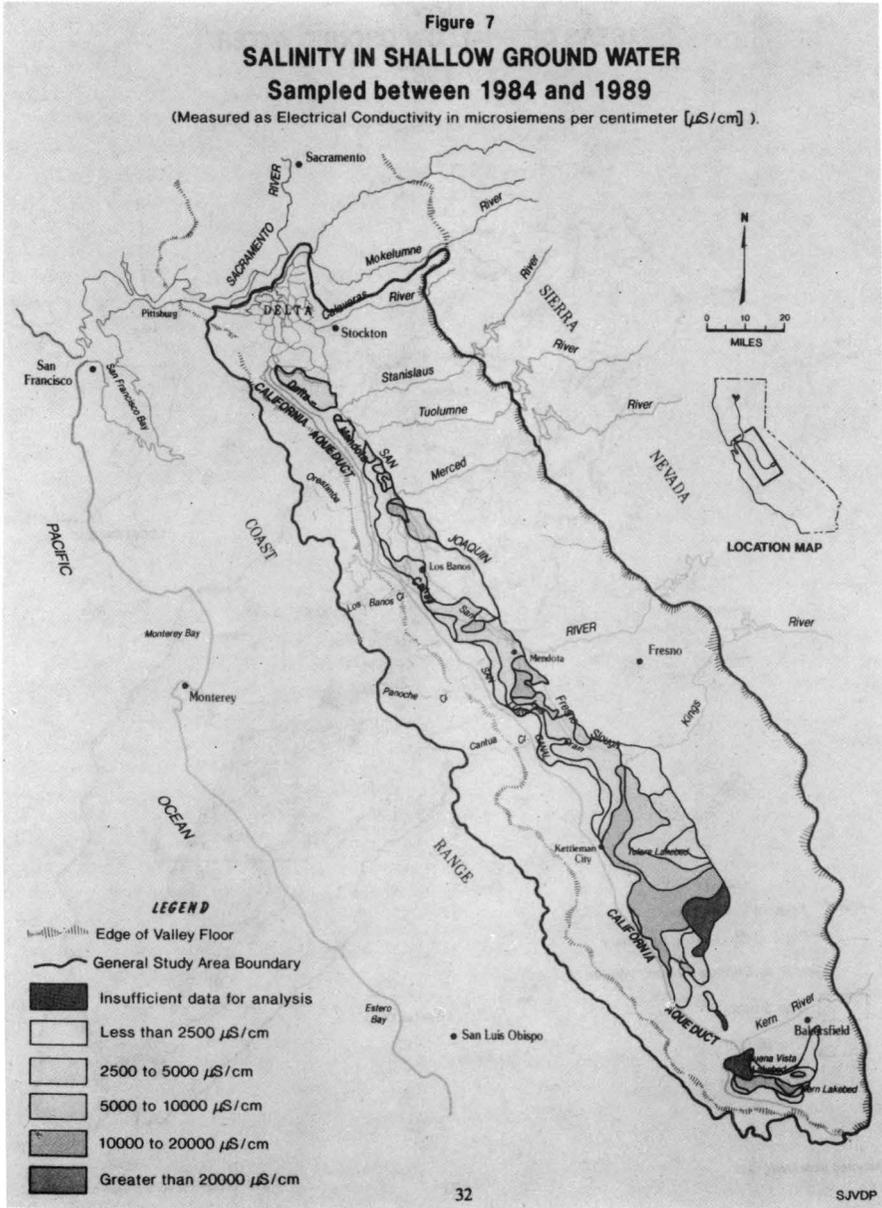


Figure 8
SELENIUM CONCENTRATIONS IN SHALLOW GROUND WATER
Sampled between 1984 and 1989

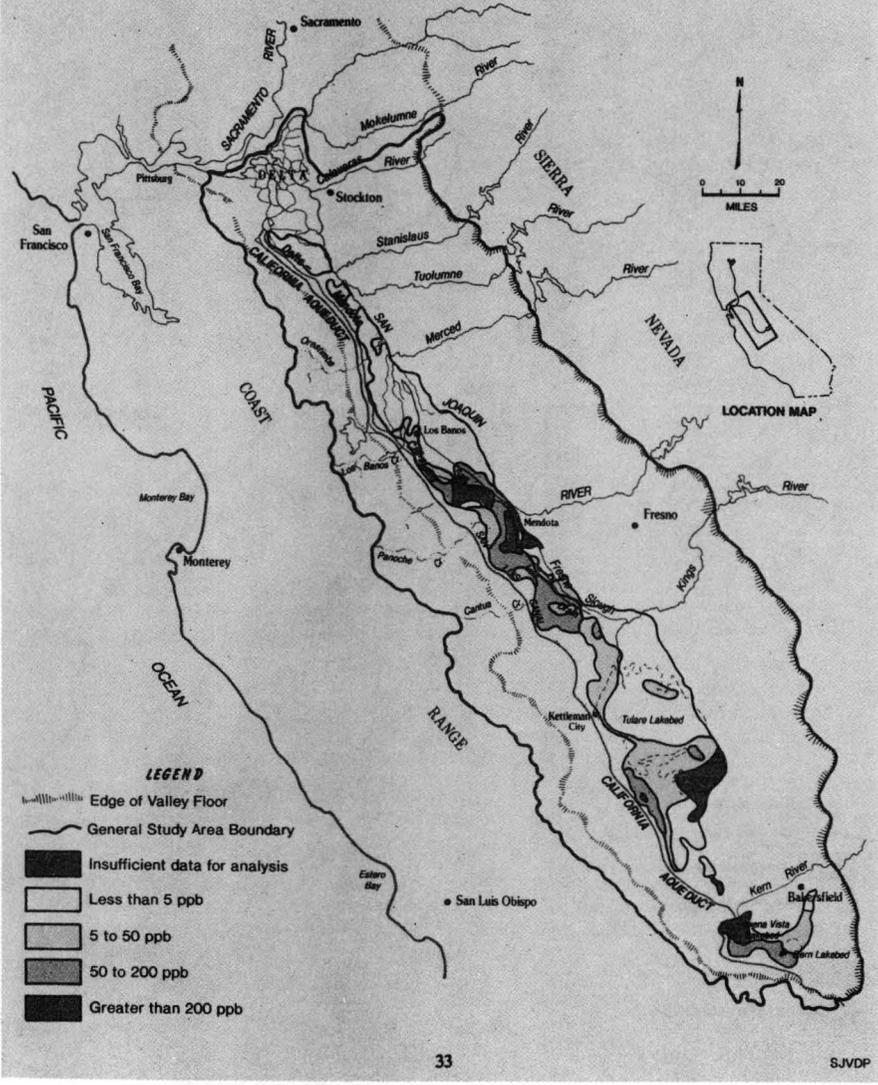


Figure 9
BORON CONCENTRATIONS IN SHALLOW GROUND WATER
Sampled between 1984 and 1989

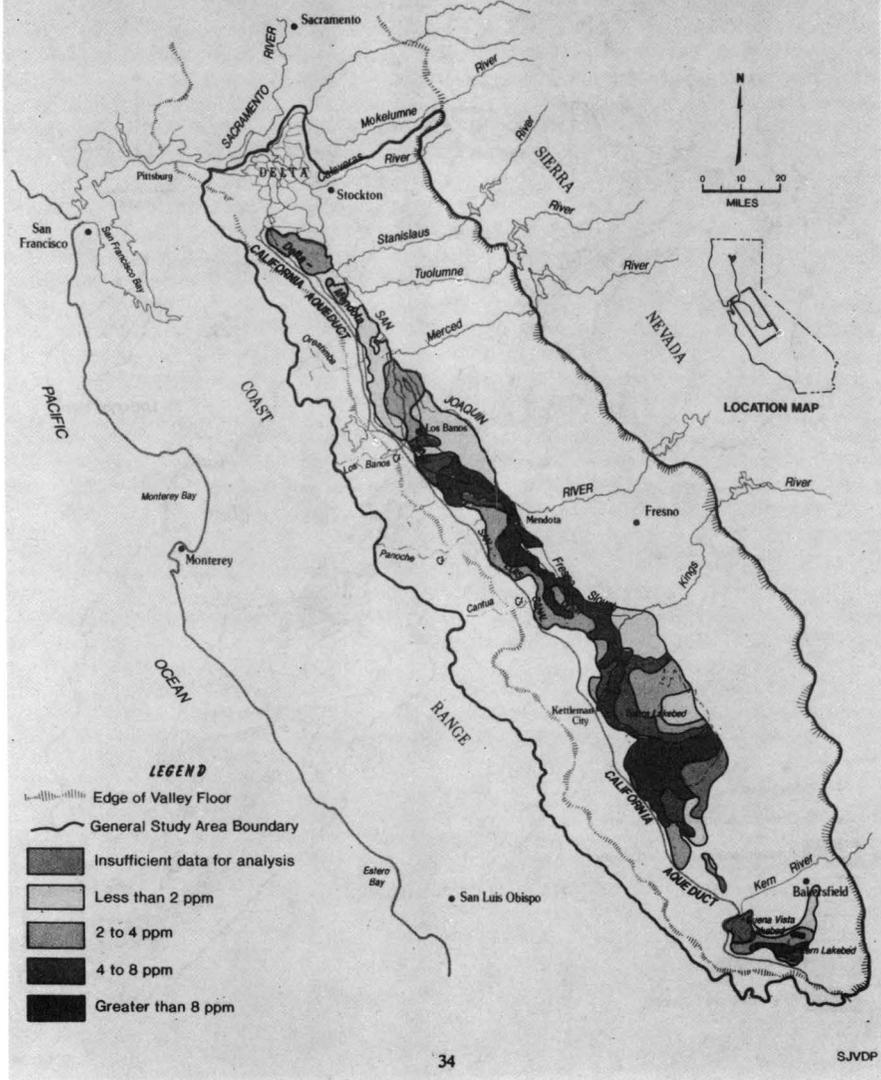


Figure 10
MOLYBDENUM CONCENTRATIONS IN SHALLOW GROUND WATER
Sampled between 1984 and 1989

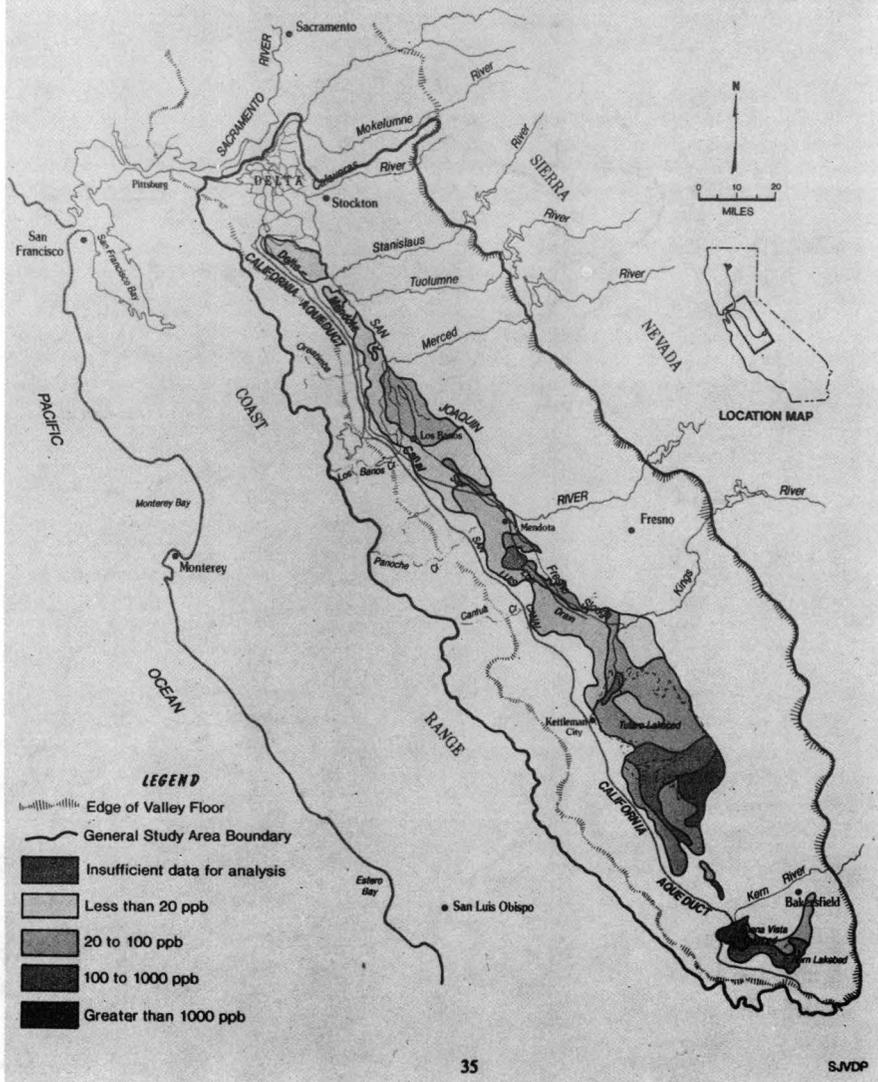
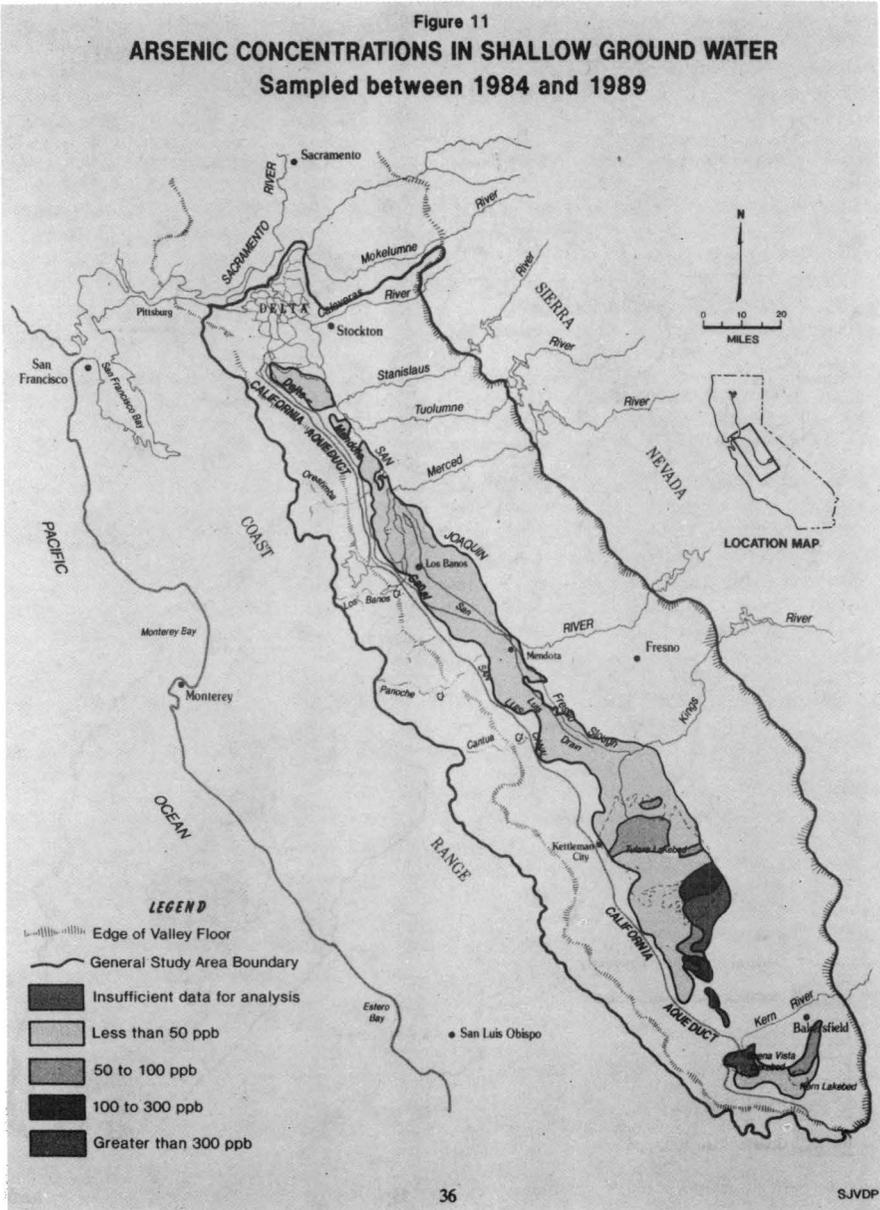
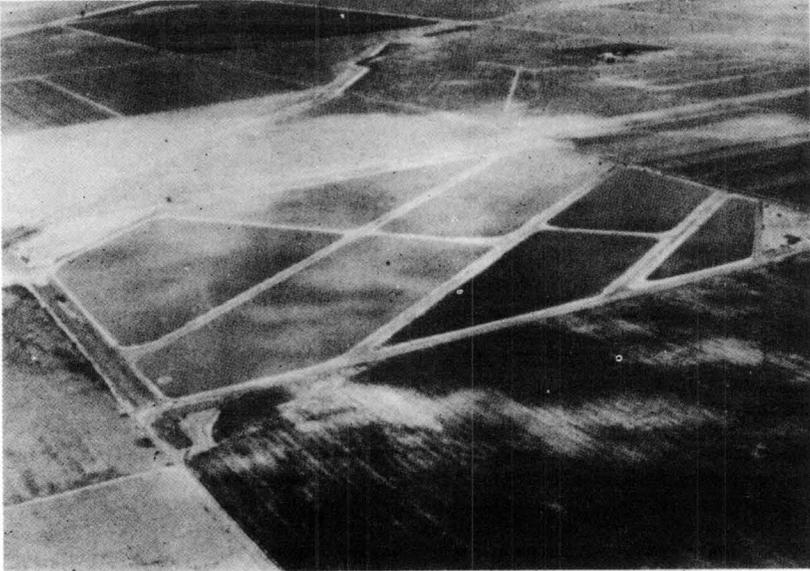


Figure 11
ARSENIC CONCENTRATIONS IN SHALLOW GROUND WATER
 Sampled between 1984 and 1989



A buildup of salts in the soil can adversely affect agricultural productivity. The arid soils on the westside San Joaquin Valley contain substantial amounts of naturally acquired soluble salts that can leach into the ground water below the root zone. These salts contribute heavily to the salinity of the soil solution and, subsequently, to the drainage water, if a field is drained. About half the soluble salts in the crop root zone are derived from the soil (CH₂M Hill, 1988). Evapotranspiration increases the concentration of salts in the soil, and use of irrigation return flows also further concentrates them.



Ponds used to evaporate subsurface drainage water often cover several hundred acres, are generally divided into cells, and can evaporate about 4 feet of water per acre each year.

The chemical forms of total dissolved solids (salts) found in subsurface agricultural drainage vary from region to region in the San Joaquin Valley. The composition of drainage water is largely dominated by sodium and sulfate, although chloride is dominant in some places. A U.S. Geological Survey study (Deverel, et al., 1984) described concentration ranges for these major substances in drainage water from the Coast Range alluvium, the basin trough, and the transitional basin rim. Salts are highest in the basin rim zone. Median concentration of sulfate ranged from 310 to 3,450 ppm, with a maximum of 65,000 ppm. Chloride varied from a median of 220 to 455 ppm, with a maximum of 16,000 ppm. Sodium ranged from a median concentration of 230 to 1,100 ppm in the three zones, with a maximum concentration of 30,000 ppm. Other major substances are calcium, magnesium, potassium, and bicarbonate plus carbonate. Electrical conductivity (EC) ranges from a median of 1,900 to 6,055 $\mu\text{S}/\text{cm}$ in

the three zones, while the maximum observed value was 68,000 $\mu\text{S}/\text{cm}$. By comparison, the electrical conductivity of seawater is about 50,000 $\mu\text{S}/\text{cm}$.

High concentrations of nitrate with values greater than 70 ppm have also been observed in some areas. Nitrates are considered to have a dissolved salt source, although certain pollutant-type sources such as fertilizers and feedlots have also been documented. A potential public health hazard may exist if nitrates in public water supplies exceed 45 ppm. Nitrates and sulfates in drainage water also have been shown to hinder selenium removal in certain treatment processes (Hanna, et al., 1990).

Extensive sampling and analyses by Federal and State scientists during the period 1984-1989 have shown that pesticides are rarely detected in westside subsurface drainage water. However, pesticides have been observed in field irrigation runoff (tailwater), and commingling of tailwater and subsurface water does occur in parts of the valley (Gilliom and Clifton, 1987).

Evaporation ponds are one of the most common means to dispose of subsurface drainage water in the southern San Joaquin Valley. High salinity in the ponds, entering either from outside sources or developing from evaporation, produces concentrations of salts that may cause environmental problems. The dominant minerals (salts) in the evaporation ponds are typically sodium sulfate and sodium chloride, mainly due to the composition of geologic formations contributing to subsurface drainage systems. Inflow TDS concentrations were observed to range from 2,500 to 65,000 ppm in one study (CVRWQCB, 1988c). Concentrations in the ponds affected by evaporation have been measured as high as 388,000 ppm. (Seawater is about 31,000 ppm TDS.) During the evaporation-driven process of concentration, numerous physical, chemical, and biological processes affect the reactivity, solubility, and availability of trace element constituents in these high-salinity evaporation ponds (K.K. Tanji, in press).

Trace Elements

Toxic and potentially toxic trace elements occur naturally in some soils on the western side of the San Joaquin Valley, and they are leached into the shallow ground water during irrigation. These elements, originally found in the geologic formations of the Coast Ranges, can be mobilized, transported, and concentrated in irrigation drainage water. Another minor source of trace elements is imported irrigation water.

Over the past several years, many studies have evaluated the chemical composition of agricultural drainage water. These studies, conducted by government agencies and other researchers, have produced evidence of the existence of a large group of trace elements or chemical substances that may be found at elevated concentrations at some time or place in irrigation drainage water. This group of elements or chemical constituents, called "substances of concern," comprises 29 substances (Table 4). Basically, these substances are of concern in the environment because of their actual or possible adverse effects on water quality, public health, agricultural productivity, and/or fish and wildlife.

Table 4. SUBSTANCES OF CONCERN

Of Primary Concern	Of Probable Concern <i>Subject to future California water-quality objectives</i>	Of Possible Concern <i>Elevated concentrations at some sites</i>	Of Possible Concern <i>Little information available</i>	Of Limited Concern <i>Known toxic elements in low concentrations</i>	Probably Not of Concern at Present
Selenium Boron Molybdenum Arsenic Salts	Cadmium Chromium Copper Manganese Nickel Zinc	Uranium Vanadium Nitrates	Tellurium Antimony Lithium Germanium Bismuth Strontium Fluoride Beryllium	Lead Silver Mercury	Magnesium Iron Barium Aluminum

Criteria used by the Drainage Program as evidence of primary concern include these factors:

(1) The substance has been cited in State/Federal water-quality regulations (there are water-quality criteria affecting its concentration, use, and distribution); (2) it is known to cause toxicity and create other problems for fish and wildlife; and (3) it can become hazardous to other wildlife and to humans by accumulating in the food chain or by direct exposure to contaminated soils, sediments, air, or ground water and surface water.

The trace elements of primary concern are selenium, boron, molybdenum, and arsenic, all of which occur naturally in westside soils. Arsenic is of concern primarily in the Tulare and Kern Subareas, where it has been observed in elevated concentrations in shallow ground water. In other locations, such as parts of Westlands Water District, concentrations of hexavalent chromium in shallow ground water have been observed above usual background levels. The State Water Resources Control Board and the Drainage Program have also identified salts as substances of primary concern.

In addition, other elements for which the State Board eventually may establish site-specific water-quality criteria are cadmium, copper, manganese, nickel, and zinc (SWRCB, 1987). Samples from some evaporation ponds have shown high concentrations of uranium. Elevated concentrations of vanadium have also been found in some evaporation ponds. Other substances have also been measured in ongoing monitoring programs. These include nitrates, tellurium, mercury, antimony, germanium, bismuth, strontium, fluoride, beryllium, lead, magnesium, iron, aluminum, lithium, silver, and barium. In some instances, there is not enough information on the effects of these elements to establish them as substances of primary concern, and in others, the concentrations are not high enough to establish a definite level of concern.

Selenium leads the four elements of primary concern, primarily because it is widely distributed in the study area and because of its proven and potential toxicity. Water and mudflows have transported the selenium to the valley in particulate and dissolved forms derived from the weathering and erosion of source rocks. Decades of irrigation have

transferred soluble selenium from the upper soils to the shallow ground water, where its highest concentrations occur generally along the edge of the valley trough in the lower parts of the Coast Range alluvial fans.

Selenium concentrations in shallow ground water show a wide range of values. In the U.S. Geological Survey's study of three physiographic zones (Coast Range alluvium, the basin rim, and the basin trough) on the western side of the valley (Deverel, et al., 1984), values ranged from less than 1.0 part per billion (ppb) to 3,800 ppb, with a median concentration for all zones of 6.0 ppb. Water entering Kesterson Reservoir in the spring of 1984 had an average of 385 ppb. To protect freshwater aquatic life, the Environmental Protection Agency recently established ambient water-quality criteria for selenium — 5.0 ppb for chronic toxicity and 20 ppb for acute toxicity (USEPA, 1987). Saltwater limits are higher. The State Board has established a monthly mean objective for selenium of 5.0 ppb for a specific area of the San Joaquin River.

Evaporation ponds can accumulate and concentrate trace elements that may be hazardous to wildlife, especially waterfowl and shore birds that use the ponds. A study of 22 ponds by the Central Valley Regional Water Quality Control Board indicates that trace-element concentrations vary widely (CVRWQCB, 1988c). Each of the four primary substances of concern (selenium, boron, molybdenum, and arsenic) occurs in high concentrations in one or more of the ponds. Selenium, for example, in these 22 ponds ranges from less than 1.0 ppb to 1,900 ppb, with a median value of 17 ppb.

Elevated concentrations of boron (greater than 2.0 ppm) are found in parts of all the subareas under study, except the Northern Subarea. Although boron is essential to the nutrition of certain plants, concentrations in excess of 0.5 ppm are known to be harmful to some crops. For this reason, it is regarded primarily as an agricultural crop problem. The State Board established water-quality objectives for boron in the San Joaquin River that ranged from 0.8 to 1.3 ppm, depending on the time of year or whether it is a critically dry water year. The Regional Board's studies show that boron in evaporation ponds ranges from 2.5 to 840 ppm, with a median concentration of 20 ppm.

Molybdenum has been found in elevated concentrations (greater than 20 ppb) in various areas of the San Joaquin Valley, particularly in the Tulare and Kern subareas. Molybdenum in very low concentrations is essential to many plants and some mammal species. In high concentrations, it can be injurious to the growth of many kinds of plants. It can be toxic to livestock through bioaccumulation, particularly in ruminant animals (cattle and sheep). A technical committee of SWRCB recommended a 10-ppb criterion in water to protect agricultural uses. The EPA has not set any water-quality criteria for molybdenum. Molybdenum is an abundant element in evaporation ponds, ranging in concentration from 7.0 to 7,775 ppb at the inlets to the ponds and 58 to 40,000 ppb in the ponds. Few studies have been performed to assess the potential consequences of elevated dietary molybdenum in humans.

Arsenic is a known toxicant that has been shown to become concentrated at relatively high levels in evaporation ponds in the Tulare Basin. Arsenic values in evaporation ponds range from 2.0 to 900 ppb in the inlets to the ponds and 1.0 to 13,000 ppb in the ponds. Occurrences in other parts of the San Joaquin Valley are not as frequent, nor are the levels as

high, on the average. Certain chemical forms of inorganic arsenic are suspected human carcinogens. The EPA has set 50 ppb as the current maximum contaminant level for arsenic compounds in drinking water and established 190 ppb as the water-quality criterion for freshwater aquatic life.

Uranium was not one of the elements of concern studied in earlier evaluations of drainage-water constituents. However, the presence of elevated concentrations of uranium in Tulare Basin evaporation ponds has been documented (CVRWQCB, 1988b). These ranged from 30 to 11,000 ppb in studies conducted in 1987-88. The mean concentration for all pond samples was 675 ppb, while the mean concentration in the inflow samples of the three basins studied was 280 ppb. Over 60 percent of the evaporation pond area exceeded a Canadian marine water-quality objective of 500 ppb uranium. At the present time, there is no information regarding the role uranium may play in the toxicity problems of the evaporation ponds. In 1988-89, the USGS studied the occurrence of uranium in shallow ground water in parts of the Tulare Subarea. Results have not yet been published.

The toxicity of drainage-water constituents is influenced by their chemical interaction with other substances. The understanding of these interactions is limited. In addition to the independent effects of trace elements, antagonistic or synergistic interactions may occur among various constituents.

The list of substances that may be of concern in drainage water is not final at this time. Certain other substances not now listed have occasionally been detected in drainage-water samples or in water influenced by subsurface drainage. Future studies and continued monitoring may produce data that will indicate whether certain chemicals not presently thought to be important will have to be more thoroughly appraised.

DRAINAGE-WATER TREATMENT AND REUSE

At the beginning of the Drainage Program, major effort was focused on treatment of drainage water to make it environmentally acceptable and/or reusable. Selenium became the principal concern in those efforts because of confirmed associations between adverse effects on wildlife and the presence of selenium in drainage water. Unlike other substances of primary concern, no practical treatment method for selenium removal was known to exist.

Treatment Processes

Problems at Kesterson Reservoir generated about 150 ideas and suggestions that were submitted to the Drainage Program. Many were oriented toward drainage water treatment and many were research proposals. The staff initially screened all the ideas and submitted about 30 of them to the Program's Treatment and Disposal Subcommittee for evaluation and final screening. The subcommittee further narrowed the choices, but because of funding limitations, only the most promising methods were pursued.

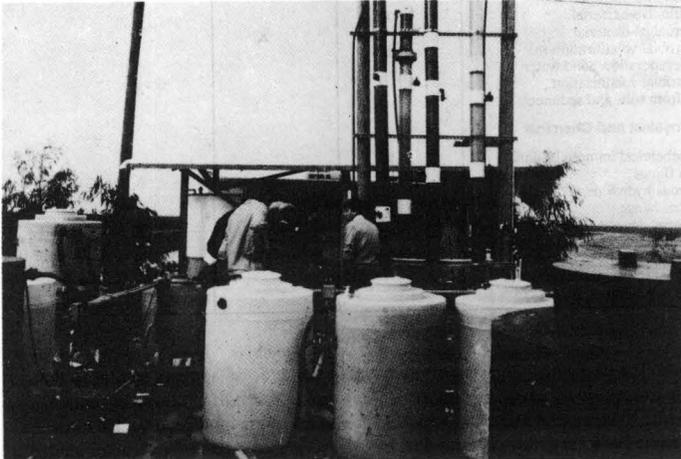
The Drainage Program investigated the 11 processes listed in Table 5 but did not fund all the developmental research. Others (for example, Westlands Water District, Panoche Drainage District, and the California Department of Water Resources) also funded research on treatment processes. Chapter 3 of the Drainage Program's *Preliminary Planning Alternatives*

summarized the various treatment processes investigated. Technical reports on the various treatment processes have been prepared and a review and evaluation of each treatment process has been completed (Hanna, et al., 1990).

Anaerobic-Bacterial Process

This process was tested by EPOC AG in a small-scale pilot plant, using a biological reactor (including upflow fixed-film beds, fluidized beds, and sludge blanket reactors) and microfiltration. EPOC AG concluded in 1987 that the biological process is a practical and proven method for treatment of selenium-laden drainage.

The optimum treatment train was sludge blanket to fluidized bed to microfiltration. The process lowered selenium levels in the feedwater from 300 to 500 ppb down to 12 to 40 ppb, and thence to below 5.0 ppb with ion exchange "polishing." However, interpretation of the data generated by the EPOC AG pilot plant is complicated by the ever-changing nature of the plant's operation. It operated under field conditions, with wide changes in drainage water quality and diurnal and seasonal temperature variation, as well as in other significant parameters.



The anaerobic-bacterial process of removing selenium from drainage water was tested in this small plant near Mendota in 1986 and 1987.

Laboratory-scale research at the University of California, Davis, was conducted as followup to the work by EPOC AG, mainly to determine the mechanisms of selenium removal in the anaerobic-bacterial process (Schroeder, et al., 1989). It was determined from studies using sequencing batch reactors and fluidized bed reactors that selenate reduction occurred simultaneously with nitrate reduction. It was theorized that selenate reduction was primarily a detoxification mechanism, rather than a respiratory process. In respiration, nitrate would

be used before selenate. The researchers postulated that the bacteria are detoxifying their environment of high concentrations of selenate, while simultaneously respiring on nitrate.

Facultative-Bacterial Process

This process was studied in the laboratory at the U.S. Bureau of Mines Research Center in Salt Lake City, Utah (Altringer, et al., 1987). Selenium was reduced from selenate to selenite, using facultative bacteria that can live with or without oxygen, and precipitated from solution in elemental form. This study also demonstrated that the mechanism of selenium removal is influenced by nutrient addition, oxygen supply, and temperature. Aerobic conditions encouraged bacterial growth, but selenate reduction was enhanced when the air supply was restricted.

Table 5. STATUS OF DRAINAGE-WATER TREATMENT PROCESSES TO REMOVE OR IMMOBILIZE SELENIUM

Process	Research	Development	Testing and Evaluation
Biological			
Anaerobic-bacterial			X
Facultative-bacterial	X		
Microalgal-bacterial		X	
Microbial volatilization in evaporation pond water	X		
Microbial volatilization from soils and sediments			X
Physical and Chemical			
Geochemical immobilization	X		
Iron filings			X
Ferrous hydroxide		X	
Ion exchange	X		
Reverse osmosis to remove salts and other contaminants			X
Generate electrical energy and heat for desalination with a cogeneration process			X

In many respects, the mechanism of selenium removal in this process appears similar to that occurring in the anaerobic-bacterial and microalgal-bacterial processes. It involves reducing selenate to selenite to elemental selenium, which accumulates in the biological sludge of the reactors. The same bacteria genus contained in EPOC AG's anoxic fixed-film reactor sludge was shown in this study to reduce selenate first and adapt well under high selenium concentrations. The study also demonstrated that optimal selenate reduction by facultative bacteria occurs under anoxic conditions.

Microalgal-Bacterial Process

This process was investigated by the University of California at Berkeley (Oswald, et al., 1990). The process is based on the principle that soluble selenate can be reduced by microorganisms to less-soluble selenite and elemental selenium in an anoxic sludge blanket reactor. While elemental selenium settles and accumulates in the reactor sludge, selenite suspended in the reactor effluent can be precipitated with ferric chloride and removed by a dissolved air flotation system.

The carbon source for the biological reactor is algae cultivated in high-rate algal ponds fed by drainage water. If drainage nitrate levels are above that which can be assimilated by pond algae, a denitrification reactor is added upstream from the selenate-reducing reactor.

The researchers believe that excess algae can be fermented to produce methane for power generation, carbon dioxide can be recycled for pH control in the algae ponds, and the digested sludge can be diverted to the biological reactors to supplement the algal feed. Although the field tests did not reach steady-state conditions, the process showed promise of greater than 95-percent removal of selenium.

Microbial Volatilization of Selenium in Evaporation Pond Water

This process was studied primarily as an in-situ means to maintain selenium levels in evaporation ponds below the hazardous waste criterion of 1.0 ppm. It was not intended to meet the more stringent criteria for wildlife protection.

Investigators in 1990 reported that compounds high in protein, such as casein, dramatically accelerate biological removal of selenium, but substantial amounts of the compounds are apparently required, probably creating eutrophic ponds (Frankenburger and Thompson-Eagle, 1989). Bacteria were identified as the predominant active selenium methylators in pond water. The researchers conclude that further studies are needed to determine whether protein-mediated methylation can be optimized through the addition of coenzymes, methyl donors, and aeration, as well as through the addition of specific microbial inoculants. They further conclude that it may be possible to design a pilot bioreactor to test selenium removal. This technique lags in developmental efforts.

Microbial Volatilization of Selenium from Soils and Sediments

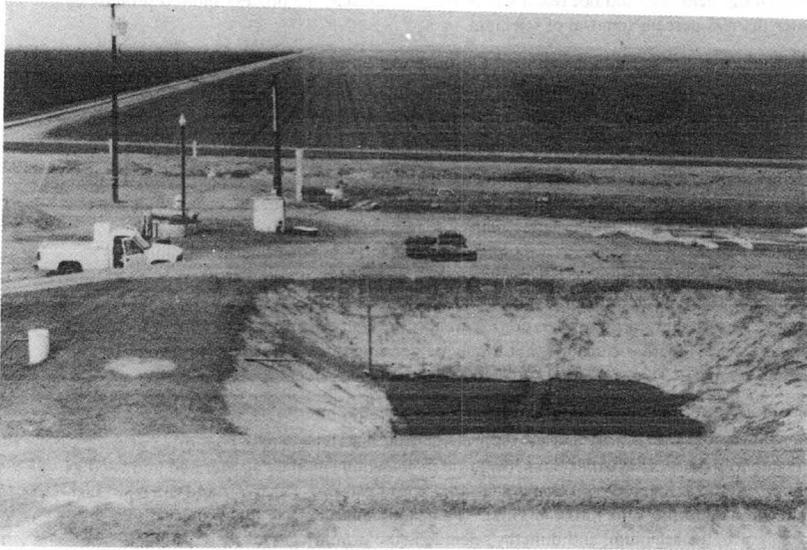
This process is being investigated by researchers from the University of California at Riverside to determine whether biomethylation of selenium could be accelerated and used as a bioremediation technique to remove selenium from Kesterson Reservoir and the San Luis Drain (Frankenburger and Karlson, 1989). Indigenous soil fungi are the primary organisms that volatilize the selenium, and dimethylselenide is the primary gaseous end product. The process was field-tested, following treatment methods in which different additives were used. This work was done at Kesterson Reservoir, on San Luis Drain sediments, and at a Peck Ranch evaporation pond. All treatments included moisture application and rototilling.

At Kesterson Pond 4, where selenium concentration in the upper 6 inches of soil averaged about 39 milligrams per kilogram, treatment using citrus peel + ammonium nitrate + zinc sulfate and treatment using casein were most effective. The average emission rate with the citrus peel treatment was about 40 times greater than it was for background level. It was

estimated that the treatment would require about seven years to achieve the cleanup goal of 4 mg/kg from the initial concentration of 39 mg/kg. The selenium volatilization rate is highly temperature-dependent, with the highest rates occurring in the late spring and summer months.

Geochemical Immobilization

A physical/chemical attenuation process to transform and immobilize selenium in place was investigated by UC Riverside researchers (Neal and Sposito, 1988). The study was conducted to identify the pertinent variables in an irrigated soils system designed to implement management techniques that would control the eventual fate of selenium by immobilizing it in the soil profile. The researchers concluded that the chemical form in which selenium exists in the aqueous phase governs the applicability of this process. If, as in the soils of the western San Joaquin Valley, selenate predominates, farm level management practices to achieve physical/chemical attenuation would have little success in immobilizing selenium.



Panoche Water District is testing the removal of selenium by passing drainage water through a bed of iron filings in the bottom of this basin.

Iron Filings

In 1985, Harza Engineering Company tested its patented heavy metals adsorption process for removing selenium from drainage water at Panoche Drainage District. In this process, heavy and toxic metals are adsorbed onto iron filings and removed from solution as drainage water flows through a bed of "activated" iron filings. Before the beds are exhausted, the iron filings are replaced, activated, and returned online. The spent material can be disposed of at landfills or recycled to the metal-working industry.

A problem arose in initial field testing. The filings solidified and clogged the bed. A study was conducted at the University of Wisconsin, Madison, to determine the mechanism by which selenium is removed and the selenium species formed to effect removal (Harza, 1989). It was concluded that selenium is removed by chemical adsorption on iron oxyhydroxide surfaces at an orange-brown layer of iron filings, where drainage water enters the column. Before the oxyhydroxide layer forms, selenium can be removed throughout the iron-filing bed by physical adsorption. There is still uncertainty regarding the exact mechanism whereby selenium is removed in the Harza process.

The study did not conclusively define the cause of the bed-clogging problem. The formation of magnetite (Fe_3O_4), a ferromagnetic solid that restricts flow, was suggested as a possible cause. Other possibilities, such as calcite precipitation, were also suggested, but bed-hardening also occurred in columns with selenate-spiked distilled water.

Pilot tests are presently being conducted in treatment ponds at Panoche Drainage District. Information from these tests should help to better evaluate the effectiveness and cost of this process.

Ferrous Hydroxide

Studies of this process were conducted by staff of the U.S. Bureau of Reclamation's Denver Office (Rowley, et al., 1990). The process is based on a reaction in which ferrous hydroxide reduces selenate to elemental selenium. The reaction rate depends on pH, for which the optimum range is 8 to 10. Temperature affects the rate of selenate removal by about doubling the rate for each 10°C increase. Most of the tests were conducted at 20°C , the approximate average temperature of drainage water.

The reaction time for selenate removal is inversely proportional to the ferrous hydroxide concentration, which was commonly used in the range of 2.5 to 20 millimoles per liter. The reaction times were very short (99-percent selenate removal in less than one minute) when deionized water was used for testing, but substantially longer times were required when drainage water was used. Field tests near Mendota resulted in 90-percent selenate removal after four hours.

It was concluded that high concentrations of bicarbonate would decrease the reaction rate by half, while high concentrations of nitrate would reduce the reaction rate by a factor of 5. If high concentrations of both ions were present, the initial rate of reaction would be reduced by a factor of 17. Although oxygen does not appear to affect the rate of selenate removal, it oxidizes about 1.6 millimoles per liter of ferrous hydroxide if the water is saturated at 20°C .

Ion Exchange

Use of selenium-selected resins to remove selenium was investigated in laboratory tests on drainage-water samples (Boyle, 1988). Two strong anion-base resins, both similar to commercial resins, showed selectivity for the selenate ion over the sulfate ion. The investigators concluded that this indicated ion exchange is a promising method. However, studies have not been conducted to demonstrate field-scale reliability and costs.

Reverse Osmosis to Remove Salts and Contaminants

This is a versatile, proven treatment process capable of removing salts, as well as trace-element contaminants, but it is also much more costly than the other treatment processes. The California Department of Water Resources operated a drainage-water desalting demonstration plant at Los Banos from the fall of 1983 to August 1986. DWR concluded that additional work is required on the pretreatment system to establish the feasibility of a drainage water desalting facility. DWR has issued a report on the pretreatment systems tested (DWR, 1986), and reports on other components of the project (ion exchange and reverse osmosis) are being completed.

Cogeneration

This process uses waste heat from the thermal generation of energy to evaporate drainage water. However, from review of a cogeneration study completed in 1989 (RMI, 1989), the Drainage Program concluded that cogeneration using natural gas fuel is not promising for evaporation of unconcentrated drainage water because of the high cost and the relatively small amount of drainage water treated (about 7,500 acre-feet annually in conjunction with a 100-megawatt powerplant).

Westlands Water District, with Drainage Program participation, conducted a preliminary study of burning salt-tolerant agroforest biomass to evaporate drainage water concentrated by agroforestry crops (RMI, 1990). RMI concluded that wood fuel cannot be economically substituted for natural gas to fuel a cogeneration component of a drainage water evaporation plant.

Future of Treatment Processes

The implementation of any drainage water treatment process is burdened largely by three major items: (1) The need to keep costs low and affordable for agricultural application, (2) the stringent performance criteria imposed by the need to reduce selenium to extremely low concentrations (less than 5 ppb) in receiving water, and (3) the early developmental status of technology for selenium removal from drainage water. Because selenium-removal technology, unlike reverse-osmosis desalting, has not progressed to large-scale application, it is premature to recommend a specific treatment process at this time. However, selenium removal research indicates that treatment may be a viable drainage management strategy under certain conditions and, therefore, further treatment research is justified.

Because the Drainage Program wanted to encourage the search for an economical way to remove selenium from drainage water, its Interagency Technical Advisory Committee's Treatment and Disposal Subcommittee was asked for advice on which process to pursue. The subcommittee recommended support of a 30,000-gallon-per-day demonstration plant using the anaerobic-bacterial process field-tested by EPOC AG. The Department of Water

Resources intends to fund the demonstration plant in 1990, with support from the U.S. Bureau of Reclamation.

In the EPOC AG field-pilot tests, selenium in drainage water at a concentration of 300 to 550 ppb was lowered to about 10 to 40 ppb after microfiltration and to less than 10 ppb after polishing in boron selective ion-exchange resins. EPOC AG has reported estimated treatment costs for a 1-million-gallon-per-day prototype plant of about \$76 per acre-foot to construct (capital at 4 percent, with 20-year plant life) and \$148 per acre-foot to operate. Total product cost would be about \$224 per acre-foot. It was also estimated that, for a 10-mgd plant, the total unit treatment cost would decline to about \$145 to \$175 per acre-foot, depending on the availability and cost of a carbon source. These estimates did not include waste-stream disposal costs.

A study sponsored by the Drainage Program reviewed and evaluated each treatment process investigated, and, when cost estimates were available, adjusted them on a common basis (Hanna, et al., 1990). Revisions of EPOC AG's cost estimates were based on increases in the interest rate from 4 percent to 9 percent, electricity rates from \$0.045 to \$0.08 per kilowatt-hour, labor costs from \$28,470 to \$40,000 per person per year, and capital costs by 35 percent. Added to these were replacement costs and 27 percent for overhead and profit. Those changes raised the estimated total product cost from \$224 to \$456 per acre-foot for a 1-mgd plant and from \$175 to \$301 for a 10-mgd plant. Neither estimate includes costs of polishing to lower selenium levels to less than 10 ppb, or of waste-stream disposal.

Reuse

If drainage water could be economically reused, it would be a resource, not a waste disposal problem. The Drainage Program funded investigations of the reuse of drainage water for irrigation of salt-tolerant trees and halophytes. It also reviewed the results of reuse investigations conducted by others. These mainly concerned the use of drainage water in powerplant cooling, temperature-gradient solar ponds, aquaculture, salt and mineral recovery and marketing, and agriculture.

There are no current plans for siting major thermal powerplants in the valley and hence no significant demands for drainage water for cooling. Treatment costs would be substantial to produce drainage water acceptable for powerplant cooling. Possibilities exist, though, that energy-producing solar ponds could be used in drainage water management because of the increasing demand for, and cost of, electrical energy and because of growing concern for air quality in California. Both the Bureau of Reclamation and the Department of Water Resources are pursuing further solar pond investigations.

The potential for both salt and mineral recovery and aquacultural reuse rests largely with the marketability of the products — primarily sodium sulfate, in the case of salt recovery, and the products grown in drainage water, in the case of aquaculture. Such markets do not appear promising at present because sources are available elsewhere, but these are subject to change in the future.

Reuse of drainage water by irrigating salt-tolerant crops or by blending with normal irrigation supplies are the only reuse options that appear promising at this time.

AGRICULTURAL ECONOMY

Agriculture is the mainstay of the economy of the westside San Joaquin Valley. Knowledge of the agricultural economy and the way in which it relates to the region, the State, and the nation are important to understanding and planning for management of the drainage problem. The information that follows is from the Census of Agriculture reports (1978, 1982, 1987), Census of Manufacture reports (1978, 1982, 1983, and 1985), and data from the California Department of Food and Agriculture and a commercial agricultural lending agency, as presented in a report sponsored by the Drainage Program (Archibald, 1990). Additional information is available in the full report.

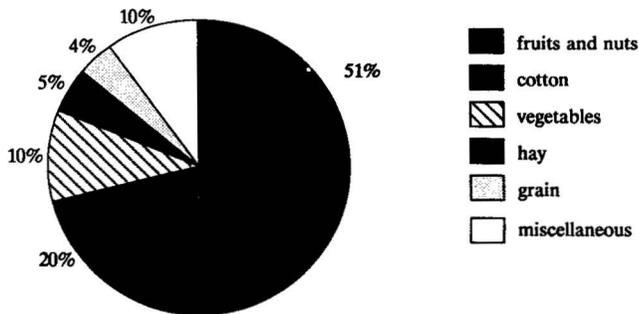
The Contribution of Agriculture

California leads the nation in the market value of agricultural production. In 1987, California's total value of agricultural output was \$13.92 billion; this represented 10.2 percent of the total \$136 billion U.S. agricultural production. Of the California total, \$9.27 billion was contributed by crops and \$4.65 billion by livestock, poultry, and related products.

The San Joaquin Valley is California's largest single agricultural area, contributing \$6.82 billion (49 percent) of the State's total agricultural output. Crops accounted for \$4.45 billion (65 percent), and livestock and livestock products contributed \$2.37 billion (35 percent). Figure 13 provides a breakdown of the total crop production value in the San Joaquin Valley.

Of the total value of crop production in the U.S., 50.9 percent was derived from irrigated land and 49.1 percent from nonirrigated land. In contrast, only 19.9 percent of the value of livestock and livestock products was derived from irrigated land, while 80.1 percent was

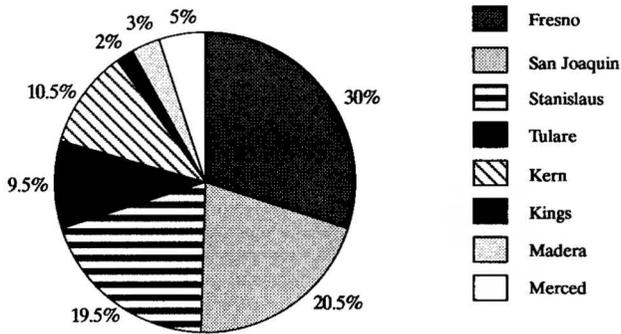
Figure 13. SAN JOAQUIN VALLEY TOTAL CROP PRODUCTION VALUE
(Value = \$4.45 billion in 1987)



contributed by nonirrigated land. Irrigated land in California accounted for about 45 percent of total U.S. crop production on irrigated land, and the San Joaquin Valley alone contributed about 21 percent of the U.S. total.

The importance of agriculture to the economy of California can be estimated by examining employment statistics. Statewide in 1987, agriculturally induced employment accounted for at least 17.3 percent of employment and 18.5 percent of total payroll. Within the San Joaquin Valley, these categories were 48.6 and 54.2 percent, respectively. Figure 14 shows agriculturally induced employment in the San Joaquin Valley.

Figure 14. AGRICULTURALLY INDUCED EMPLOYMENT IN THE SAN JOAQUIN VALLEY BY COUNTY, 1987



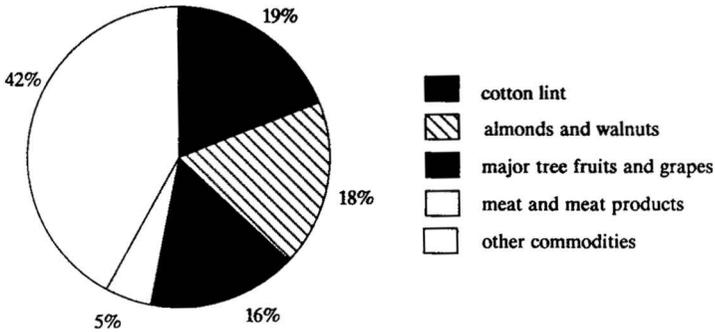
In 1987, agriculturally induced employment in each valley county was even more striking, representing more than 50 percent of employment in Kings, Madera, Merced, and Stanislaus counties and about 50 percent in Fresno, San Joaquin, and Tulare counties. In Kern County, agriculture accounted for only 20 percent of employment, reflecting the development and growing importance of other industries, such as petroleum.

Exports

California also leads the nation in agricultural export value. The State's export value declined during the 1980s, as did U.S. export value, but the State's value recovered significantly by 1987. The leading single export commodity from California is cotton lint. Figure 15 shows a breakdown of the value of California commodity exports. In 1987, 62 percent of California's cotton output was exported. This accounted for nearly half the value of U.S. cotton exports. About 60 percent of the State's almond crop and 45 percent of the walnut crop were exported. This was the entire amount of U.S. exports of these two crops.

Given these levels of exports, an estimated 1.76 million acres of California cropland were dedicated to producing for export markets in 1987. Cotton dominates exports in terms of land use. In 1987, production from 710,000 acres of cotton was required to meet California's

Figure 15. SHARE OF CALIFORNIA COMMODITY EXPORTS, BY VALUE, 1987



export market. Of that area, 682,000 acres were in the San Joaquin Valley, and 450,000 of those acres are on the valley's western side. The rise in incomes in countries importing agricultural products from California favors growth in higher value export crops, such as fruits, nuts, and beef. For the 1990s, based on expectations of income and population growth in importing countries, the U.S. Department of Agriculture projects a 3-percent annual growth rate for agricultural exports, led by growth in high-value products. Food grain exports are not expected to grow as fast as feed grain exports, because importing countries are increasing their domestic meat production and must import feed grains.

Land Use

Total California farmland in 1987 was 30.6 million acres, with about one-third (10.5 million acres) in the San Joaquin Valley. Farmland on the western side of the valley accounts for one-third (3.4 million acres) of the valley total. About 7.5 million acres of cropland are irrigated, with irrigated pasture accounting for only 5 percent of the total. Over half (57 percent) of the State's irrigated cropland is in the valley, and 40 percent of this is on the western side. Together, the Westlands, Tulare, and Kern Subareas account for more than 75 percent of westside irrigated cropland.

California farmland as a whole declined 2.3 percent from 1982 to 1987, a drop that was consistent with the national pattern, which declined 2.26 percent in the same period. For the valley, the decline was 3.0 percent; on the western side, it was 11 percent.

A partial explanation for the decline of irrigated westside cropland is the acreage enrolled in the Federal Commodity Acreage Reduction Program and the Conservation Reserve Program. Idled cropland in the valley increased 125 percent from 1982 to 1987, or 13.4 percent of total irrigated cropland in 1987. Land under the Acreage Reduction Program increased 256 percent from 1982 to 1987, to a total of 7.1 percent. Land set aside under the Conservation

Reserve Program for the valley as a whole was less than 1 percent of irrigated land. Drought conditions in 1987 also help explain the reduction in irrigated acreage.

Forty-three percent of irrigated cropland on the western side of the San Joaquin Valley was in cotton in 1987. In the five subareas, the share of cropland in cotton ranged from 2.1 percent in the Northern Subarea to 52.2 percent in the Westlands Subarea (Figure 16). The cotton shares for the Kern, Tulare, and Grasslands subareas are 51.0, 49.5, and 34.6 percent, respectively. Other field crops, including feed grains, hay, wheat, sugar beets, dry beans, oilseeds, and rice, accounted for 34.3 percent of the valley's cropland and 38.4 percent of the westside cropland in 1987. The shares of cropland in these field crops ranged from 28.7 percent in the Westlands Subarea to 51.9 percent in the Northern Subarea. Most dry beans have been grown in the Northern Subarea; most sugar beets, in the Northern and Grasslands subareas; and most oilseeds, in the Tulare Subarea. Conversely, hay has been grown throughout the west side, but minimally in the Westlands Subarea. Cotton is minimal in the Northern Subarea, as is wheat in the Grasslands Subarea.

In 1987, fruit and nut acreage represented 8.3 percent of cropland on the western side and 33.4 percent in the San Joaquin Valley as a whole (Figure 16). Together, almonds, walnuts, and apricots accounted for 92 and 86 percent of tree and vineyard cropland in the Northern and Grasslands subareas, respectively.

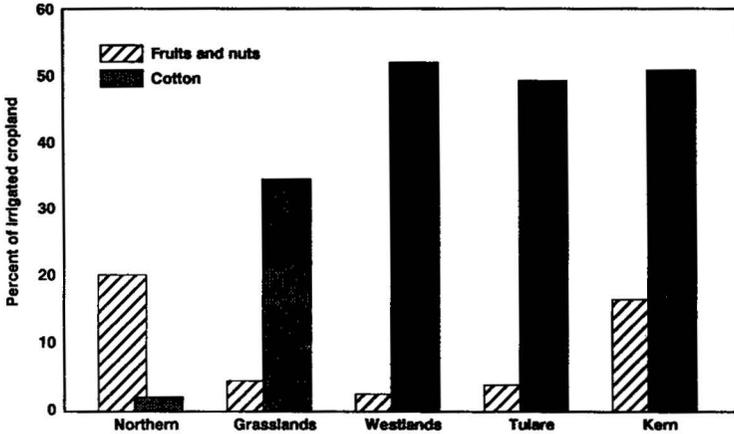
In 1987, vegetables accounted for 10.3 percent of cropland on the western side, up from 7.7 percent in 1982 and 7.3 percent in 1978. This represented an increase of 17,000 acres during the 10-year period. The share of cropland in vegetables ranged among the subareas from a high of 25.8 percent in the Northern Subarea to a low of 2.8 percent in the Tulare Subarea. Westlands Water District, which makes up most of the Westlands Subarea, had the greatest vegetable acreage, with 140,868 acres (Westlands Water District, 1988). Tomatoes, cantaloupes, lettuce, romaine, and dry onions occupied about 62 percent of land planted to vegetables in the valley. Tomatoes were the dominant crop, with 36 percent of the vegetable acreage.

Production Expenses

The western side of the San Joaquin Valley accounted for 29 percent of total valley agricultural production expenses in 1987. Given that the westside share of irrigated cropland is 40 percent, this indicates lower per-acre expenses for the western side than for the remainder of the valley. This could reflect a combination of a greater ratio of field and row crops to trees and vines on the western side and some economies of scale associated with large operations. Labor expenditures exceeded 20 percent of the total, followed by chemicals and machinery (including equipment), each at 10 percent, and energy at 6 percent. The shares of expenditures for labor, interest, and property taxes are lower than for the rest of the valley. Westside growers, however, dedicate a larger fraction of their production expenses to machinery, energy, chemicals, and irrigation water. In the subareas, cash rents per acre appear to decline as a proportion of total expenditures from north to south. The proportion of expenses in the form of interest payments was greater in the Northern Subarea, reflecting higher land values and per-acre investments in orchards. Energy expenditures in the Tulare and Kern Subareas were greater in proportion to other expenses than in other areas, reflecting the greater dependence on pumped ground water as an irrigation supply.

Westside land values have followed the national pattern, increasing from 1970 to the early 1980s and then declining, with some recent evidence of recovery. Westside land prices are about five times the national average and are highest in the Northern Subarea, where orchards are prevalent.

Figure 16. IRRIGATED CROPLAND IN COTTON, FRUITS, AND NUTS, BY SUBAREA -- 1987



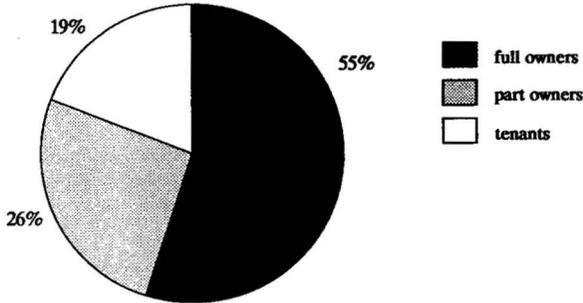
Farm Structure

Farms are fewer but substantially larger on the western side than in the rest of the valley. Average farm size in the principal study area was about 500 acres in 1987, while the average for the rest of the valley was about 100 acres. Farms in the Westlands Subarea averaged 1,100 acres in 1987; in the Tulare and Kern subareas, 500+ acres; in the Grasslands Subarea, 400+ acres; and in the Northern Subarea, 200 acres.

Farm tenure types fall into three classifications: (1) Full owners, who operate only the land they own; (2) part owners, who operate farmland they own, as well as land they rent; and (3) tenants, who operate only land they rent (Figure 17). Full ownership as a percentage of all forms of land tenure on the western side exceeded 50 percent in all subareas, except in Westlands, where it was 44 percent.

Farm operations are also divided into three basic types of management structures: corporations, partnerships, and individual or family owners. Corporations are further divided into three groups: family-held; other-than-family-held; and others, including cooperatives. In 1987, individual owners and family corporations together accounted for 76.3 percent of the farms on the westside San Joaquin Valley. In the Northern and Grasslands Subareas, corporations accounted for less than 1 percent of farms and less than 2 percent in

Figure 17. PERCENT OF FARMS BY TENURE OF OPERATOR, WESTSIDE SAN JOAQUIN VALLEY, 1987



each of the other subareas. All subareas had more than 70 percent of farms under individual ownership or in family corporations.

Less than 0.5 percent of farmland in the Northern and Grasslands Subareas was owned by corporations. During the 10-year period, 1978-1987, the portion of land owned by corporations in the Westlands and Kern Subareas increased from 6 percent to 8 percent and from 7 percent to 8 percent, respectively. In the Tulare Subarea, the portion increased from 7 percent to 16 percent. During the same period, land owned by partnerships in the Grasslands and Kern Subareas increased from 32 percent to 40 percent and from 35 percent to 40 percent, respectively. In the Westlands Subarea, the portion increased from 28 percent to 34 percent, while in the Tulare Subarea it increased from 25 percent to 35 percent. Only the Northern Subarea reported a decrease in land owned by partnerships during this period — from 38 percent to 36 percent.

Federal Agricultural Programs

Commodity Credit Corporation (CCC) payments to farm operators include loans for corn, wheat, sorghum, barley, oats, cotton, rye, rice, and honey. Government payments include deficiency payments, paid diversions, soil conservation reserve payments, payments from the Dairy Termination Program, other conservation programs, and other Federal farm programs under which payments are made directly to the farm operator. In 1987, CCC and other government payments to U.S. farms totaled \$17.9 billion; \$570 million was for loans and the remainder for payments. California received \$69.1 million in CCC loans and \$238 million for government payments. Total CCC payments for the San Joaquin Valley were \$17 million, amounting to 28 percent of California payments. The valley received \$126 million in government payments, or 53 percent of the State total. CCC loans to the western side for all program crops totaled \$11.7 million.

Cotton was the most important source of CCC payments (83.6 percent) on the western side. In the Kern Subarea, 97 percent of CCC loan payments was for cotton, and the Grasslands and Westlands subareas received 75 and 84 percent, respectively, for cotton. The Northern Subarea received almost 40 percent of its CCC payments for corn, almost 50 percent for rice, and the balance for wheat. Feed-grain payments were negligible in the other subareas.

While more than 25 percent of U.S. cotton farms participate in the CCC loan program, only 10 percent do so on the western side of the valley and in the State. In 1987, the Grasslands Subarea accounted for 13.8 percent of the westside acreage in program crops, but farmers in the subarea received 23 percent of the CCC loans. The Westlands Subarea had 27.2 percent of the acreage in program crops and received 33.1 percent of the payments. The Kern Subarea had about 25 percent of the acreage and CCC receipts. The Tulare Subarea had 32.8 percent of the acreage and 18.3 percent of loan payments.

In 1987, westside farms received 0.6 percent of total U.S. payments and CCC loans to all farms, 2.5 percent of payments and loans to farms with any land irrigated, and 7.3 percent of payments and loans to irrigated farms. The San Joaquin Valley as a whole contributed 21.3 percent of the value of U.S. agricultural output from irrigated farms and received 10.5 percent of government payments to irrigated farms.

FISH AND WILDLIFE RESOURCES

[Data, references, and analyses supporting the information included in this section can be found in the Drainage Program's 1989 report, Preliminary Planning Alternatives.]

Habitat Losses and Population Declines

Long ago, seasonal flooding of large areas of the San Joaquin Valley floor created a patchwork of aquatic, wetland, riparian forest, and valley oak savannah habitats. Surrounding these overflow lands were large areas of California prairie and San Joaquin saltbush. In the southern part of the valley, Tulare Lake and four smaller lakes were interconnected by a vast network of sloughs, riparian forests, and wetlands. On the average, during the past few thousand years, all five lakes in the Tulare Basin covered a total of about 516,000 to 625,000 acres, or about 800 to 1,000 square miles.

The diversity of habitats in the valley supported large populations of resident and migratory species of fish and wildlife. Before the region was settled, the year-round native plant and animal life in the Tulare Basin was so abundant that it supported the densest population of native Americans on the North American continent that was not engaged in agriculture. During the late 1800s, enormous numbers of waterfowl and fur-bearing mammals were commercially harvested throughout the San Joaquin Valley, and Tulare Lake supported a small commercial fishery for western pond turtles and native minnows.

Widespread development of agricultural lands, draining of the once-extensive lakes, drastically reduced instream flows, and declining water quality have taken a substantial toll on the native aquatic, wetland, riparian, and terrestrial habitats of the San Joaquin Valley. The present acreage of natural freshwater lakes on the valley floor is less than 1 percent of



Migrating ducks rising from a pond in wetlands of the Grasslands Subarea on the Pacific Flyway.

the historic extent. Current acreages of wetland and riparian habitats are less than 15 percent and about 7 percent, respectively, of their historic extent. San Joaquin saltbush habitat now occupies less than 7 percent of its historic acreage. Such drastic reductions of these habitats have caused the decline of many species of plants and animals endemic to the valley. Several species that once occurred in the valley no longer exist there or have become extinct, and 29 others are listed as endangered by the Federal or State governments.

Water Supplies and Needs

About 200,000 acres of public and private land in the San Joaquin Valley are managed primarily for the benefit of fish and wildlife. These areas need over 400,000 acre-feet per year of fresh water to satisfy optimum management needs. Reliable firm supplies of fresh water for these areas currently total about 30 percent of needs.

At present, about 4.7 million acres of irrigated agricultural land in the San Joaquin Valley receive about 17.6 million acre-feet per year of irrigation water. Until recently, surface and subsurface agricultural drainage from some of these lands, commingled with other surface water, provided over 50 percent of the water used by fish and wildlife areas, and these waters still provide instream flows for fisheries and other beneficial uses.

Several major dam, reservoir, and canal systems have been constructed and are operated in the Central Valley to serve agricultural and urban water needs. These projects have created

many severe problems for fisheries in the San Joaquin and other river systems. Although specific instream flow needs for many streams and associated fisheries in the valley have not yet been determined, it is apparent that instream flows in the mainstem San Joaquin (above its confluence with the Merced River) and in the major tributaries are currently inadequate to sustain migration of salmon. Further study is needed to determine instream flow needs of San Joaquin River fisheries. Additional planning, analysis, and field testing of methods to provide adequate and firm supplies of clean, fresh water for valley fish and wildlife are also warranted.

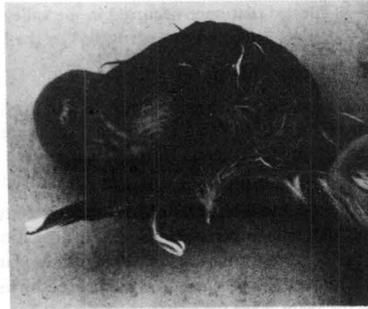
Toxicity of Drainage-Water Contaminants

Analyses of subsurface agricultural drainage water have revealed high salinity and elevated concentrations of toxic or potentially toxic elements (including arsenic, boron, cadmium, chromium, copper, lithium, manganese, molybdenum, nickel, selenium, strontium, uranium, vanadium, and zinc). Recent laboratory and field toxicity research reveals that fish and wildlife are more sensitive to the toxic properties of several of these chemical elements than previously believed. This is illustrated by the following examples for selenium, boron, and salts.

The U.S. Environmental Protection Agency's ambient freshwater aquatic life water-quality criterion for selenium was recently reduced from 35 to 5 ppb. The State Water Resources Control Board and the Central Valley Regional Water Quality Control Board have recommended that water used for wetlands management in the Grasslands Subarea contain average selenium concentrations of 2 ppb or less. Furthermore, University of California scientists have identified 1.0 to 1.5 ppb waterborne selenium as the range that causes no adverse effects. Selenium concentrations in North Mud and Salt Sloughs in the Grasslands Subarea average 6.0 ppb. Selenium concentrations in the 7,000 acres of evaporation ponds average 49 ppb, based on acreage-weighted means, and range above 1,000 ppb.

Boron, which was previously thought to be nontoxic to wildlife, has been shown to have adverse effects upon wildlife at concentrations of 900 ppm (dry weight) in the diet. Waterfowl food-chain organisms collected from Kesterson Reservoir and several other evaporation ponds in the valley have been found to contain concentrations of boron that approach or exceed this toxic threshold.

Highly saline water, free from elevated concentrations of trace elements, can also pose a health threat to wildlife. For example, freshwater ducklings are very sensitive to salty water. Toxicity tests with mallard ducklings have shown that molt was slowed when they were provided a single source of drinking water containing



Embryo of a black-necked stilt deformed by selenium poisoning.

3,000 ppm total dissolved solids, and growth was reduced when their sole source of drinking water was 7,720 $\mu\text{S}/\text{cm}$ electrical conductivity. In addition to containing elevated concentrations of various trace elements, evaporation ponds in the San Joaquin Valley, heavily used by ducks and other aquatic birds for nesting and rearing of young, are also very saline — up to 388,000 ppm TDS — and average 31,850 ppm TDS, about equal to seawater. The combination of saline ponds and the extremely limited acreage of freshwater wetlands in the southern San Joaquin Valley during the spring breeding season potentially increases this toxic threat to aquatic birds.

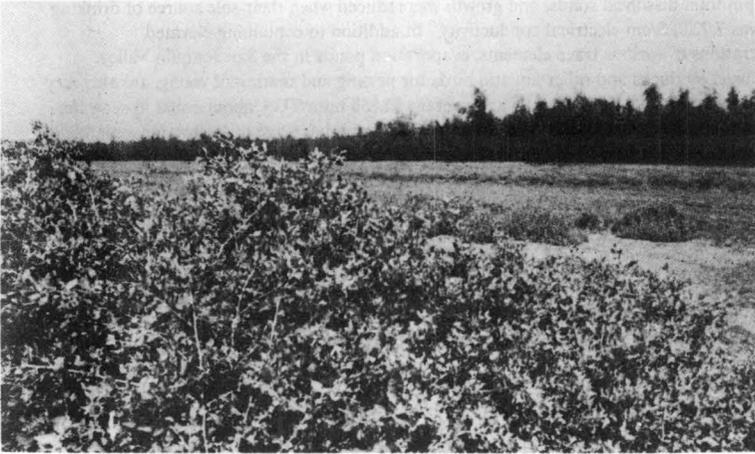
Finally, the toxicity to fish and wildlife of various salts and trace elements carried in drainage water depends upon, among other variables, the species, life stage, health, and diet of the target organism; the chemical form of the contaminant; the bioavailability of the contaminant (which for waterborne concentrations can be affected by other chemical characteristics of the water); and the interactions (additive, synergistic, and antagonistic) of multiple contaminants. Very little information is available regarding many of these complex issues, and additional research is warranted.

Contamination and Biological Effects

Elevated concentrations of drainage-water contaminants have been discovered in water, sediments, food-chain organisms, and major vertebrates in a number of San Joaquin Valley areas outside Kesterson Reservoir and the San Luis Drain. These areas include rivers, streams, and ponds; riparian zones and wetlands; and upland sites. All these areas (both natural and manmade) provide fish and/or wildlife habitat. In several of them, elevated contaminant concentrations exceed documented toxicity thresholds, and studies have documented adverse biological effects that are believed to be contaminant-related.

In the San Joaquin Basin, the same drainage water that previously was used to flood wetlands in the Grasslands area is now being discharged into various canals and natural channels for conveyance to the San Joaquin River. In the Tulare Basin, the number and size of evaporation ponds receiving drainage water have continued to increase.

Evaporative concentration is dramatically increasing the waterborne concentrations of drainage-water contaminants such as boron and molybdenum in these ponds. In addition, through bioconcentration and possibly biomagnification, aquatic plants and animals can accumulate tissue concentrations of some drainage contaminants 100 to 10,000 times greater than those in the water. Statistically significant adverse biological effects (including impaired egg hatchability, elevated frequencies of embryo deformities, and reproductive failure) have been documented at seven of the valley's evaporation pond systems (about 58 percent of the ponds studied, which represent about 60 percent of the total acreage of ponds in the valley). Not all evaporation ponds have been studied, and efforts to date have focused upon breeding birds. Additional research is needed to determine whether adverse biological effects are occurring at other ponds and what effects, if any, operation of the ponds is having on wintering waterfowl and shorebirds, endangered species, and public health. Additional field research is also needed to field-test techniques for decontaminating and restoring drainage-water-contaminated fish and wildlife habitats and significantly reducing or eliminating the hazards posed to wildlife by evaporation ponds.



A test plot of eucalyptus trees (background) and atriplex (fore- and midground) being irrigated with drainage water. Plant transpiration reduces the water volume and concentrates the salts in the remaining drainage.

Agroforestry Plantations

Agroforestry plantations are being established in the study area in an attempt to reduce the magnitude of agricultural drainage-related problems. The trees (primarily eucalyptus) and halophytes (such as atriplex) are used to: (1) Lower the ground-water table and (2) reduce the volume of drainage water by increasing evapotranspiration. Recent studies have shown that the plantations provide habitat for several species of wildlife, including mourning doves, ring-necked pheasants, blacktailed jackrabbits, desert cottontails, a wide variety of songbirds, and possibly some large mammals such as foxes and coyotes. The plantations may benefit both farmers and wildlife. However, where they are irrigated with concentrated drainage water, more research is needed to determine whether these sites pose a contaminant hazard to wildlife. Appropriate management practices that will either increase wildlife values or reduce or eliminate contaminant hazards must be identified.

PUBLIC HEALTH

Public health concerns associated with drainage water were investigated during this study (Klasing and Pilch, 1988; Klasing, et al., 1990). Table 6 summarizes the concerns with drinking water, food crops, fish and game, and occupational exposures.

Safety of Food Crops

To date, selenium concentrations have been measured in about 125 food-crop samples grown in the western San Joaquin Valley, as well as in the milk and liver of some cows raised in the area. Overall, selenium concentrations in crops from the study area were similar to typical

U.S. selenium concentrations reported for those samples. Of the food samples analyzed, even daily consumption of the crops with the highest selenium levels found in the western part of the valley would not approach the quantity necessary for selenium toxicity. At most, they would provide part of the nutritional requirement for selenium in the human diet. The selenium content of cow's milk and liver obtained from the study area were similar to that for crops; however, the extent to which these cattle may have been exposed to elevated concentrations of selenium is unknown.

Certain crops in isolated areas may possibly contain higher concentrations of selenium than have been previously measured. If this is the case, persons who place heavy reliance on those foodstuffs to meet their dietary needs (such as may occur with subsistence gardening) would increase the risk of selenium toxicity. However, this has not been reported to have occurred in the westside San Joaquin Valley. Most consumers eat a variety of foodstuffs from many geographic areas. Persons whose consumption patterns are limited either to a small number of foodstuffs or to a very small geographic region may increase their risk of both deficiencies and excesses of trace elements in their diet.

The risk to public health from potentially elevated concentrations of other agricultural drainage-water contaminants in foodstuffs is not known at this time. Currently, several other elements (arsenic, boron, and molybdenum) that have been found to be elevated in some agricultural drainage water are being analyzed in local food crops.

Safety of Consuming Fish and Game

Because selenium can be concentrated by some aquatic plants and invertebrates to levels far higher than those found in the water in which they grow, selenium from agricultural drainage water has become toxic to some aquatic birds that feed in drainage-contaminated aquatic environments. Fish and aquatic birds may in turn accumulate relatively high concentrations of selenium in their tissues, becoming a potential health risk to humans who consume them. A survey of these species at specific locations within the western San Joaquin Valley has shown that unrestricted consumption of contaminated fish or game over an extended period could cause recognizable signs of selenium toxicity. To date, however, selenium toxicity in humans has not been reported to public health officials or confirmed as a result of such consumption.

Studies of other agricultural drainage-water contaminants in the tissues of fish and wildlife have not shown risks that exceed those from exposure to selenium. Therefore, procedures currently recommended to reduce selenium exposure from contaminated fish and wildlife (for example, health advisories to limit consumption of such game) can be expected to also protect the consumer from overexposure to other drainage contaminants.

Table 6. PUBLIC HEALTH CONCERNS ASSOCIATED WITH DRAINAGE WATER

Constituent	Drinking Water	Food Crops	Fish and Game	Occupational Exposures
Selenium	Some domestic wells in high-selenium areas may exceed the present EPA-recommended safe level of 10 ppb. However, EPA has proposed raising the level to 45 ppb. See the Federal Register, May 22, 1989; vol. 54, no. 97.	Field tests suggest that normal consumption of crops is unlikely to exceed recommended dietary allowances.	Consumption of fish and game from evaporation ponds and other contaminated areas that exceed safe levels should be restricted. In most other cases, normal consumption would be unlikely to cause toxicity.	Workers should restrict their exposure of direct contact with elevated levels of contaminants.
Molybdenum	Daily consumption of water from some domestic wells in high-molybdenum areas may exceed recommended health levels.	No standard defined.	No health-related data available.	Same as above.
Arsenic	Some domestic wells in high-arsenic areas may exceed recommended safe levels.	Regulatory standards are not developed.	Consumption of fish and game from evaporation ponds and other contaminated areas should be restricted.	Same as above.

Safety of Foraging

Preliminary investigation of persons who forage in the western side of the San Joaquin Valley has not shown evidence of overexposure to selenium. However, substantial difficulties exist in obtaining and evaluating survey data of this nature. Thus, it cannot be assumed that the population of foragers in this region is safe from exposure to potentially toxic concentrations of agricultural drainage-water contaminants. Persons who make a regular practice of foraging would likely be at similar or greater risk from exposure to drainage contaminants than would fishermen and hunters, who are likely to eat a more varied diet.

Occupational Exposures to Drainage Contaminants

Concentrations of selenium in the blood and urine of personnel monitored during closure and cleanup operations at Kesterson Reservoir were within normal limits. Thus, it seems unlikely that such occupational exposures at sites similarly contaminated would cause above-normal selenium levels. Occupational exposures to other contaminants have not been evaluated. Because occupational activity may result in significant contaminant exposures by inhalation or dermal routes rather than by ingestion, different methods for assessing exposure and adverse health effects may be warranted. As an example, certain chemical forms of chromium and arsenic (and several other metals) are known to cause respiratory cancers or other chronic pulmonary diseases when inhaled. No investigation has been made of specific risks to workers from inhalation or dermal exposures to contaminants found at sites where drainage water has accumulated and concentrated (such as evaporation ponds or treatment facilities). No evidence is available to suggest that health risks from these exposure routes would be elevated for the general population.

Safety of Drinking Water

Some ground-water sources of drinking water in westside San Joaquin Valley have concentrations of certain drainage constituents that can adversely affect human health, particularly when consumed over a long period. Arsenic, selenium, and nitrates have all been found in some domestic wells in the valley in concentrations that exceed current water-quality guidelines. With the exception of nitrates, these elevated concentrations are merely background levels that, in many cases, can be considered normal for these elements in the study area. Nonetheless, it is important to document when concentrations of substances exceed criteria set to protect an area's public health so that this information can be used in formulating drainage planning alternatives.

SOCIAL CONDITIONS

Community Infrastructure

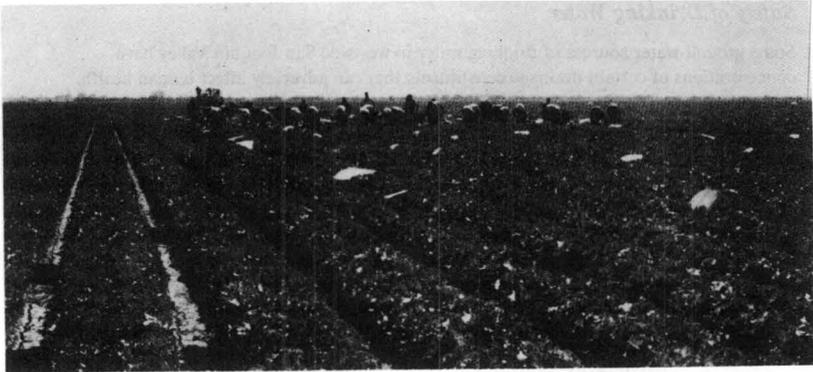
While the economies of the communities on the western side of the San Joaquin Valley are primarily based on agriculture, these towns have sufficient infrastructure and other commercial resources to adapt to broad changes in the valley economy. A number of these communities are currently experiencing significant growth caused by residential-development overflow from coastal metropolitan areas. The rural character of these towns is being rapidly altered as they become more suburban, with residents commuting to cities on the eastern side of the San Joaquin Valley, to the Santa Clara Valley, and to the San Francisco Bay area. The direct dependence of westside community residents on agriculture is diminishing because a larger proportion is working in nonagricultural jobs.

The extent and rapidity of this suburbanization were not anticipated, and the emergence of zoning changes and subdivision development poses new problems for farms and wetlands in the surrounding areas. Given this continuing growth and high real estate prices in the metropolitan areas from which the newcomers originate, this transformation is expected to continue and even accelerate.

Farm Labor

Farm workers in the San Joaquin Valley are typically immigrants. Most come from Mexico, but significant numbers also come from Central America, Asia, and the Middle East. Only about ten percent of California's farm laborers were born and raised in the United States, and only about half of these are from California. Once they have arrived, a large minority of farm workers continues to migrate, either by moving back and forth between the U.S. and Mexico during the year or by following seasonal cropping patterns around the State. About 37 percent of the State's farm workers take part in one of these forms of continuing migration (Mines and Martin, 1986).

Crop specialization on valley farms has created seasonal employment for farm workers, who often secure a succession of short-term jobs to remain employed for most of the year. Although mechanization, new seeds, and improved production techniques are causing seasonality to decline, large numbers of seasonal farm workers are still employed in California (Martin, 1987).



Large numbers of farm workers are needed to tend and harvest crops on the westside San Joaquin Valley.

Farmers in the San Joaquin Valley depend more on hired labor than do farmers elsewhere in the U.S. Most farmers rely either on foremen to recruit laborers, usually without the direct involvement of top management, or on farm labor contractors, who hire farm workers and then contract with growers to provide a temporary workforce. The use of intermediaries to meet farm labor demands is becoming increasingly important in the State (Martin, 1987).

Issues surrounding farm workers' health and safety are growing in importance as concern for public health and environmental quality focus attention on farm chemical use and other management practices.

Water Supply and Drainage Management Organizations

Most agricultural water management processes in the San Joaquin Valley either originate in organizations or are strongly mediated by them. At the most general level, valley water management is institutionalized within organizations and networks of interorganizational relationships that structure linkages among water users, local water management organizations, and government agencies. Responsibility for water-use policy, planning, and day-to-day activities affecting drainage-related agricultural water management in the valley is dispersed among a large number of public and private water management organizations. Public water management involves water agencies, joint power authorities, hundreds of special districts, county governments, and a plethora of State and Federal administrative and regulatory agencies. Private water management is structured by incorporated and unincorporated river water associations and nonprofit mutual water companies, numerous agricultural corporations, family farms, and other groups (Coontz, 1989 and 1990a).

Water Management Networks

No single organization or network shapes overall water management or is found in all phases of water management throughout the valley. Valley water management is shaped by a variety

of networks of private and public water management organizations. Network structures affecting agricultural water management at any given location and for specific kinds of water management activities are unique configurations of arrangements among various organizations. "Application" and "regulatory" networks are among the more important types affecting agricultural water management practices (Coontz, 1990b).

Application networks develop programs to provide professional and/or financial assistance to both on-farm and local organization water managers with the aim of improving water management practices and facilities. University researchers, Federal and State agencies, and contract consulting firms are the cornerstones of application networks.

Regulatory networks are composed of relationships among government regulatory agencies and various groups with interdependent interests tied to drainage management. Regulatory networks mediate conflicting interests by attempting to constrain and/or induce the discretionary activity of network participants so that they conform to a limited range of accepted actions and/or results. At least two qualitatively different regulatory networks, roughly corresponding to the valley's two hydrologic basins, shape regional regulatory strategies. These are a prescription-oriented network in the Tulare Lake Basin, which defines a range of acceptable actions to resolve drainage problems, and a performance-oriented network in the San Joaquin River Basin, which places more emphasis upon defining and meeting water-quality objectives.

Regional Institutional Spheres

In addition to organizations and networks, regional institutional spheres are important social structures that shape agricultural water management. They are configurations of unique political, economic, and social arrangements among and between water users and local water management organizations within a region. These spheres are more geographically restricted than regulatory networks and application networks. The principal institutional factors contributing to regionally specific variations that influence relationships among and between water managers within a region to outside organizations or government agencies include: (1) The degree to which formal or informal water management arrangements dominate, (2) the extent to which State or Federal agencies are integrated into water supply management, especially by the institutional structure of water rights and water contracts, (3) the degree to which agricultural water supply management and drainage management represent separate or integrated management structures, and (4) the relative importance of market relations in regional water management. The Drainage Program's five subareas roughly correspond to major regional institutional spheres (Coontz, 1990b).

THE EXISTING INSTITUTIONAL STRUCTURE

[Information in this section is summarized from a comprehensive study of water resources institutions sponsored by the Drainage Program (Thomas and Leighton-Schwartz, 1990).]

Water management institutions and laws that can both contribute to and help solve drainage and drainage-related problems are best described by illustrating the "chain of custody" of the water that ultimately results in problem drainage. Governing all water use in the State is the

Constitution of the State of California. The Constitution provides that all water within the State is the property of the people of California.

Though conceptually the physical resource remains a public asset, individuals may acquire an exclusive right to its use in the nature of a property right. But it is a highly qualified one. The State Water Resources Control Board oversees the allocation of these rights and the protection of water resources for the people of California. Private rights are conferred to those who exercise physical control over the water — be it surface or ground water — and put the water to a reasonable and beneficial use. Recognized beneficial uses pertinent to the drainage problem include irrigation, ground-water storage, and fish and wildlife uses. An “environmental water right” vests only where the water is diverted from its natural channel, as when it is applied to a refuge, but it does not vest when the water is left in the waterway.

Specifically, appropriative and riparian water rights (post-1914) are now administered through water permits issued by the State Board. Most of the irrigation water that eventually contributes to drainage is supplied through the Federal and State Water Projects as appropriative rights holders. However, appreciable amounts are supplied from ground-water pumping and local surface water. The Bureau of Reclamation holds water permits from the State Board entitling it to store, divert, and deliver water to the San Joaquin Valley through the Central Valley Project. The California Department of Water Resources holds permits for the water it develops and distributes to the valley through the State Water Project.

In protecting the public's water resources, the State Board retains authority to modify these permits to prevent the unreasonable use of water. However, unlike the diversion of surface water, there is no State-administered permit system for ground-water extraction. Nonetheless, the State Board's authority to prevent waste and unreasonable use of water comes not only from its contractual rights under the permits it issues, but also from the State Constitution, which does extend to the use of ground water. This authority is codified in State law and provides that the State Board, on its own motion or by petition of DWR or an aggrieved person, may prevent the unreasonable use of any surface or ground water.

In theory, this authority allows the State Board to require the Bureau of Reclamation and DWR, their contractors, or the end water user to take steps to reduce the generation of surface and subsurface drainage caused by excessive water application. In practice, however, the State Board has never used this power to address the drainage problem, and its exercise is sufficiently discretionary and judgmental that it is unlikely to provide a reliable solution to the overall problem.

Moving down a link in the chain of water management and use, the Bureau of Reclamation and DWR provide water to local water entities, including water agencies, water districts, irrigation districts, mutual water companies, and joint-powers authorities through contracts. These irrigation water service contracts vary significantly, but generally impose repayment, place, and manner-of-use restrictions on the districts. Pursuant to Federal contracts, which are effective for 40 years and automatically renewable, water entitlement is a stated maximum volume of firm water supply in acre-feet per year and currently priced between \$3.50 per acre-foot and \$19.31 per acre-foot. The price depends on the cost of facilities that were necessary to develop and deliver the water at the time of the contract and annual operation and maintenance costs. When these contracts are renewed, water charges will be based on

annually adjusted cost-of-service rates. In 1990, Central Valley Project irrigation cost-of-service rates for the Delta-Mendota Canal and San Luis service areas varied between \$13.58 and \$23.01 per acre-foot (USBR, 1989). Water use is restricted to agriculture, and may be neither transferred to another nor used outside the district's boundaries without the approval of the Bureau of Reclamation.

Pursuant to State Contracts, which are effective for 75 years, the amount of total annual firm entitlement of State Water Project water that may be delivered in any month for agricultural use is limited to 18 percent of a contractor's annual entitlement amount. The price, which is based on the estimated actual operation, maintenance, energy, and capital recovery cost, is calculated annually. The 1990 price of State Water Project water in the San Joaquin Valley ranges from \$32 per acre-foot to \$67 per acre-foot (DWR, 1989). Transfers of SWP water must be approved by DWR. DWR seeks concurrence of all SWP contractors on transfers.

The final link in the chain is the sale of the water from the district to the grower. Generally, growers have pro rata shares or entitlement to the district's water, and pay for it at a rate designed to defray the costs of capital facilities, contract charges from project operations, and administrative expense. A few districts are currently experimenting with tiered or progressive water rates that are designed to induce conservation of water in excess of minimal evapotranspiration and leaching requirements. Some also impose rules on the recycling of tailwater. Generally, however, growers are left unfettered with regard to their decisions on how much water to apply, when, and in what manner. Some districts, most notably Westlands Water District, do provide informational programs to their growers on these variables, expressly designed to help the growers minimize drainage generation.

The regulatory institutions that govern the ultimate fate of drainage water in the valley's environment are predominantly State-created. The functions and dysfunctions of the regulatory system can be conveniently explained by referring to the public resources put at risk by drainage water. Existing regimes cover three of these resources: surface water, ground water, and wildlife.

The State Board protects both surface- and ground-water quality in the State through water-quality standards developed by Regional Water Quality Control Boards. Water-quality standards consist of "beneficial-use" designations and "water-quality objectives" which are established to protect the beneficial uses. These are set as part of regional or statewide water-quality control plans in quasi-legislative proceedings.

The Central Valley Regional Board has established a plan to protect San Joaquin basin surface water. The protection scheme, which is applicable to districts in the Northern and Grasslands subareas and the Westlands Water District, requires that drainers meet water-quality objectives for selenium, boron, and molybdenum. The Regional Board may revise the standards it established for selenium and boron because the Environmental Protection Agency, which has authority to oversee State water-quality protection, has determined that they do not protect beneficial uses. This scheme requires that drainers provide the Regional Board with plans, known as Drainage Operation Plans. The DOPs should include measures to reduce drainage and, hence, the amount of pollution discharged to the river.

Ground water is protected through State and Federal programs. Federal law provides little more than planning authority in protecting ground-water quality, but drives the protection of subsurface drinking water in California through standards established by the EPA. The primary focus of the Federal program is the prevention of contamination, rather than correction of existing pollution problems.

The more comprehensive ground-water protection schemes are those imposed by the State. California's ground-water strategy is to maintain ground-water quality at a level that satisfies present and future drinking water needs and other beneficial uses (such as irrigation) and, where feasible, to restore ground-water quality to these levels.

The State provides for two distinct kinds of ground-water protection standards: those relating to water quality and those relating to drinking water. Drinking-water standards address the quality of water at the point of delivery to consumers. Water-quality standards and drinking-water standards are established under two separate statutory schemes, administered by two different State agencies. The former is regulated by the State Board and the Regional Boards, and the latter is regulated by the California Department of Health Services. Additional protection is provided by the Department of Water Resources in its regulation of the design and construction of wells.

Protection of both wildlife and ground water from drainage disposed of in evaporation ponds has come largely from the State. DHS and the Central Valley Regional Board are the agencies charged with regulatory responsibilities. DHS basically deferred regulation of valley ponds to the Regional Board, which issues permits for the pond operations. Ponds that contain drainage water that exceeds State hazardous waste threshold limits may be operated under an exception to the State's land disposal ban. This exception expires in 1992.

The U.S. Fish and Wildlife Service is the principal Federal agency responsible for protecting and enhancing the nation's fish and wildlife resources, including preventing the unlawful take of migratory birds under the Migratory Bird Treaty Act. Its authority to protect migratory birds is broad. The agency may request Federal prosecution of evaporation pond owners and operators, which might lead to closure of ponds. To date, the USFWS has not prosecuted any San Joaquin Valley evaporation pond owners or operators.

The California Department of Fish and Game has similar authority under State laws. Under the State Fish and Game Code, DFG may seek action by the Attorney General against the impairment of fish and wildlife, including drainage-related impairment such as contamination of surface-water habitats from drainage discharges.

The fish and wildlife agencies may themselves be regulated by other Federal and State agencies. Specific to the drainage problem, USFWS and DFG are subject to the Regional Board's regulations for operations of their refuges and wildlife areas that discharge drainage water. The USFWS has prepared a Drainage Operations Plan for operation of the San Luis National Wildlife Refuge.

Chapter 4. THE PLANNING FRAMEWORK

Planning takes place within an established framework of public sector policy and law and private sector resource use and management. This framework must be acknowledged in developing plans for solving drainage and related problems, and planning objectives and criteria must be based on it.

This chapter outlines drainage-related public policy, local drainage management initiatives, and the planning objectives, methods, and criteria upon which plans presented in the following chapters are based.

PUBLIC POLICY

The policy base adopted for Drainage Program planning is discussed in the following sections in terms of drainage service, environmental protection, drainage studies and monitoring, and constraints.

Drainage Service

The need for management of drainage water has long been recognized by both the State and Federal governments and has been stated in a number of official documents, especially in the Federal legislation and administrative arrangements for supplying water to the western side of the San Joaquin Valley. Official recognition of the need for solving the drainage problem, if not indeed commitments for actually solving it, appears in legislative statements about "drainage service" or "drainage management plans."

The legislation authorizing the San Luis Unit of the Federal Central Valley Project requires that an interceptor drain be provided for the Unit. Beginning in 1965 and each year since then, Congress has included a provision in the CVP appropriations act that prohibits selection of a final point of discharge for the San Luis Drain until certain conditions have been met. An appraisal-level study of the San Joaquin Valley Drain serving the entire valley was authorized in 1974 and completed in 1979 (IDP, 1979), and a feasibility study was authorized in 1980 but was never completed. The funding of studies indicates the Federal government recognizes the need for a drainage solution. Construction of an 85-mile portion of the San Luis Drain demonstrates a Federal commitment to solve the problem. A 1986 Federal court order in the compromise settlement of *Westlands Water District v. United States of America* requires the United States to develop and adopt a drainage plan acceptable to Westlands by December 31, 1991.

The State of California has also acknowledged in a number of documents the need to manage agricultural drainage in the San Joaquin Valley. *The California Water Plan* (DWR, 1957)

recognized the need for drainage in areas proposed to be irrigated, especially on the western side of the San Joaquin Valley. The Tulare Basin has subsequently become a part of the area provided irrigation water from the State Water Project. In discussions with the Federal government regarding a master drain from the San Joaquin Valley, the State has, at various times since 1957, tentatively agreed to participate in such a drain, but has never actually done so.

Environmental Protection

Federal and State environmental protection laws, regulations, and local ordinances affect possible drainage-related strategies and provide objectives and constraints that must be satisfied in drainage plans. The primary laws relevant to drainage problems are:

Federal	State
Fish and Wildlife Coordination Act	California Environmental Quality Act
Migratory Bird Treaty Act	California Administrative Code:
National Environmental Policy Act	Title 22 (Hazardous Wastes)
Resource Conservation and Recovery Act	Title 14 (Natural Resources)
Federal Endangered Species Act	California Fish and Game Code
Clean Water Act	California Water Code
	Porter-Cologne Water Quality Control Act
	Toxic Pits Cleanup Act
	California Endangered Species Act

For planning, it is assumed that, at a minimum, drainage plans will have to meet the objectives and standards embodied in or developed pursuant to these laws. The primary standards to be met from both State and Federal laws are included in the Level A performance standards presented in the "Planning Objectives" section of this chapter.

Plans developed to comply only with present laws may not provide sufficient guidance for future decision-making. Efforts are under way to increase protection from additional potentially harmful substances introduced into the environment and to lower the permissible concentration of a toxicant or contaminant in the environment. Moreover, the trend of scientific discovery is toward revealing an increasingly complex natural environment. It is possible that even more stringent standards for environmental protection may apply in the future. To address a range of possible future conditions, plans will be developed for more stringent (Level B) performance standards. These standards are also presented in the "Planning Objectives" section of this chapter.

The A and B levels of performance are presented to bracket a range of probable future conditions. Judgment must be exercised in limiting the enormous range of possible future conditions. For example, the Drainage Program has assumed that water-quality objectives will be set in terms of concentrations of substances allowable in receiving water, rather than in terms of the total load allowed in drainage water. This is a subjective assumption, not a declaration of a preference.

Drainage Studies and Monitoring

Intensive studies of causes and impacts of contaminant-related drainage problems began in 1983 and were continued through the balance of the decade (see "Selected Bibliography" at

the back of this report). Although much has been learned, knowledge of some aspects of drainage problems is still limited, and many uncertainties about solving the problems remain. Areas of limited knowledge include interactive and long-term effects of contaminants on fish and wildlife, levels of public health risk posed by contaminants, specific causes of water table rise and deterioration of water quality on small land units, the long-term sustainability of agriculture under existing hydrologic and economic conditions in the valley, and future drainage conditions. To learn more, the effects of the drainage problem on the environment should be monitored.

The basic strategy of monitoring should be to identify and collect information on biota, soils, and the water regime so that changes in drainage problems and conditions can be determined, particularly in response to actions taken to solve the problem. Plans can then be re-evaluated periodically and adjusted in light of new knowledge and new conditions. Design, funding, and implementation of a comprehensive long-term monitoring program are needed.

Constraints

In addition to the laws and performance standards cited previously, two Drainage Program policies further constrain planning. All alternative plans must: (1) Meet the water-quality objectives of the State of California, and (2) focus on in-valley solutions. [Action by the Drainage Program Policy and Management Committee on June 15, 1987.]

Objectives for both surface- and ground-water quality adopted by the Central Valley Regional Water Quality Control Board and approved by the State Water Resources Control Board have become objectives for plan development. Level B performance standards make provision for more stringent standards in the future.

The focus on in-valley solutions precluded study by the Program of the removal of drainage water from the valley by any means other than the San Joaquin River. This policy did recognize, however, the need to study and describe the distribution and fate of salts in the drainage problem area.

LOCAL DRAINAGE MANAGEMENT INITIATIVES

Initiatives by local water management organizations to manage drainage and related problems are presently under way in each subarea, and it appears they will contribute to improving management of the problem. Most local initiatives to improve existing water supply and drainage management practices involve outside cooperators, sponsors, regulators, or other participants. These efforts are typically implemented through a variety of organizational and institutional arrangements that link individual water users, local and regional water management organizations, university researchers, and State and Federal agencies (Coontz, 1990b). Local initiatives should be encouraged, supported, and coordinated as part of an overall management plan.

Many local initiatives are not mentioned in the alternatives and recommended plan presented in the following chapters because the plan is not detailed. Some of the more significant of these include: (1) on-farm water management evaluation and conservation programs; (2) drainage

reuse, treatment, and disposal studies and demonstration projects; and (3) construction of new water management facilities and improvements to existing facilities. Local initiatives seeking to reduce drainage volumes, effect institutional change, restore and protect fish and wildlife habitat, and develop workable methods of treating and disposing of drainage water are important contributors to management of the problem and are considered part of the plan.

PLANNING OBJECTIVES

The technical objectives that guided formulation of alternative plans are stated in terms of specific aspects of drainage and drainage-related problems: water quantity, water quality, land use, and public health.

- Water quantity objectives pertain to control of ground-water levels by managing the water in and out of the shallow aquifer and to provision of fish and wildlife water supplies.
- Water quality objectives involve allowable water constituent levels of the San Joaquin River, Salt and Mud Sloughs, ground water pumped to lower water tables, evaporation pond influent, and wetland and agricultural water supplies.
- Land use objectives stress future maintenance of agricultural productivity.
- Public health objectives are concerned with protecting the public from the possibility of contaminated fish, wildlife, and agricultural foodstuffs.

Table 7 lists the planning objectives and quantifies them, where applicable. Performance Levels A and B are shown for each objective, even when they are the same. The need for and use of performance levels were described previously in the section of this chapter on "Environmental Protection."

PROGRAM PLANNING METHODS

The method used to formulate and evaluate alternative plans is described in the Drainage Program's report, *Formulating and Evaluating Drainage Management Plans for the San Joaquin Valley* (1988). [Details of the planning procedures and their application are presented in a Drainage Program technical report (D.G. Swain, 1990).] Early in this Program, over a hundred ideas and concepts for solving part or all of the drainage problem were screened and reduced to some 80 drainage and drainage-related management options. These options were further evaluated through an extensive review period for technical feasibility, potential effectiveness in solving the drainage problem, cost, and acceptability to the public. This reduced the number to about a dozen major options that could be combined in various ways to manage or solve drainage problems on the western side of the valley.

For each subarea, those options effective in reducing the drainage-water problem were combined into three planning alternatives that emphasize: (1) Source Control (the conservation and reuse of agricultural water), (2) Ground-Water Management (the extraction

Table 7. PLANNING OBJECTIVES, CRITERIA, AND STANDARDS

ITEM	OBJECTIVE	
	Performance Level A	Performance Level B
WATER QUANTITY		
Plan/design average regional deep percolation that must be managed after 0.02-0.35 ac-ft/acre/yr reduction by source control measures	0.4 ac-ft/ac/yr	0.4 ac-ft/ac/yr
Plan/design minimum depth to water table	5 feet	5 feet
Criteria for conditions required for deep pumping of semiconfined aquifer	Minimum combined aquifer thickness of 100 feet	Minimum combined aquifer thickness of 200 feet
Water supply to fish and wildlife	<p>a. Water conserved by reducing deep percolation could be used to meet drainage water replacement water needs and alternative habitat water requirements associated with evaporation ponds. Water for restoration of drainage-contaminated wetlands will also be included.</p> <p>b. Additional water supplies needed to improve fish and wildlife resources will be quantified, and possible sources and means of supply will be identified.</p>	
WATER QUALITY (Mean monthly values, unless otherwise noted)		
<i>San Joaquin River (Mouth of Merced River to Vernalis)</i>		
Total Dissolved Solids, near Newman (ppm)	— ^a	650 ^b
Total Dissolved Solids, near Vernalis (ppm)	450 ^c	450 ^c
Boron, near Newman (ppm)	0.8 ^d (3/15 - 9/15)	0.7 ^b
	1.0 ^d (9/16 - 3/14)	
	1.3 ^d (Critical year only)	
Selenium, near Newman (ppb)	5 ^d 8 ^d (Critical year only)	2 ^k
Molybdenum, near Newman (ppb)	10 ^d	10 ^b
<i>Salt and Mud Sloughs and San Joaquin River, Sack Dam to Mouth of Merced River</i>		
TDS (ppm)	— ^a	2,000 ^b
Boron (ppm)	2 ^d	2 ^b
Selenium (ppb)	10 ^d	2
Molybdenum (ppb)	19 ^d	10 ^b
<i>Pumped Ground-Water Aquifer Limits</i>		
TDS (ppm)	1,250	1,250
Boron (ppm)	1.0	0.5
Selenium (ppb)	5.0	2.0

a Objectives not presently established or estimated.

b State Water Resources Control Board staff recommendations in "Regulation of Agricultural Drainage to the San Joaquin River," August 1987. USEPA has disapproved certain of the Board's objectives and the matter is presently unresolved.

c U.S. Bureau of Reclamation and South Delta Water Agency agreement.

d Central Valley Regional Water Quality Control Board Resolution No. 88-195, Adoption of Amendments to the Water-Quality Control Plan for the San Joaquin River Basin (5C).

e Grassland Water District agreement with agricultural drainers.

Table 7. PLANNING OBJECTIVES, CRITERIA, AND STANDARDS (continued)

ITEM	OBJECTIVE	
	Performance Level A	Performance Level B
WATER QUALITY (continued)		
<i>Evaporation Pond Influent (concentrations that may eliminate the need for hazing and alternative habitat)</i>		
Selenium (ppb)	5	2
Molybdenum (ppb)	— ^a	— ^a
Arsenic (ppb)	— ^a	— ^a
<i>Wetland Water Supply (average monthly concentration)</i>		
TDS (ppm)	2,500 ^f	1,250
Boron (ppm)	4 ^g	1
Selenium (ppb)	2	2
Molybdenum	— ^a	— ^a
Arsenic	— ^a	— ^a
<i>Agricultural Water Supply (average monthly concentration) [†]</i>		
TDS (ppm)	500 ^g	1,250 ^h
	2,500 ^h	2,500 ^h
Boron (ppm)	0.5 ^g	1.0 ^g
	2.0 ⁱ	4.0 ⁱ
LAND USE		
<i>Agricultural use</i>	Maintain existing irrigable lands in production, except for land needed for drainage water reuse (trees), disposal activities, and urbanization.	Maintain irrigated agriculture on lands overlying exceptionally high concentrations of selenium in ground water, if economically feasible; if not feasible, retire the land.
PUBLIC HEALTH		
<i>Fish</i>		
Selenium objective for San Joaquin River (ppb)	5	2
<i>Wildlife</i>		
Selenium objective for evaporation ponds (ppb)	5 ^j	1.0-1.5 ^k
<i>Agricultural Foodstuffs</i>	Use irrigation water (both surface & ground water) & soil that will not produce a health risk in agricultural crops, animals, or animal byproducts.	Use irrigation water (both surface & ground water) & soil that will not produce a health risk in agricultural crops, animals, or animal byproducts.

f Level B criteria for agricultural water supply show the effect of increased (compared to Level A) water conservation on farmland and increased restrictions on drainage discharge; that is, more salt and boron would be excluded from receiving water through reuse and recirculation of drainage water.

g This objective is based on crop yield vs. irrigation efficiency and uniformity analysis for beans (a salt/boron-sensitive crop) and cotton (a salt-tolerant crop).

h Water-quality limit for direct use of water (without blending) for irrigation of salt-tolerant crops, using management strategies proposed (Rhodes, 1987).

i Diluted subsurface drainage used for irrigation of cotton and other boron-tolerant agricultural crops.

j Ambient fresh-water aquatic life criterion (USEPA, 1987). May require warnings for consumption of fish and wildlife by pregnant women and young children.

k "No adverse effects level" (UCCC, 1988); "no adverse effects level" (Davis et al., 1988).

of irrigable water from deep within the semiconfined aquifer to lower the near-surface water table in waterlogged land areas), and (3) Land Retirement (the retirement of irrigated agricultural lands overlying shallow ground water that contains greatly elevated concentrations of dissolved selenium and that are difficult to drain). Planning alternatives were devised for both Level A and Level B performance standards.

Comparison of the alternatives permitted drawing conclusions that were useful in formulating the recommended plan. The plan is the optimum mix of the planning alternatives used to reduce the drainage-water problem, coupled with fish and wildlife resource components.

ESTIMATING THE VOLUME OF WATER CAUSING DRAINAGE PROBLEMS

The term *problem water* was coined by the Drainage Program to represent the volume of subsurface water that occurs (or will occur) in a given place to cause a drainage problem. A drainage problem exists when there is a condition of too much shallow ground water occurring in the root zone of crops — associated often with concentrations of dissolved salt or boron in that water that reduce crop production and/or increase farm management costs. A grower experiencing economic loss under this condition has three choices: (1) Grow more salt-tolerant or boron-tolerant plants (at less profit), (2) abandon irrigated agriculture on this land, or (3) apply drainage management to this land. Such management usually begins with installing artificial drains to remove the subsurface drainage volume. If potential toxicants such as selenium are present in the drained water, storage or disposal becomes more difficult, costly, and potentially hazardous to the environment.

Problem water is generally ground water that is less than 5 feet from the surface of the land. In a hydrologic sense, considerably deeper water can move along a pressure gradient and up from greater depths into the 0- to 5-foot zone (Belitz, 1988); thus, as long as the regional water table remains high, other ground water is continually replenishing the problem water. The irrigated area that is, and likely will be, affected by a 0- to 5-foot water table is shown in Table 8. The forecasts are based on observed trends between 1977 and 1987, modified by physical limitations of the total area that will develop high water table conditions. These lands are considered to have a potential drainage problem. They are considered to have an actual drainage problem if and when the quality of water in the root zone causes one of the grower reactions indicated previously. The estimated extent of the drainage problem area (underlain by problem water) is shown in Table 9. The drainage problem area is smaller than the area with a water table less than 5 feet from the ground surface because of water-quality conditions.

The shallow ground-water area (0 to 20 feet from the land surface) was divided into water-quality zones to aid in determining drainage problem areas and to aid in planning. The divisions, which were made on the basis of the concentration of salts and trace elements in the shallow ground water, are shown on Figure 18. Problem water occurs in these zones and, by 2040, will affect most of the land within the zones.

The annual volume of problem water targeted for management is the average annual amount of water added each year to the root zone (largely through irrigation) in excess of water that

percolates to deep aquifers. This problem water is water that remains in the root zone area, redissolving salts and other substances, evaporating up through the soil column, and becoming loaded with increasing concentrations of minerals as the summer irrigation season advances. Table 10 provides an estimate of the annual volume of problem water in each subarea for 2000 and 2040. For the whole study area, the unit volume of problem water in 2000 is forecasted as about 0.70 acre-foot per acre of problem area; and for 2040, it is forecasted as about 0.75 acre-foot per acre. The increase is due to the slow but steady trend toward increased mineralization that will occur in some subareas before a coordinated effort to manage the drainage problem can get under way at the scale required.

Table 8. FORECAST OF IRRIGATED AREA WITH WATER TABLE LESS THAN 5 FEET FROM GROUND SURFACE (Based on Existing Trends) In 1,000s of acres

Subarea	1990	2000	2040
Northern	49	49	49
Grasslands ¹	230	230	230
Westlands	104	170	227
Tulare	320	359	387
Kern	62	110	164
TOTAL	765	918	1,057

¹ Excludes 90,000 acres of wetland habitat with a high water table.

Note: All currently drained lands are included, even though drainage may have lowered the water table below 5 feet.

Table 9. FORECASTS OF EXTENT OF DRAINAGE PROBLEM AREA In 1,000s of acres

Subarea	2000	2040
Northern	34	44
Grasslands	116	207
Westlands	108	204
Tulare	125	348
Kern	61	148
TOTAL	444	951

Note: Total area in 2000 revised upward from 409,000 acres in SJVDP's *Preliminary Planning Alternatives*, August 1989.

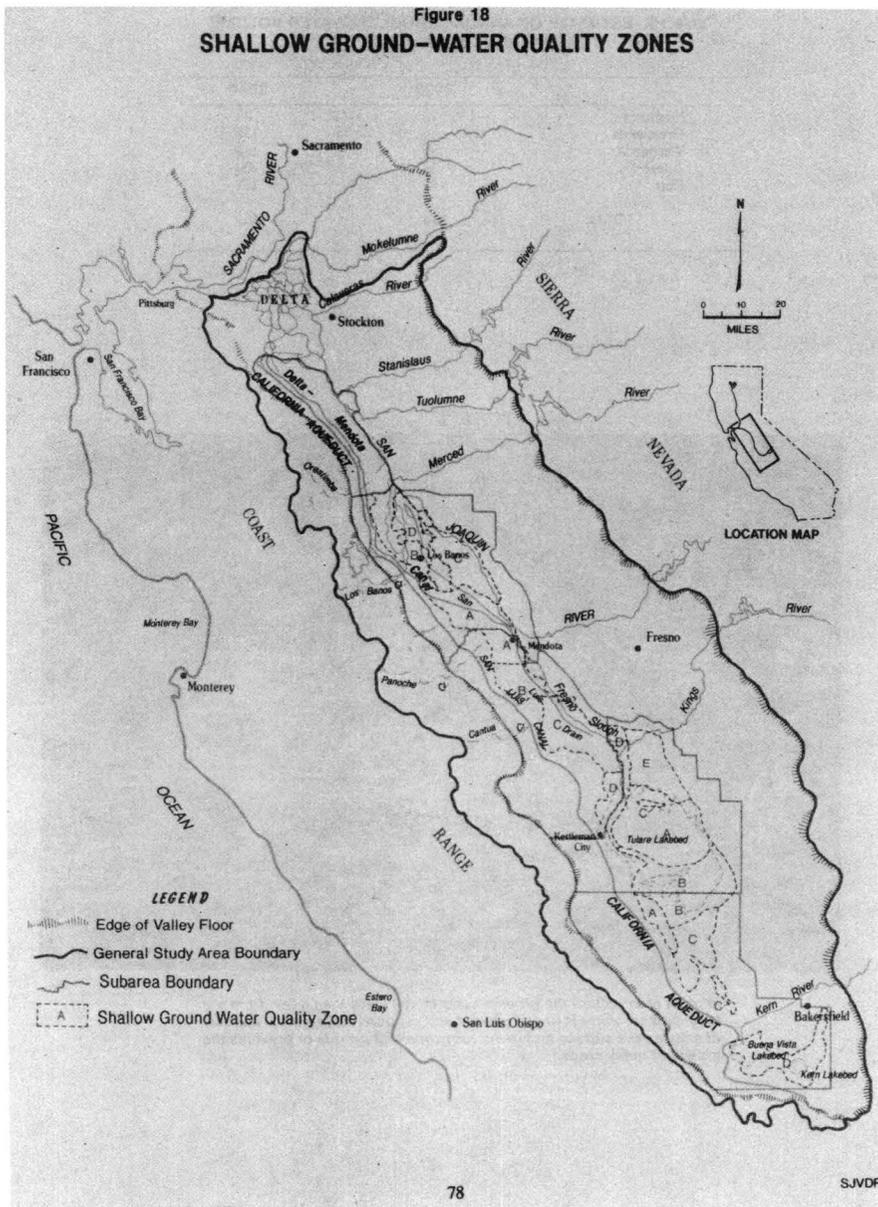
**Table 10. ESTIMATE OF ANNUAL PROBLEM WATER VOLUME
in 1,000s of acre-feet**

	2000	2040
Northern	26	38
Grasslands	86	155
Westlands	81	153
Tulare	75	209
Kern	46	111
TOTAL	314	666



In most areas where the ground-water table is less than 5 feet from the land surface, water is drawn upward and evaporates, leaving a deposit of salts on the surface and in the root zone that retards or prevents the growth of many crops.

Figure 18
SHALLOW GROUND-WATER QUALITY ZONES



Chapter 5. IN-VALLEY MANAGEMENT OPTIONS AND PLANNING ALTERNATIVES

This chapter reports the results of analyses made by use of the planning process described in Chapter 4. The analyses are a necessary transition step toward laying out a recommended plan.

First, an estimate is presented of the future drainage problem and its consequences, assuming present trends continue and no coordinated and comprehensive action is taken by local, State, and Federal entities to solve drainage problems. This is called the Future-Without Alternative, and it is useful as a basis for comparison with planned actions for the future. Next, planning building blocks, called "options," are described. These can be fitted together in compatible mixes to form alternatives to the future-without alternative. Finally, three planning alternatives that emphasize different strategies are formulated and displayed as a basis for designing the recommended plan presented in Chapter 6.

THE FUTURE-WITHOUT ALTERNATIVE

The future-without alternative represents conditions that could develop in the valley if coordinated, comprehensive actions are not taken by local, State, and Federal entities to solve drainage and drainage-related problems. The President's Council on Environmental Quality requires that all Federal planning studies include a future-without alternative as part of project planning. The future-without alternative is intended to give planners and the public a common ground from which to judge the need for actions to change present trends. It is also a baseline against which the economic, environmental, social, institutional, and physical effects of planned actions may be measured to determine their positive or negative effects.

Development of the future-without alternative involves: (1) Describing a general, overall theme for the future in the valley; (2) developing a set of assumptions about economic, environmental, social, institutional, and physical conditions in the valley and projecting trends; and (3) quantifying the effect of these assumptions on the planning subareas.

The Overall Theme

In February and March 1987, the San Joaquin Valley Drainage Program conducted multi-disciplinary workshops designed to develop future scenarios of conditions that would likely prevail in the absence of a coordinated, comprehensive plan to solve the valley's drainage and drainage-related problems. Participants included valley farmers, wildlife refuge managers, water district managers, academicians and researchers, and Federal and State agency personnel. The

groups discussed major themes and trends that were forcing changes in agricultural drainage-related conditions in the valley. They concluded that central themes shaping future trends were related primarily to the public's desire to protect fish and wildlife and to sustain agriculture in the valley (SJVDP, 1987).

Assumptions About the Future

Assumptions regarding future economic, environmental, social, institutional, and physical conditions and trends in the valley are summarized below. Two overriding assumptions are that no catastrophic natural events and no major changes in the national political, economic, or social climate would occur.

More specific assumptions and trends are:

- The present trend toward less Federal government participation and more privatization would continue. Government expenditures for major water projects would continue to decline, and Federal farm subsidies would be reduced gradually. More responsibility for natural resources management would fall on State and local governments and the private sector.
- Public pressure for environmental protection would increase, leading to more stringent environmental regulations, and increased governmental enforcement of those regulations. This could result in user charges, taxes, and penalties to aid environmental protection.
- Agricultural economic conditions would remain relatively stable. The United States, the State of California, and the San Joaquin Valley would compete favorably in world agricultural markets. Irrigated agriculture in the valley would be able to afford and install some drainage improvements but would not be able to do so uniformly, and some land would be removed from production as a result of drainage and related problems.
- California's population would continue to grow, increasing the urbanization of the San Joaquin Valley, including westside agricultural lands, more of which would be converted to urban, residential, commercial, and industrial uses (with their attendant transportation and communication needs). Air pollution, waste generation, and noise would increase.
- Importation of water to the study area would not be significantly increased.
- There would be a shift in the northern part of the valley from agricultural water use to urban uses.
- Existing public wildlife areas would be preserved and protected, but no new areas or water supplies would be developed. Wetlands acreage on both public and private wildlife areas would diminish as their intermittent water supplies disappeared.
- Overall, surface- and ground-water quality in the study area would continue to deteriorate.
- The land area adversely affected by a high ground-water table would increase. The shallow ground water would become more saline, and, as a result, agricultural land would be removed from production.

- Except for use of the San Joaquin River, in conformance with water-quality objectives, no drainage outlet from the valley would be provided.
- The rate of adoption of water conservation measures in drainage problem areas would increase.
- Independent and uncoordinated actions related to agricultural drainage would result in litigation, not only between agricultural and environmental interests but also among groups having similar interests.
- Piecemeal legislation and institutional change would add to the drainage problem, causing the range of choices for water, land, and fish and wildlife managers to narrow and bringing significantly higher costs to most concerned parties.

The Shape of the Future Under the Future-Without Alternative

The future-without alternative, as shaped by assumptions described in the previous section, is described here in terms of land-use change and assessments of the hydrologic, economic, fish and wildlife, public health, and social effects of that change.

Land-Use Change

Analysis of present trends toward change in the future hydrologic system of the western side provided estimates of irrigated land, land abandoned due to salinization, and land drained by 2000 and 2040 (Table 11). The main conclusion drawn from these estimates and from backup data compiled in the Drainage Program's technical reports is that the absence of a clear, comprehensive approach to drainage management would likely lead to soil salinization and the abandonment of about 460,000 acres of irrigated agricultural land by 2040. The result would be major losses in agricultural production.

Table 11. IRRIGATED LAND CHANGES UNDER THE FUTURE-WITHOUT ALTERNATIVE
In 1,000s of acres

SUBAREA	1990			2000				2040			
	Drained Area	Irrigable Area	Irrigated Area ¹	Drained Area	Abandoned Lands ²	Change to Urban Land Use	Irrigated Area ³	Drained Area	Abandoned Lands ⁴	Change to Urban Land Use	Irrigated Area ³
Northern Grasslands	24	165	157	34	0	5	152	51	0	25	133
Westlands	51	365	329	85	0	4	325	152	40	20	225
Tulare	5	640	576	50	28	0	551	49	140	5	446
Kern	42	612	551	86	38	0	517	94	190	5	325
TOTAL	11	762	686	14	18	5	665	40	90	35	573
TOTAL	133	2,544	2,299	269	84	14	2,210	386	460	90	1,802

¹ Irrigated area is 95% of the irrigable area in the Northern Subarea and 90% of all other subareas.

² Calculated as 20 % of the 2040 abandoned land estimate, except Grasslands, where discharge to the river is expected to forestall salinization and resultant abandonment until after 2000.

³ Irrigated area is 90% of the difference between the irrigable area and the sum of the land abandoned and land changed to urban, except in the Northern Subarea where the factor is 95%.

⁴ Values based on WADE model analysis, using estimated 2040 area with water table less than 5 feet from ground surface, and present salinity and selenium concentrations in shallow ground water (0 to 20-foot depth).

By 2040, salinization of irrigated land could be expected to diminish the irrigated area by about 11 percent in the Grasslands Subarea, 22 percent in the Westlands Subarea, 31 percent in the Tulare Subarea, and 12 percent in the Kern Subarea. No irrigated land in the Northern Subarea would be affected.

Hydrologic Effects

A general reduction in irrigated agricultural water requirements is expected in areas with shallow ground water at or near 5 feet in depth. This could occur because of increasing contributions of a very high water table to evapotranspiration and abandonment of waterlogged lands. The shallow ground water would become more saline, as would overlying lands. On affected lands, this condition would change farming practices and selection of crops grown. Eventually, the value of the lands for irrigated agriculture would decline to a level that would force abandonment of the lands. Changes in land use within the study area, including conversion of irrigated lands to residential and commercial development, would also reduce irrigation deliveries.

Limited opportunities to dispose of drainage would gradually reduce water deliveries to the lands with rising soil salinity during the next 50 years. Estimated reductions of irrigable land areas and irrigation water requirements due to salinization, changes in land use, and a modest increase in irrigation application efficiencies are shown in Table 12.

The quality of water provided by the State and Federal water projects would not change significantly throughout the planning horizon. However, the water in crop root zones would become more saline and, in places, would become loaded with boron due to increased evaporation of water from a near-surface water table.

The present quantity of firm water supply available for wildlife management areas would probably diminish under the future-without alternative. In a normal year, firm water deliveries of 97,000 and 17,000 acre-feet are available, respectively, to wetlands within the Grasslands and Northern subareas. These amounts do not allow for any replacement of the selenium-contaminated drainage water used for wetland management.

Table 13 shows that the quantity of subsurface drainage would be expected to more than double the present level by 2040. These estimates reflect the effects of increasing on-farm source control measures to reduce deep percolation by an average of 0.20 acre-foot per acre in the Grasslands, Westlands, and Kern subareas and 0.05 acre-foot per acre in the Tulare Subarea. The estimate reflects no reduction in the Northern Subarea. In contrast, the average target adopted for the Drainage Program's planning alternatives is 0.35 acre-foot per acre in the Grasslands, Westlands, and Kern subareas, and 0.20 acre-foot per acre in the Tulare Subarea, with no reduction in the Northern Subarea.

Table 12. CHANGE IN IRRIGABLE AREA AND WATER REQUIREMENT UNDER THE FUTURE-WITHOUT ALTERNATIVE

Subarea	Irrigable Area ¹ (1,000s of acres)			Total Irrigation Water Requirement ² (1,000s of acre-feet)		
	Present	2000	2040	Present	2000	2040
Northern Grasslands	165	160	140	530	520	460
Westlands	365	361	305	1,180	1,140	970
Tulare	640	612	495	1,580	1,470	1,190
Kern	612	574	417	1,300	1,220	880
	762	739	637	2,040	1,870	1,610
TOTAL	2,544	2,446	1,994	6,630	6,220	5,110

¹ In any given year, about 90% of this area is actually being irrigated, except for the Northern Subarea, where 95% is irrigated.

² The procedure used to estimate the water requirement is described in D.G. Swain (1990).

Table 13. ESTIMATED SUBSURFACE DRAINAGE VOLUME UNDER THE FUTURE-WITHOUT ALTERNATIVE in 1,000s of acre-feet

Subarea	Present	2000	2040
Northern Grasslands	18	26	37
Westlands	38	54	105
Tulare	4	28	27
Kern	32	47	52
	8	8	22
TOTAL	100	163	243

The present weighted average concentration of salts in drainage water estimated to occur in each of the water quality zones varies from about 1,000 to 25,000 parts per million total dissolved solids. Under future-without conditions, the quality of the shallow ground water would improve gradually in areas of high salinity where drainage is provided and salts are leached from soils. However, in undrained areas with a high water table, the lands may have become salinized before the quality of shallow ground-water had improved significantly.

Economic Effects

The future-without conditions were analyzed for 2040, and the agriculturally related economic impacts are compared to present conditions in Table 14. Overall, the future-without would exhibit a net decline in irrigated acreage, income, sales, and jobs. About 554,000 acres would be abandoned or converted to noncrop uses, with an associated loss of crop value of about \$440 million per year. The negative impacts on retail sales in the surrounding communities would be about \$63 million annually. Personal income in the study area would be reduced by over \$123 million annually.

Table 14. REDUCTION IN RETAIL SALES, INCOME, AND EMPLOYMENT FROM PRESENT TO FUTURE-WITHOUT CONDITIONS, 1987-2040

Item	Subarea				Total
	Grasslands	Westlands	Tulare	Kern	
Reduction in irrigated crop area (1,000s of acres)	62	151	210	131	554
Lost crop value	42,747	130,344	175,452	92,712	441,255
Direct retail sales	1,555	4,743	6,385	3,374	16,057
Indirect and induced retail sales	4,545	13,903	18,804	9,913	47,165
Total retail sales	6,100	18,646	25,189	13,287	63,222
Direct personal income	5,362	16,532	22,637	11,859	56,390
Indirect and induced personal income	7,285	29,805	14,376	15,441	66,907
Total income	12,647	46,337	37,013	27,300	123,297
Direct employment	399	1,183	1,519	822	3,923
Indirect and induced employment	1,020	2,160	1,022	1,071	5,273
Total employment	1,419	3,343	2,541	1,893	9,196

Note: Crop value, retail sales, and income are in 1,000 (1990) dollars per year and employment is in person-years per year.

Employment projections indicate that total agricultural employment in the four subareas would fall by nearly 4,000 jobs. The loss of agricultural production would cause more than 5,000 jobs to be lost in the supporting industries and communities serving agriculture. Overall employment losses could reach nearly 9,200 jobs.

The secondary and induced impacts would be felt statewide, with the greatest experienced in the valley communities and the balance predominantly felt in the San Francisco Bay area and the Los Angeles basin.

This analysis does not take into account the value of resources freed after lands are abandoned. Depending on the assumptions concerning the reallocation of water and the fate of the lands abandoned, other positive values could be expected. Alternative uses for the abandoned or reallocated resources could be expected to exhibit some compensating income and employment characteristics.

The loss of fish and wildlife habitat and populations in the San Joaquin Valley associated with future-without conditions would mean less direct recreational use of these resources. This would result in regional economic impacts in the form of reduced retail sales, personal income, and employment. In addition, the value society receives from simply knowing that environmental resources in the valley exist and that the option exists to use these resources would be reduced under future-without conditions. No estimates have been made of the economic values and regional economic impacts for future-without conditions, compared to present conditions.

Other agricultural areas that produce similar crops could benefit when competitors abandon their lands. The net result of such a regional shift has not been analyzed. However, it is expected that the bulk of net acreage and crop reductions would occur in relatively salt-tolerant row and grain crops, such as cotton and wheat.

Clearly, a major reallocation of resources would occur. Water, land, and labor would be only part of the picture. The losses to the financial community and the local tax base would be substantial. Losses in land asset value could encourage a new round of investment at a lower cost. However, a net outmigration of investment capital would probably occur in heavily impacted valley communities.

Effects on Fish and Wildlife Resources

Without a firm supply of suitable quality water delivered when needed, the total acreage of healthy wetlands in the valley would continue to decline. At present, there are about 85,000 to 90,000 acres of seasonal and permanent wetlands in the valley. It is estimated that, by 2040, only about 55,000 acres (those with firm water supplies) would remain. Populations of migratory and resident wildlife species dependent on those scarce habitats would decline. Effects on populations of wintering migratory birds (waterfowl, shorebirds, and long-legged wading birds, for example) would probably be especially severe as birds crowded into ever-smaller areas of habitat, increasing the incidence and impact of avian diseases. Opportunities for such human uses of these wildlife resources as bird watching, nature study, and waterfowl hunting would diminish or even be prohibited.

Even with hazing and other similar efforts, evaporation ponds containing elevated concentrations of selenium, boron, arsenic, molybdenum, uranium, other trace elements, and salts would constitute an extremely serious contaminant hazard to wintering and resident populations of aquatic birds. Operation of toxic ponds could also pose contaminant hazards to endangered predators known to occur in the southern end of the valley (for example, the bald eagle, American peregrine falcon, and San Joaquin kit fox). The development and operation of expanded or new pond acreage would likely impact populations of several other endangered species. Because elevated concentrations of selenium were found in tissues of birds taken from some evaporation ponds, a public health warning was issued, advising hunters to limit or discontinue their consumption of waterbirds taken from those ponds. All these contaminant hazards would be compounded by the decreasing acreage of clean wetlands habitat.

Agroforestry plantations, developed to aid drainage management, would provide valuable new habitat for a variety of birds, mammals, and other species of wildlife, if the tree farms do not pose a contaminant hazard.

Water-quality objectives for the San Joaquin River basin adopted by the Central Valley Regional Water Quality Control Board still allow certain waterways to contain concentrations of selenium considered by some researchers to be toxic to wildlife. The actual effects on the fishery are unknown, due to a lack of toxicity studies.

Because of inadequate instream fishery flows from eastside tributaries to the San Joaquin River and high volumes of subsurface agricultural drainage water flows from the Grasslands area, upstream migrating adult salmon pass from the San Joaquin River into Mud and Salt Sloughs

instead of the Merced River to spawn. This situation has prompted expensive efforts to trap and artificially spawn adult fish and transport the eggs to the Merced River Fish Facility for hatching and rearing. In a future-without scenario, this situation could be expected to continue indefinitely.

Several efforts have recently been initiated to address the inadequate instream fishery flows (for example, in the mainstem San Joaquin River between the Merced River and Friant Dam) and related environmental problems in the basin. Such efforts include the California Department of Water Resources' San Joaquin River Management Program, the U.S. Bureau of Reclamation's San Joaquin River Basin Resource Management Initiative, and litigation regarding renewal of 40-year water contracts from the Friant project. It is uncertain whether any of these efforts will provide flows in the mainstem San Joaquin River of adequate quantity and quality to support a viable fishery, including restoration of Chinook salmon runs.

In addition, loading of selenium and other drainage-related contaminants into the Bay-Delta ecosystem would continue under the future-without alternative. It is unknown what effects, if any, long-term loading of these systems with such trace elements would have on the health of the fishery, on other water-dependent wildlife, or on humans consuming such animals.

Public Health Effects

The greatest risk to public health from the lack of a coordinated action to solve the drainage problem is likely to arise from increased use of conventional evaporation ponds for disposal of agricultural drainage water. Where bioaccumulation of trace elements occurs through the aquatic food chain, consumption of contaminated game would increase human exposure to elevated concentrations of these elements. Decommissioning of evaporation ponds might also pose occupational hazards from inhalation of airborne contaminants.

Because ground- and surface-water quality in the valley will continue to deteriorate, potential human exposure to water contaminants will become greater. Future population growth and urban expansion projected for the San Joaquin Valley will bring people closer to all sources of agricultural drainage-water contaminants (air, soil, water, and biota) and thus reinforce the likelihood of adverse effects from exposure of such contaminants.

Social Effects

Farmland is expected to be abandoned more rapidly toward the end of the planning period. However, since the impacts would be spread over several decades, their effect upon farm operators, employees, and rural communities would permit adjustment that would moderate the cumulative social effects associated with the loss of productivity.

While land is being abandoned, the value and marketability of drainage-affected agricultural land would slowly stagnate, while uncertainty about the future would grow. Without an integrated regional solution, individual farmers would have increasing difficulty acquiring financing for farm operations and installation of drainage management facilities.

Patterns of land abandonment would likely be irregular, with farmers attempting to preserve the most productive lands for high-value crops and selecting less productive lands for on-farm

drainage disposal. The remaining irrigated lands would be used more intensively as lands with drainage problems were abandoned. Over time, the cropping pattern in the approximate 1-million-acre drainage problem area would become less diverse, with production shifts toward less profitable salt-tolerant crops. Farmers with marginal technical capacity and financial resources would suffer the most severe consequences; many small and/or undercapitalized farm operations would go out of business.

Those who farm lands without drainage problems could acquire a competitive economic advantage over those who farm lands with high water tables and associated high salinity, by realizing increases in land value and profitability. Nevertheless, the total agricultural production (and associated agribusiness) in the San Joaquin Valley would likely decline significantly from present levels.

There would also be a significant conversion of farmland to alternative uses, either wildlife habitat or residential/commercial development. San Joaquin Valley towns within the drainage study area would become less dependent upon their traditional agricultural support base and more autonomous as fully developed small cities. Population expansion associated with the growth of valley communities would likely put greater pressures upon wildlife refuges and recreational lands.

The current level of cooperation among water districts in water management activities could deteriorate as drainage conditions worsened in the valley. As the value of the assessment base of farmland dropped due to lower land values, water districts would be less able to take action to resolve drainage problems. The smaller districts would be more adversely affected (at least five of them in the drainage study area could lose more than 50 percent of their assessment base through land abandonment). Some water management districts might be forced to merge and/or centralize operations to meet growers' needs and would probably not be capable of resolving drainage problems without considerable assistance from other agencies.

OPTIONS FOR DRAINAGE-WATER MANAGEMENT

The Drainage Program has identified a broad range of individual structural and nonstructural management options, which analyses show have potential for helping to solve subsurface agricultural drainage and related problems in the San Joaquin Valley. Some 80 options, classified into seven categories, were identified and described in the Program's *Preliminary Planning Alternatives* report of August 1989. The options are the basic building blocks of the alternative plans. However, no single option will achieve all the desired results. Several of them, fitted together into a coordinated, comprehensive plan for action, could be effective in managing drainage problems. The mix of options will have to be varied to accommodate local and regional differences in drainage problems and opportunities for solution. Different mixes of options are emphasized in the alternatives described later in this chapter. The options shown through analysis to be most useful in drainage problem management at this time are briefly discussed in the following sections.

Drainage-Water Source Control

A first step in solving valley drainage problems is to reduce the production of potential drainage water; that is, to control drainage production at the source. Source control options encompass a broad array of measures to apply irrigation water more efficiently and to manage land and water

in ways that reduce the magnitude and adverse effects of drainage and drainage-related problems. Options included in the alternatives are:

- **Water conservation:**
 - Improve existing irrigation practices and/or adopt new irrigation methods.
 - Improve irrigation scheduling.
 - Improve management of irrigation systems.
 - Manage the water table to increase its contribution to crop evapotranspiration.
- **Change in land use:**
 - Cease irrigation of lands that have high salinity and selenium concentrations in underlying shallow ground water and that are difficult to drain.

Each of the alternatives presented later in this chapter includes some degree of source control. Water conservation and retirement of lands from irrigated agriculture are discussed separately as drainage management plan components.

Ground-Water Management

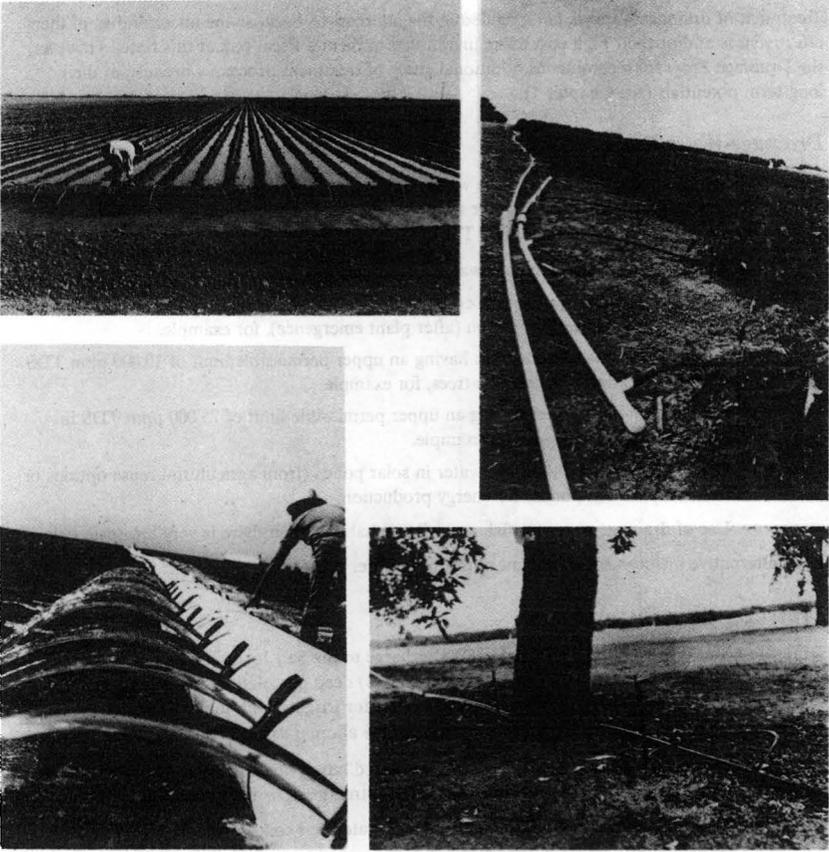
In some parts of the principal study area, water in the semiconfined aquifer above the Corcoran Clay (Figure 4) is of suitable quality for direct application in irrigation.⁽¹⁾ This water occurs in both the Sierran sediments and the Coast Range alluvium parts of the aquifer. Where there is an adequate vertical hydraulic connection between waterlogged lands and this deeper, usable ground-water zone, pumping from the zone may be used to lower the water table. Planned application of pumped water as a substitute for a portion of the surface-water irrigation supply could bring the system into hydrologic balance and stabilize the water table at a lower depth. This would make part of the surface-water supply currently required for that area available for other uses.

Drainage-Water Treatment

Various drainage-water treatment processes have been investigated at several levels of development. The goal of these investigations has been to identify methods of removing trace elements of concern (mainly selenium) from drainage water.

These processes have not been investigated equally or developed to the same level of technology. A review of the capabilities and limitations of processes investigated was completed and is presented in Hanna, et al., 1990. A few, such as anaerobic-bacterial treatment, high-rate algal ponds, and ferrous hydroxide, have advanced beyond laboratory bench-scale research. However, investigations of even these methods are incomplete, and more work with larger scale "pilot" or "prototype" plants is needed to establish technical performance and reliable cost estimates. Moreover, there has been no substantial operational experience with any drainage-water treatment process. The most promising new processes for selenium removal are biological processes. Of these, research is most advanced on the anaerobic-bacterial process. Research and demonstration are continuing on the physical and chemical removal of selenium, such as the work being done on iron filings at Panoche Water District, and this procedure should be pursued further. Reverse osmosis and other desalting methods are proven but high-cost methods.

¹ Blending with other irrigation water supplies to make possible the use of saline ground water on crops normally grown in the drainage problem area was not included as an alternative plan component.



Irrigation water can be applied more efficiently by using shortened furrow lengths (upper left), drip systems (upper right), gated pipe (lower left), and microprinters (lower right).

Treatment of drainage water is not included in the alternatives because the uncertainties of their effectiveness and/or their high cost make investment in them a fiscal risk at this time. However, the Drainage Program recommends additional study of treatment processes because of their long-term potentials (see Chapter 1).

Drainage-Water Reuse

Of the various possible reuses of drainage water, irrigation (including salt-tolerant trees and halophytes), fish and wildlife habitat water supply, and solar ponds for energy production appear to have the greatest promise at this time. The options considered for the alternatives are:

- Reuse of subsurface drainage water for agriculture:
 - Reuse on very salt-tolerant crops having an upper permissible limit of 2,500 ppm TDS in water supply; cotton (after plant emergence), for example.
 - Reuse on salt-tolerant trees having an upper permissible limit of 10,000 ppm TDS in water supply; eucalyptus trees, for example.
 - Reuse on halophytes having an upper permissible limit of 25,000 ppm TDS in water supply; atriplex, for example.
- Use of concentrated drainage water in solar ponds (from agricultural reuse options or from evaporation ponds) for energy production.
- Use of drainage water for fish and wildlife habitat when there is very low toxic risk.

Each alternative includes some amount of drainage-water reuse.

Drainage-Water Disposal

Drainage-water disposal options include: (1) Discharge to the San Joaquin River, with and without dilution; (2) discharge to evaporation ponds; (3) deep percolation into ground water; (4) injection into deep geologic formations; and (5) use for irrigation on the eastern side of the valley. The following are considered for inclusion in the alternatives at this time:

- Discharge to the San Joaquin River without dilution (including use of portions of the San Luis Drain to convey drainage water to treatment or disposal areas).
- Discharge to ponds to evaporate drainage water and concentrate dissolved constituents.
- Deep percolation into the semiconfined aquifer.

Westlands Water District continues to experiment with deep-well injection and, if successful, may use option (4), immediately above.

Fish and Wildlife Measures

Fish and wildlife measures have been developed that address the Drainage Program's goal to "protect, restore, and to the extent practicable improve fish and wildlife resources of the San Joaquin Valley." Options included here are those which could be undertaken in concert with other options to address drainage-related problems. Options for improvement of fish and wildlife

resources are discussed in the Drainage Program's *Preliminary Planning Alternatives* report. Options considered for inclusion in the alternatives at this time are:

- Protection (in addition to the assumed enforcement of water-quality, wildlife, and other environmental laws):
 - Modify evaporation pond design, construction, operation, and monitoring so that ponds are bird-safe or bird-free.
 - Develop definite plans for evaporation pond closure when closure appears to be necessary or inevitable.
 - Provide alternative habitat (including adequate water supplies) near evaporation ponds that require hazing because they are unsafe for birds.
- Restoration:
 - Flood and flush habitat with freshwater.
 - Manage soil and vegetation to decontaminate wildlife habitat.
- Substitute water supplies for fish and wildlife to replace contaminated drainage water. Substitute water would also improve protection and assist restoration. (These options must include modifications of existing supply or drainage systems to allow delivery of water to fish and wildlife areas directly, or by exchange arrangements.)
 - Use water saved from source-control options (that is, on-farm water conservation and/or land retirement).
 - Use wetland areas to seasonally store agricultural water supplies for release during April and May to improve fish habitat in the San Joaquin River.
 - Use ground water produced by ground-water management options.
 - Use nontoxic drainage water to produce saline wetlands.

Institutional Changes

Growers and private and public fish and wildlife managers operate within a framework of Federal, State, and local laws, policies, and practices. Some changes in the existing institutional framework may help solve drainage problems, directly or indirectly, by allowing implementation of plan components that otherwise might not be undertaken. The options listed here appear to be those most likely to be used in helping solve the drainage problem. A long list of potential institutional changes was provided and discussed in the Drainage Program's *Preliminary Planning Alternatives* report. Analysis of potential changes is provided in the Natural Heritage Institute report on institutional change (Thomas and Leighton-Schwartz, 1990). The primary options being considered are:

- Use of tiered irrigation water pricing, or other types of financial incentives, by water districts, the Central Valley Project, or the State Water Project.
- Drainage contribution surcharge on irrigation water.
- Modification of water-transfer and water-marketing policy and laws.
- Formation of regional drainage management entities that might be structured as special districts, joint powers authorities, or nonprofit mutual benefit cooperatives.

Evaluation of Options

Before options are used in alternatives, it is necessary to: (1) Determine the geographical applicability of the options, and (2) evaluate their cost, performance, and impacts. The shallow ground water quality zones shown in Figure 18 are the units used for evaluation.

Options are applied within the framework of objectives and standards shown in Table 7. The applicability of drainage management options to each of the drainage water quality zones, under either performance Level A or B, is displayed in Tables 15 and 16, respectively. Source control is applicable in every area. Discharge of drainage water to the San Joaquin River is applicable in the Northern Subarea and in two areas of the Grasslands Subarea. Salt-tolerant trees can be grown to transpire drainage water in 10 of the 16 areas. Trees cannot be grown in the other six areas because drainage water from field crops (water supply for trees) will exceed 10,000 ppm total dissolved solids (salt). Growing extremely salt-tolerant plants, such as saltbush, is not precluded in any area. Table 15 shows that, under performance Level A, land retirement may be applicable in some shallow ground-water areas where dissolved selenium is above 200 ppm. Table 16 shows that, under performance Level B, much more area is candidate for retirement when the criterion is lowered to 50 ppb. Existing evaporation ponds may be continued under both A and B performance levels, but only if they are bird-safe or can be made bird-free. The assumed safe level of selenium concentration for Levels A and B are 5 ppb and 2 ppb, respectively. In the ground-water management option, water may be pumped from the semiconfined aquifer when the thicknesses of suitable aquifer materials exceed 100 feet (Level A) or 200 feet (Level B) and the quality of the water produced is suitable for irrigation.

The results of an evaluation of the options considered effective and available are presented in Table 17. The evaluation is based on uncertainty analyses, economic analyses, and standard impact assessment techniques.

In addition to the restraints provided by the planning objectives, criteria, and standards given in Table 7, the evaluation of options in Table 17 should shape the extent to which a given option can be used in an alternative. Table 17 indicates that virtually all options have some limitations or produce an adverse effect on an important parameter of interest; for example, fish and wildlife, the economy, or the local community. Conversely, each option shows characteristics and effects beneficial to some interests. Judgment has to be exercised in determining the emphasis to place on a given option, considering the balance of effects. The lowest-net-cost option is sought, but not at the expense of significant risk to other interests.

The evaluation reveals that, although some options are cost-effective, certain risks must be acknowledged. For example, the feasibility of discharge to the San Joaquin River might be affected significantly by possible future changes in water-quality regulations. Similarly, reuse might be affected by significant adverse effects on wildlife. In contrast, the risks of reuse of drainage water are less than the risks of evaporation ponds, and reuse has a comparative cost advantage. (Measures considered promising to make evaporation ponds bird-free or bird-safe are included in cost estimates.) Therefore, it is concluded that, comparatively, use of evaporation ponds should be minimized and reuse maximized.

Table 15. APPLICABILITY OF DRAINAGE MANAGEMENT OPTIONS
LEVEL "X" PERFORMANCE STANDARDS

Subareas and Water Quality Zones	Drainage Source Control	San Joaquin River Discharge ¹	Salt-Tolerant Trees	Halo-phytes	Land Retirement ²	Existing Evaporation Ponds	New Evaporation Ponds ³	Ground Water Management ⁴
Grasslands								
A	X	Y(15.5k AF)	X	X	Y(37.4k Ac.)	Y(0.1k Ac.)	NA(>5 ppb Se)	Y(2k Ac.)
B	X	Y(4.0k AF)	X	X	NA(<200 ppb Se)	NA	X	Y(51k Ac.)
C	NR	X	NR	NR	NR	NR	NR	NR
D ⁵	NR-W	NR-R	NR-W	NR-W	NR-W	NR-W	NR-W	NR-W
Wetlands								
A	X	NA	X	X	Y(7.6k Ac.)	NA	NA(>5 ppb Se)	Y(9k Ac.)
B	X	NA	NA(>10k ppm TDS)	X	Y(7.0k Ac.)	Y(0.1k Ac.)	NA(>5 ppb Se)	NA(<100 ft. thick)
C	X	NA	X	X	NA(<200 ppb Se)	NA	NA(>5 ppb Se)	Y(69k Ac.)
D	X	NA	X	X	NA(<200 ppb Se)	Y(0.4k Ac.)	NA(>5 ppb Se)	Y(43k Ac.)
Tulare								
A	X	NA	X	X	NA(<200 ppb Se)	Y(0.5k Ac.)	X	Y(34k Ac.)
B	X	NA	NA(>10k ppm TDS)	X	NA(<200 ppb Se)	Y(3.6k Ac.)	NA(>5 ppb Se)	NA(<100 ft. thick)
C	X	NA	X	X	NA(<200 ppb Se)	Y(0.2k Ac.)	NA(>5 ppb Se)	NA(<100 ft. thick)
D	X	NA	NA(>10k ppm TDS)	X	NA(<200 ppb Se)	Y(0.3k Ac.)	NA(>5 ppb Se)	Y(38k Ac.)
E	X	NA	X	X	NA(<200 ppb Se)	Y(0.3k Ac.)	X	Y(100k Ac.)
Kern								
A	X	NA	NA(>10k ppm TDS)	X	Y(2.2 Ac.)	Y(1.3k Ac.)	NA(>5 ppb Se)	NA(<100 ft. thick)
B	X	NA	NA(>10k ppm TDS)	X	NA(<200 ppb Se)	NA	NA(>5 ppb Se)	NA(<100 ft. thick)
C	X	NA	X	X	NA(<200 ppb Se)	Y(0.2k Ac.)	X	NA(<100 ft. thick)
D	X	NA	NA(>10k ppm TDS)	X	Y(0.9k Ac.)	Y(0.2k Ac.)	NA(>5 ppb Se)	NA(<100 ft. thick)

¹ Applicability of option depends on the selenium criterion (mean monthly concentration of 8 ppb) and a critical water year hydrology (for example, 1986-87) for San Joaquin River near Newman. Selenium load is expected to decrease up to 50% by 2040 as a result of the gradual removal of selenium from the shallow ground water and soils due to the leaching process.

² The selenium concentration of 200 ppb in the shallow ground water was used to select lands on which irrigated agriculture would be discontinued.

³ New evaporation ponds can be used when drainage water selenium concentration exceeds 5 ppb and is ≤ 50 ppb only if ponds can be made bird-safe or bird-free. Measures necessary to make ponds bird-free will include alternative habitat with an adequate firm water supply.

⁴ Option limited by the aquifer thickness and quality of the ground water (less than 1,250 ppm TDS).

⁵ Managed wildlife wetland area.

X Option is applicable without any limitation in its application.

Y Option is applicable but limited to the quantities and units included in the parentheses.

NA Option not applicable because it fails to meet the performance standard in parentheses (see Table 7) or not physically available in the instances of

discharge to the San Joaquin River.

NR Option not suggested because increased conservation with resulting increased salinity will reduce the likelihood that drainage water can be used for wetland habitat.

NR-W Option is not applicable since shallow ground water within wetlands is not a problem; it benefits waterfowl.

**Table 16. APPLICABILITY OF DRAINAGE MANAGEMENT OPTIONS
LEVEL "B" PERFORMANCE STANDARDS**

Subareas and Water Quality Zones	Drainage Source Control	San Joaquin River Discharge ¹	Salt-Tolerant Trees	Halo-phytes	Land Retirement ²	Existing Evaporation Ponds	New Evaporation Ponds ³	Ground Water Management ⁴
Grasslands								
A	X	Y(4.5k AF)	X	X	Y(90.0k Ac.)	Y(0.1k Ac.)	NA(> 5 ppb Se)	Y(17k Ac.)
B	X	Y(4.0k AF)	X	X	Y(0.3k Ac.)	NA	X	Y(16k Ac.)
C	NR	X	NR	NR	NR	NR	NR	NR
D ⁴	NR-W	NR-R	NR-W	NR-W	NR-W	NR-W	NR-W	NR-W
Wetlands								
A	X	NA	X	X	Y(23.2k Ac.)	NA	NA(> 2 ppb Se)	NA(< 200 ft. thick)
B	X	NA	NA(> 10k ppm TDS)	X	Y(39.4k Ac.)	Y(0.1k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft. thick)
C	X	NA	X	X	Y(57.9k Ac.)	NA	NA(> 2 ppb Se)	Y(54k Ac.)
D	X	NA	X	X	NA(< 50 ppb Se)	Y(0.4k Ac.)	NA(> 2 ppb Se)	Y(31k Ac.)
Tulare								
A	X	NA	X	X	NA(< 50 ppb Se)	Y(0.5k Ac.)	X	Y(21k Ac.)
B	X	NA	NA(> 10k ppm TDS)	X	NA(< 50 ppb Se)	Y(3.6k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft. thick)
C	X	NA	X	X	NA(< 50 ppb Se)	Y(0.2k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft. thick)
D	X	NA	NA(> 10k ppm TDS)	X	NA(< 50 ppb Se)	Y(0.3k Ac.)	NA(> 2 ppb Se)	Y(33k Ac.)
E	X	NA	X	X	NA(< 50 ppb Se)	Y(0.3k Ac.)	X	Y(95k Ac.)
Kern								
A	X	NA	NA(> 10k ppm TDS)	X	Y(219.5 Ac.)	Y(1.3k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft. thick)
B	X	NA	NA(> 10k ppm TDS)	X	NA(< 50 ppb Se)	NA	NA(> 2 ppb Se)	NA(< 200 ft. thick)
C	X	NA	X	X	NA(< 50 ppb Se)	Y(0.2k Ac.)	X	NA(< 200 ft. thick)
D	X	NA	NA(> 10k ppm TDS)	X	Y(23.6k Ac.)	Y(0.2k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft. thick)

¹ Applicability of option depends on the selenium criterion (mean monthly concentration of 2 ppb) and a critical water year hydrology (for example, 1986-87) for San Joaquin River near Newman. Selenium load is expected to decrease up to 50% by 2040 as a result of the removal of salts from the shallow ground water and soils due to the leaching process.

² The selenium concentration of 50 ppb in the shallow ground water was used to select lands on which irrigated agriculture would be discontinued.

³ New evaporation ponds can be used when drainage water selenium concentration exceeds 2 ppb and is ≤ 50 ppb only if ponds can be made bird-safe or bird-free. Measures necessary to make ponds bird-free will include alternative habitat with an adequate firm water supply.

⁴ Option limited by the aquifer thickness and quality of the ground water (less than 1,250 ppm TDS).

⁵ Managed wildlife wetland area.

X Option is applicable without any limitation in its application.

Y Option is applicable but limited to the quantities and units included in the parentheses.

NA Option not applicable because it fails to meet the performance standard in parentheses (see Table 7) or is not physically available in the instances of discharge to the San Joaquin River.

NR Option not suggested because increased conservation with resulting increased salinity will reduce the likelihood that drainage water can be used for wetland habitat.

NR-W Option is not applicable since shallow ground water within wetlands is not a problem; it benefits waterfowl.

Table 17
SUMMARY EVALUATION OF OPTIONS CONSIDERED FOR DRAINAGE MANAGEMENT ALTERNATIVES¹

Option	Annual Cost/ Acre of Land Served	Remarks on Costs	Engineering (Phys- ical) Feasibility	Social Effects	Institutional	Effects on Envi- ronment and Public Health	Agriculture	Fish and Wildlife	Economic
Source con- trol (con- firm reduc- tion of applied wa- ter)	\$60	Costs based on currently available methods to reduce irrigation water application.	(+) Available and proven technology; (0) would save only part of problem. Some deep percolation would con- tinue.	(+) Enhances lo- cal control; (+) spinoff advan- tages in more trained personnel.	(+) Simplicity (means are available); (0) depends on ac- ceptance by pri- vate sector.	(+) Reduces risk of insect or vector prob- lem; (0) may increase concentration of dis- solved constituents in receiving waters.	(+) Increases over- all efficiency of irri- gated farming and may increase pro- duction; (-) general- ly requires addition- al economic and la- bor input.	(+) Fresh water that could be reallocated for fish and wildlife.	(+) Lowest cost drainage manage- ment method available to grow- er.
Reuse: sal- tolerant crops, trees, halophytes ²	\$150-160	Includes evapora- tion ponds for fi- nal disposal. Total costs are reduced by \$47/ton of wood fiber.	(+) Proven technology, although yet to be demonstrated at scale needed; (-) complex operation requiring on- farm changes; (0) needs disposal process, 4-8, evaporation ponds, to complete process.	(0) Raises skill re- quirements for farm labor; (-) possible increas- ing commitment to self-sufficiency tree monoculture.	(0) Need to im- plement on large scale prob- ably invites more govern- ment involve- ment.	(-) Adverse air impact possible if wood fiber used in valley for co- generation of power; (+) deepening valley through qual- ity through consump- tion of CO ₂ and pro- duction of O ₂ .	(-) Trees and shrubs would not yield a net profit as alter- nate crops; (0) may allow some on-farm management of drainage water.	(0) Increases ter- restrial habitat, but may create new contaminant hazards.	(+) Could pro- duce substantial benefits from harvested wood, but value of shrubs uncertain.
Ground wa- ter manage- ment ²	\$160-185	Based on 200-gpm wells on 1/2-mile grid. Total costs lowered by \$50/AF value of water produced.	(0) Proven technology, but no operational ex- perience for this pur- pose.	(0) Requires vol- untary com- pliance or im- posed control.	(-) May require change in laws or their admin- istration; litiga- tion likely on ef- fect	(-) Could accelerate degradation of poten- tial and existing water supplies.	(+) Provides addi- tional alternate wa- ter supply during drought; (-) during wet years pumping is still required.	(+) Produces wa- ter that may be adequate in qual- ity and could be made available for fish and wild- life.	(0) Relatively ex- pensive, but pro- vides water sup- ply; (-) accelera- tes degradation of water, making leaching more ex- pensive.

Table 17 (continued)
 SUMMARY EVALUATION OF OPTIONS CONSIDERED FOR DRAINAGE MANAGEMENT ALTERNATIVES¹

Option	Annual Cost/Acre of Land Served	Remarks on Costs	Engineering (Physically) Feasibility	Social Effects	Institutional	Effects on Environment ² and Public Health	Agriculture	Fish and Wildlife	Economic
Discharge through San Luis Drain to San Joaquin River ²	\$120	Costs include cleaning, extending and maintaining part of San Luis Drain chiefly for Grasslands drainage problem area A.	(+) Simple but could require many years to implement, depending on environmental regulations, funding, and time requirements.	(0) Trends toward regional management of drainage; (-) likely objection by downstream water users despite water quality objectives being met.	(0) See "Social Effect" column; (-) objections from other regions are likely.	(+) Minimizes risks of consuming selenium from fish and wildlife taken in Grasslands; (-) some occupational exposure possible during cleanup and disposal of 60-100 cu yd of sediment.	(-) Conceptually effective, but entities dependent on this service could be jeopardized by any shift from regulations on contaminant concentration to regulations on load; (+) achieves salt balance.	(+) Drainage water bypassing sloughs and wetlands would provide additional protection. (Receiving water quality objectives would have to be met.)	(0) Cost to rehabilitate drain may be offset by benefit of providing drainage service.
Evaporation ponds: existing, new, and accelerated ²	\$180-300	Costs rise as inflow selenium increases; cost of construction and operation of alternate wetland habitat included. Closure or solid waste disposal is not included.	(0) Some aspects require technology now under development and a careful integration of ponds into total drainage system.	(0) Raises skill needs for pond operators.	(-) Uncertainty about extent of implementation of federal and state laws.	(-) Some existing ponds contaminate wildlife with selenium to unsafe levels (as game); (-) unless well managed and with applications of emerging technologies, ponds will be hazardous; (-) long-term problem of disposal of toxic precipitates; (-) possible occupational hazard.	(+) Method allows a range of size of operations, only single, effective means of disposal now available to some lands; (-) becoming more costly and difficult to meet environmental objectives.	(-) Some existing ponds produce significant adverse effects; (0) existing and new ponds would have to be bird-safe or bird-free; (0) one-for-one alternative habitat could be protective.	(-) May be very high cost if selenium concentrations are high. May not be affordable.
Land retirement	\$170	Estimated fair market value of \$1,500/ac for problem land and \$20/ac/yr land maintenance cost.	(+) Simple; (0) requires some decommissioning of facilities.	(0) (-) Impacts on communities depend on amount of land retired and where freed water is used.	(0) May require new institutional arrangements; (-) repayment of federal and state water contracts.	(-) Eliminates any on-site hazards associated with drainage water and its problem solution, assuming alternate land use and management are not a problem.	(-) Lands lost for agricultural production, perhaps permanently; (+) Frees water that could be reallocated to agricultural use in watershed areas.	(+) Frees water that could be reallocated for fish and wildlife; (0) reuse of retired land as wildlife habitat is unproven.	(+) Requires only willing buyer and seller; (-) on water remains in impacted area; (+) water in other uses could increase in value.

Table 17 (continued)
 SUMMARY EVALUATION OF OPTIONS CONSIDERED FOR DRAINAGE MANAGEMENT ALTERNATIVES¹

Option	Annual Cost/Acre of Land Served	Remarks on Costs	Engineering (Physical) Feasibility	Social Effects	Institutional	Effects on Environment ² and Public Health	Agriculture	Fish and Wildlife	Economic
Biological treatment ² (10-mgd plant)	\$250	Estimates omit cost of sludge disposal. No cost reduction for byproduct recovery.	(0) Process works at small pilot scale but cannot meet water quality objectives without dilution; (-) needs field demonstration of pilot plant.	(0) Raises skill requirements for farm labor and new service.	(0) Tends to build case for regional management of drainage.	(+) Assuming proper design, operation, and control of basins, similar to existing municipal sewage treatment plants.	(+) Could be highly beneficial to agriculture, if costs could be lowered.	(+) Toxins would be removed and segregated; (0) or (-) if performance level requires diluting with fresh water.	(+) Effective treatment would be required to produce by-products that would enhance economy; (-) may be unaffordably expensive.
Discharge directly to San Joaquin River ³	\$60	Costs are for on-farm tile drains, plus water control facilities required to bypass or protect wetlands.	(0) Requires more effective monitoring of seepage sources; (+) simple to build.	(0) Raises skill needs and tends to support concept of regional management of drainage.	(0) Could be considered as preferred right to drainage held by owners; (0) or (-) depends on certain rights for water supply.	(0) Selenium standards would be met; (0) basin may be a limiting factor in the future.	(-) Conceptually effective, but detrimental to agriculture. Costs could be reduced by eliminating selenium concentration to those on load; (+) maintains salt balance.	(0) or (+) if controlled and monitored appropriately; otherwise, (-).	(-) Could adversely affect downstream water users if selenium and/or boron (temporarily) become excessive.
Provision of water to fish and wildlife ⁴	Assessment incomplete		(0) Requires full suite of planning, funding, design, and building for some areas; (+) other areas could be served immediately.	(+) Enhances recreation and variety and general livability of local area.	(+) Progress in this direction would lessen threats of litigation and improve the image of agriculture.	(+) Improved water conditions will increase stability of ecosystems and lessen public health risks.	(-) If seen as a competition for water; (+) possible balancing effects if increased water draws birds away from evaporation ponds.	(+) Meets some needs for protection, restoration, and substitute water supply.	(+) Improve resources valued by California; (+) improve hunting, fishing, and other activities.

1 Guide to ratings entered on evaluation sheet: (+) = potential beneficial effect, enhancing interests implied by column heading; (-) = potential negative effect, adverse to interests implied; (0) = neutral, or positive and negative aspects counterbalance.
 2 Source control is included within the costs shown as an initial step in application of this component.
 3 Able to drain directly to San Joaquin River because of low concentrations of selenium in water service area of exchange contractions.
 4 This item pertains to water-supply deficit due to drainage-related causes.
 5 Includes state water-quality objectives.

PLANNING ALTERNATIVES

Three planning alternatives were formulated that emphasize: (1) The conservation and reuse of agricultural water, (2) the extraction of irrigable water from deep within the semiconfined aquifer to lower the near-surface water table in waterlogged land areas, and (3) the retirement of irrigated agricultural lands overlying shallow ground water that contains greatly elevated concentrations of dissolved selenium. Two levels of performance, A and B, were applied to each alternative. These alternatives were devised to compare potential reduction in problem water volumes, if differing options for managing the drainage problem were emphasized. Four strategies involving major options that were employed in formulating the planning alternatives are discussed in the following sections.

Drainage Management Strategies Underlying the Alternatives

Four main strategies for management of drainage problems have emerged during the course of this study. These are source control, drainage water reuse, ground-water management, and land retirement. Each strategy is used to reduce problem water volumes in the three planning alternatives.

Source Control

The major source of recharge to the ground water system and subsequent production of drainage water is the portion of applied irrigation water that percolates past the crop root zone into the semiconfined aquifer. Some water must pass the root zone to leach salts and maintain soil productivity. Unnecessary deep percolation can be reduced mainly through better management of irrigation systems.

Current average deep percolation in the study area is estimated to vary from about 0.90 to 1.05 feet (Burt and Katen, 1988; D.G. Swain, 1990). Assuming 0.3 foot is the minimum amount necessary to achieve required salt leaching and is also the amount moving downward through the Corcoran Clay, nonbeneficial deep percolation contributes 0.60 to 0.75 foot annually to potential problem water.

Higher irrigation efficiencies leading to reduced deep percolation can be achieved by individual options or combinations of options. The most effective of these appear to be: (1) Improving management of irrigation systems, (2) improving present irrigation practices (for example, shortening furrows and using tailwater return systems, thus increasing uniformity of water application) and adopting new irrigation methods, and (3) improving irrigation scheduling. These and other options are discussed more fully in the Drainage Program's 1989 report, *Preliminary Planning Alternatives*.

Not all potential problem water is generated by deep percolation at a given site. Some lateral movement of water from upslope areas may also contribute to drainage problems downslope. This contribution varies considerably, depending upon local geologic and hydrologic conditions, but a drainage problem most often arises from practices and conditions at the site. Reduction of deep percolation, even in areas without present drainage problems, can help reduce the long-term regional drainage problem.

Drainage-Water Reuse

The concept of drainage-water reuse is shown in Figure 19. The objective is to reduce the volume of drainage water requiring ultimate disposal by reusing it on progressively more salt-tolerant crops. The volume of water would be reduced by evapotranspiration, with dissolved constituents such as salt, boron, and selenium becoming more concentrated and probably easier to manage in an environmentally safe manner. Volume reduction through reuse would substantially reduce disposal costs and treatment costs, if treatment became necessary.

The initial good-quality water supply would be used to grow high-value, salt-sensitive crops, such as vegetables. Drainage water captured in the tile drainage system under these lands would be collected and pumped into a local distribution system to become the water supply for a salt-tolerant field crop, such as cotton. (If this were not practicable, the drainage could go directly to trees.)

Drainage from these fields would become the water supply for salt-tolerant trees, such as eucalyptus. Trees would be used at this stage, not only because of their tolerance to salt, but also because they are capable of high transpiration rates (about 5 feet of water per year). Finally, drainage from the trees would be used on halophytes that grow in extremely saline conditions, such as atriplex or salt bush. Even halophytes have limits for total dissolved salts and certain other substances, such as boron. The levels of boron and total salinity of water in the root zone must be monitored and the fields drained to maintain growth.

At that stage of the reuse process, the extremely concentrated drainage water must be disposed of, or it could be stored in small evaporation ponds, treated to remove toxicants, or, when possible, injected into deep geologic formations. Water and salts from the evaporation ponds could also be used at solar-energy ponds or cogeneration facilities.

Figure 20 illustrates pond configurations that might be used as part of a drainage water management system. The *standard evaporation pond* shown would be similar to ponds traditionally used in the valley, except that it would be improved with steepened sides and greater depths to reduce wildlife food supplies and discourage wildlife use. In contrast to traditional ponds, the new standard pond would be smaller so that birds could be more effectively hazed from it to alternative safe wetland habitat (not shown on sketch) that would be provided in the vicinity.

The *nontoxic evaporation pond* would also provide safe wildlife habitat and would be designed for that purpose. The northern portion of the Tulare Subarea (Kings River Delta) appears to be an area in which drainage water could evaporate in ponds that would be safe for wildlife use.

The *accelerated rate ponds* would employ mechanical devices to increase the rate of evaporation. Used in a facility in El Paso, Texas, the device shown here reduced the volume of applied water by about 25 percent in one pass through the system. Use of an accelerated evaporation system greatly reduces pond area, but it increases the cost.

The *solar pond* shown would use very concentrated drainage water from either the standard or accelerated pond. The area covered by a solar pond would be small. This type of pond does not appear to attract birds. The value of the electrical energy generated would offset some of the total drainage system costs.

Figure 19. THE CONCEPT OF DRAINAGE-WATER REUSE

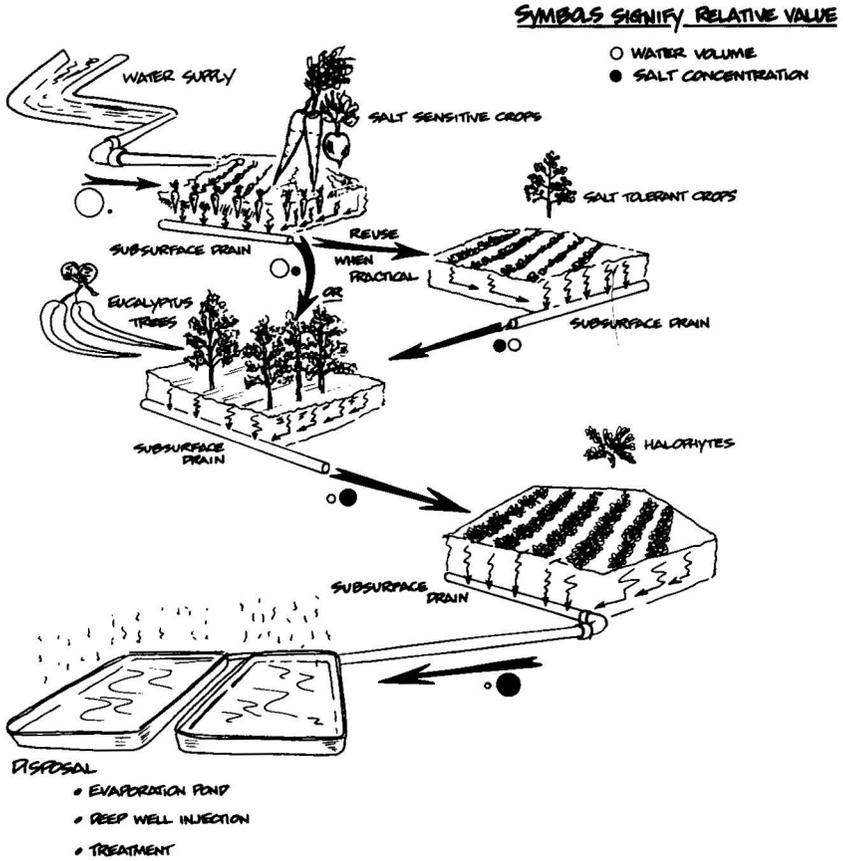


Figure 20. POND CONFIGURATIONS

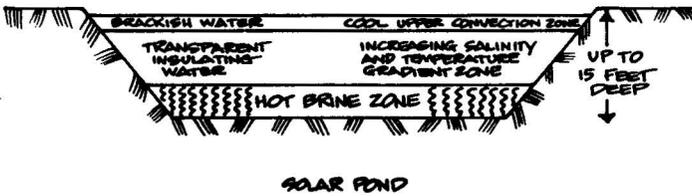
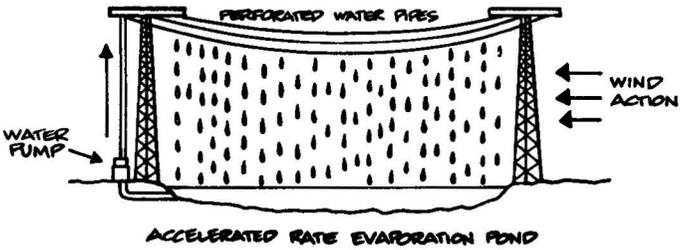
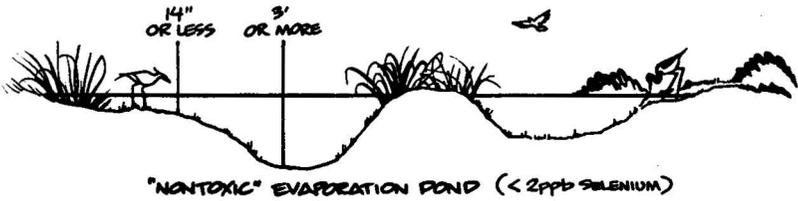
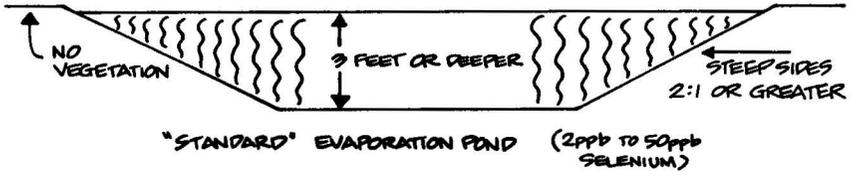
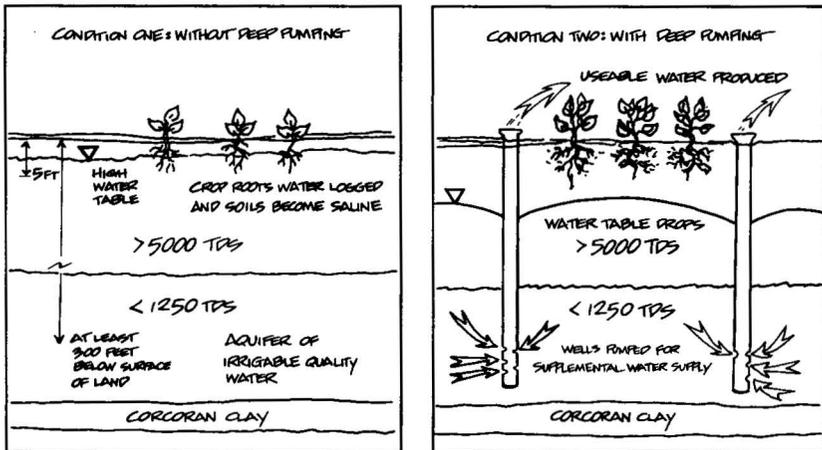


Figure 21. THE CONCEPT OF GROUND-WATER MANAGEMENT



The major benefit from the reuse strategy is the reduction of drainage-water volume. Volume could be reduced as much as 80 to 95 percent, depending on the crops, soils, and management of the system. A reduction in drainage-water volume translates to lower cost in final drainage-water management.

Ground-Water Management

The concept of ground-water management is to pump water, generally for irrigation, from the semiconfined aquifer above the Corcoran Clay to lower near-surface saline water tables (illustrated in Figure 21) and create a hydrologic balance that will keep the shallow water table below the crop root zone. In an unplanned manner, this strategy is currently being applied, to a minor extent, in the drainage problem area because some 2 million acre-feet of ground water is extracted annually from westside aquifers to supplement surface-water supplies. Although most of the pumping is from below the Corcoran Clay, the stress on the hydrologic system helps alleviate the subsurface drainage problem by providing storage space for deep percolation.

In this strategy, the ground water extracted would be in addition to present extractions, and would be designed specifically for each drainage problem area in which it was applicable. Wells would be perforated to produce water only from selected zones of the semiconfined aquifer. This method would be technically feasible only if all the following conditions existed in the subsurface aquifers under the drainage problem area: (1) Adequate vertical hydraulic interconnection

between the deep aquifer and the waterlogged surface lands (not applicable to the Tulare lakebeds where thick clays are present); (2) a sufficient volume of water in the deep aquifer to allow withdrawal for a reasonable period of time (for example, 20 years); and (3) a production (from the well) water quality of less than 1,250 ppm TDS, so it may be used for agricultural irrigation. Reconnaissance-level geohydrologic investigations indicate that these conditions probably exist beneath those parts of drainage problem areas shown in Figure 12.

Several aspects of this strategy need to be recognized as potentially limiting its overall feasibility, even though the controlled pumping that would occur under the strategy could be an improvement over existing pumping conditions. First, the periods during which wells must be pumped to lower the water table to the required depth and the period in which they are pumped to supply water for irrigation or other beneficial uses may not correspond. Second, the application of this alternative might be viewed as a planned degradation of ground water. This interpretation might be reached, even though the present extent of ground-water pumping produces a regional hydraulic stress that is causing water passing the root zone to move downward at an annual rate of 1 to 3 feet vertically, transporting with it accumulated salt, boron, selenium, and other substances. Third, if this alternative were to be economically feasible, the aquifer must be capable of producing water suitable for beneficial uses for at least 20 years.

Although recent study has removed considerable uncertainties (Schmidt, 1988 and 1989; Quinn, 1990; CH₂M Hill, 1990; Phillips, 1990), an additional significant limiting factor is the continuing lack of adequate geohydrologic information on ground-water systems in some parts of the drainage problem area.

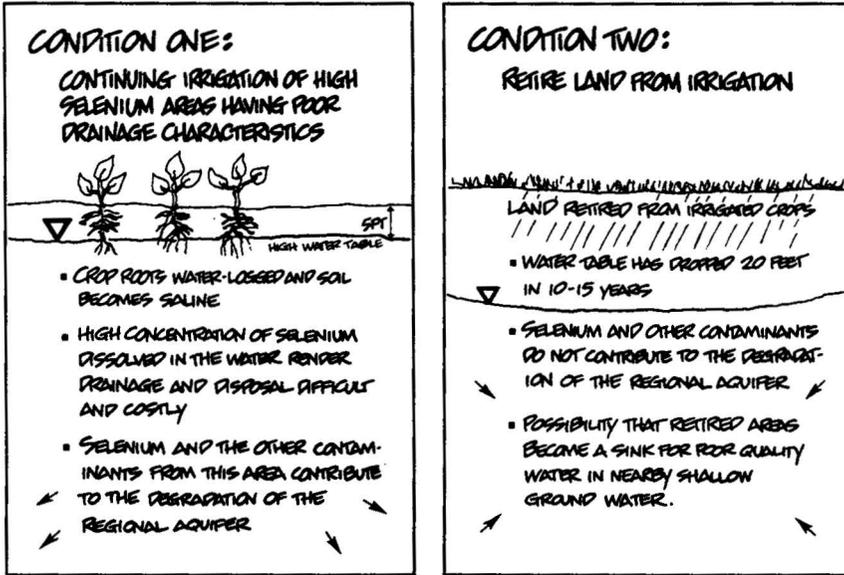
Land Retirement

The essential strategy of land retirement is to stop irrigating lands with poor drainage characteristics beneath which now lies shallow ground water so contaminated with selenium (and other substances) that drainage would be extremely difficult and the water produced would be costly to manage. Hydrologic investigations (Gilliom, et al., 1989b) indicate that, if a substantial land area (say, +5,000 acres) were retired from irrigation, the shallow water table beneath those lands would drop. To some extent, instead of contributing to their contamination, the dewatered area beneath the retired lands would then become a sink to receive some contaminated water from adjacent lands. Figure 22 illustrates how land retirement would lower ground-water levels.

The feasibility of this strategy hinges on the existence of shallow ground-water areas in which concentrations of selenium are much greater than those of surrounding areas. Figure 23 shows areas in which selenium concentrations in shallow ground water are more than 50 and 200 parts per billion. Areas over 200 parts per billion are considered to be "hot spots" and special candidates for retirement. The feasibility of land retirement also may depend on the existence of compensating benefits in the form of overall reduced costs of handling the drainage problem regionally, or in economic return to landowners from the sale or lease of the water supply no longer used for irrigation.

A related aspect of land retirement is that it could be considered a land reserve and, if at some future time, the problem necessitating retirement were to be resolved, the land could be used again for irrigated agriculture.

Figure 22. THE CONCEPT OF LAND RETIREMENT



Description of Alternatives

The following alternatives are analyzed and evaluated to subarea scope and detail.

Northern Subarea

Alternatives for problem water reduction were not prepared for the Northern Subarea because two factors that tend to motivate major changes in management of drainage problems are largely missing in this part of the valley. First, the shallow ground water is of relatively good quality and low in concentrations of dissolved gypsum, a substance that contributes greatly to problems of westside salinization of soil and ground water (D.G. Swain, 1990).

Second, growers in the Northern Subarea are solving their drainage problems by draining their land and discharging about 20,000 acre-feet per year to the San Joaquin River. If water-quality objectives on the river do not change materially, growers would likely continue discharging to the river.

In addition to controlled subsurface drainage water, the San Joaquin River also receives about 100,000 acre-feet of ground water seepage annually from the Northern Subarea (CH₂M Hill, 1988), an unknown portion of which is related to irrigation water application. Because of the large volume, this flow contributes about 25 percent of the annual salt load flowing into the San Joaquin River at Vernalis, primarily during low flows.

Nishimura and Baughman (1989) have considered this phenomenon and remedial actions that might be both possible and necessary if more strict salt objectives were set for the San Joaquin River. One of the concepts mentioned prominently is a line of shallow wells that would be pumped during high river flows to evacuate the shallow ground water and create additional storage space for drainage water that would otherwise seep into the river during low-flow periods. Hydraulic and engineering studies conducted by the U.S. Bureau of Reclamation were reviewed by D.G. Swain (1990), who concludes that the concept of seasonal evacuation to halt the seepage (which could pose a problem during low flows) would not be effective because the San Joaquin River lacks the capacity to assimilate salt in most high-flow seasons. There would simply be too few opportunities to pump the interceptor wells because of the limited number of days in which the river has assimilative capacity.

If measures were to be adopted within the subarea to lower the shallow water table adjacent to the San Joaquin River, these could reduce some of the salt load to the river because more salt would be stored in ground water. Two measures that are technically available are: (1) Improving on-farm water application to reduce deep percolation to ground water, and (2) changing the present pattern of surface- and ground-water use to greatly increase the volume of ground water extracted. Presently, only an estimated 30,000 acre-feet per year are pumped from the combined semiconfined and confined aquifers. (In the Northern Subarea, the aquifers are highly interconnected through gravel-packed and multiple-zone wells.) At present, about 94 percent of the agricultural water supply in the Northern Subarea is obtained from the combined sources of the San Joaquin River and the Delta-Mendota Canal. Substituting ground water pumped from below the irrigated area for a portion of this imported surface water would lower the water table and reduce seepage to the San Joaquin River. However, the subsurface drainage that would be discharged to the river would become more saline.

Grasslands Subarea

Figure 24 shows how various options would be combined to reduce problem water in the three planning alternatives. When read horizontally, the graphs show the effect on each option resulting from a shift from Level A to Level B performance standards. When read vertically, they show the effect on each option as the emphasis is changed from source control to ground-water management to land retirement. (Graphs are provided for this purpose in each subarea that follows.) Each Grasslands planning alternative includes the continued use of the San Joaquin River for disposal of some drainage water, although volumes would be reduced 15 to 20 percent under Level B selenium criteria, compared to the existing Level A criteria.

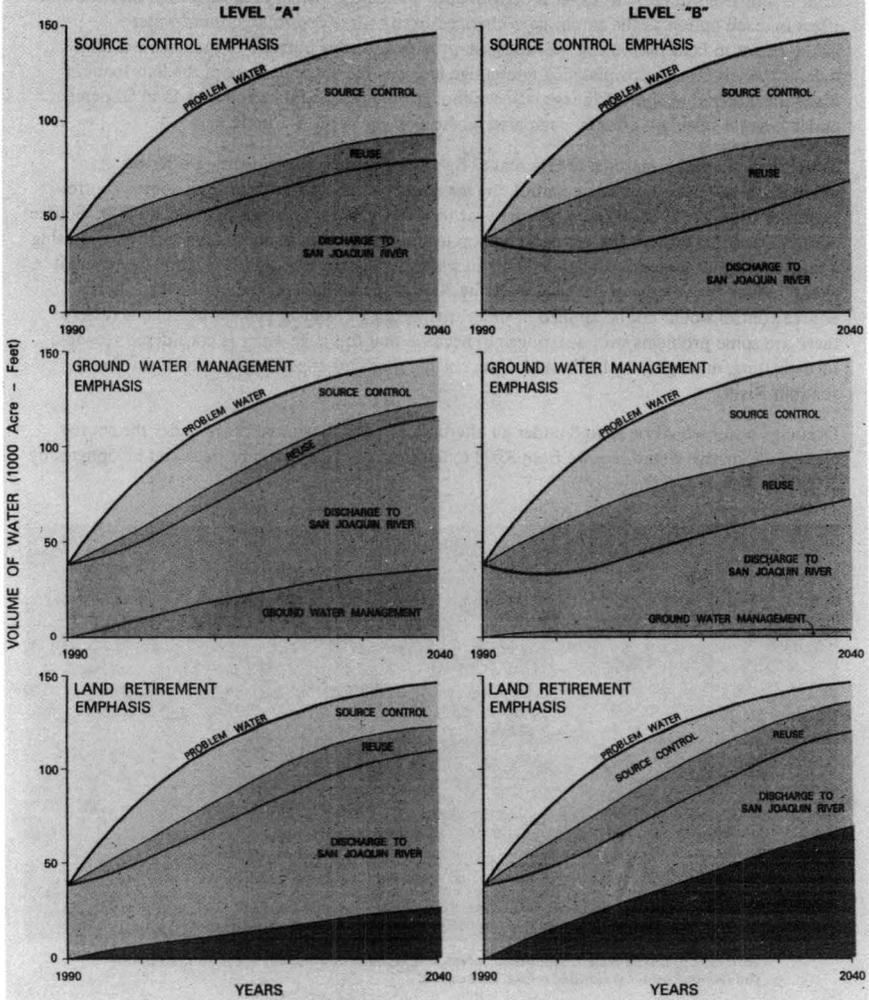
Table 18 shows major features of Grasslands Subarea planning alternatives. Under the alternatives emphasizing source control, the maximum water conservation from source control increases from about 30,000 acre-feet per year in 2000 to 50,000 acre-feet per year in 2040. Source control, featuring available water conservation technologies (such as shortening furrows and using a tailwater return system), is included only in water quality zones A and B (Figure 18), where it would reduce the volume of problem water by 30 to 40 percent, depending upon the criteria. Source control would not be applied in water quality zone C and 50 percent of Zone B (where there are some problems with waterlogging) because that drainage water is considered reusable for irrigating, managing wetlands, and/or increasing flow and improving quality of the San Joaquin River.

Drainage water would be reused under all alternatives. The maximum reuse under the source control alternative would require from 3,000 to 6,000 acres of salt-tolerant trees and halophytes by 2000 and 2040, respectively.



Wetlands in the Grasslands Subarea, which are laced with waterways, are flooded during the fall and winter waterfowl migration season.

Figure 24
PROBLEM WATER REDUCTION
GRASSLANDS SUBAREA



NOTE: Actions that reduce problem water less than 5000 acre-feet annually are not shown, but are discussed in the text.

Table 18. MAJOR FEATURES OF GRASSLANDS SUBAREA PLANNING ALTERNATIVES
In 1,000s

Performance Level and Plan Emphasis	Shallow Ground Water Area ¹	Land Affected ²	Problem Water Volume ³	Conserved Water ⁴	Land Re-using Drainage ⁵	Land Retired ⁶	Land Overlying GW Pumping ⁷	Area of Existing Evaporation Ponds	Area of New Evaporation Ponds
	Acres	Acres	Acres-feet	Acres-feet	Acres	Acres	Acres	Acres	Acres
A-2000									
Source Control	218.0	116.0	86.5	30.1	3.1	0.0	0.6	0.1	0.0
Ground Water Management	218.0	116.0	86.5	29.4	1.6	1.9	8.9	0.1	0.0
Land Retirement	218.0	116.0	86.5	26.4	2.1	10.7	0.7	0.1	0.0
A-2040									
Source Control	218.0	196.0	147.0	53.6	3.1	0.0	0.6	0.1	0.0
Ground Water Management	218.0	196.0	147.0	23.8	2.3	0.0	60.8	0.1	0.0
Land Retirement	218.0	196.0	147.0	26.6	2.8	32.3	0.8	0.1	0.0
B-2000									
Source Control	218.0	116.0	86.5	30.1	5.4	0.0	1.2	0.1	0.0
Ground Water Management	218.0	116.0	86.5	30.1	5.4	0.0	1.2	0.1	0.0
Land Retirement	218.0	116.0	86.5	22.1	3.7	23.0	0.2	0.1	0.0
B-2040									
Source Control	218.0	196.0	147.0	53.6	5.8	0.0	1.3	0.1	0.0
Ground Water Management	218.0	196.0	147.0	53.6	5.8	0.0	1.3	0.1	0.0
Land Retirement	218.0	196.0	147.0	13.8	3.0	70.2	0.7	0.0	0.0

1 Irrigated land area with a depth to shallow ground water less than 5 feet.

2 That portion of shallow water areas drained.

3 The forecasted annual drainage volume that must be managed; drained land x 0.75 acre-feet per acre of deep percolation

4 Water supply conserved by on-farm water conservation measures and management practices on problem water lands.

5 Acreage in trees and halophytes.

6 Lands targeted for retirement from irrigated agriculture (excluding lands designated for other uses).

7 Land area where pumping from the semiconfined aquifer is used to lower shallow water table below crop root zone.

Because of geohydrologic conditions, opportunities for deep pumping of the semiconfined aquifer are limited to about 60,000 acres, largely in problem zone A. No new evaporation ponds would be included with any alternative.

Under the land retirement alternative, retirement of irrigated land would be greater under Level B criteria and would increase from about 23,000 to 70,000 acres between 2000 and 2040.

Westlands Subarea

Figure 25 shows how various options would be combined to reduce problem water in the three planning alternatives. Each planning alternative places major reliance on source control for reducing problem water — up to a maximum of about 60 percent in 2040, under the source control alternative.

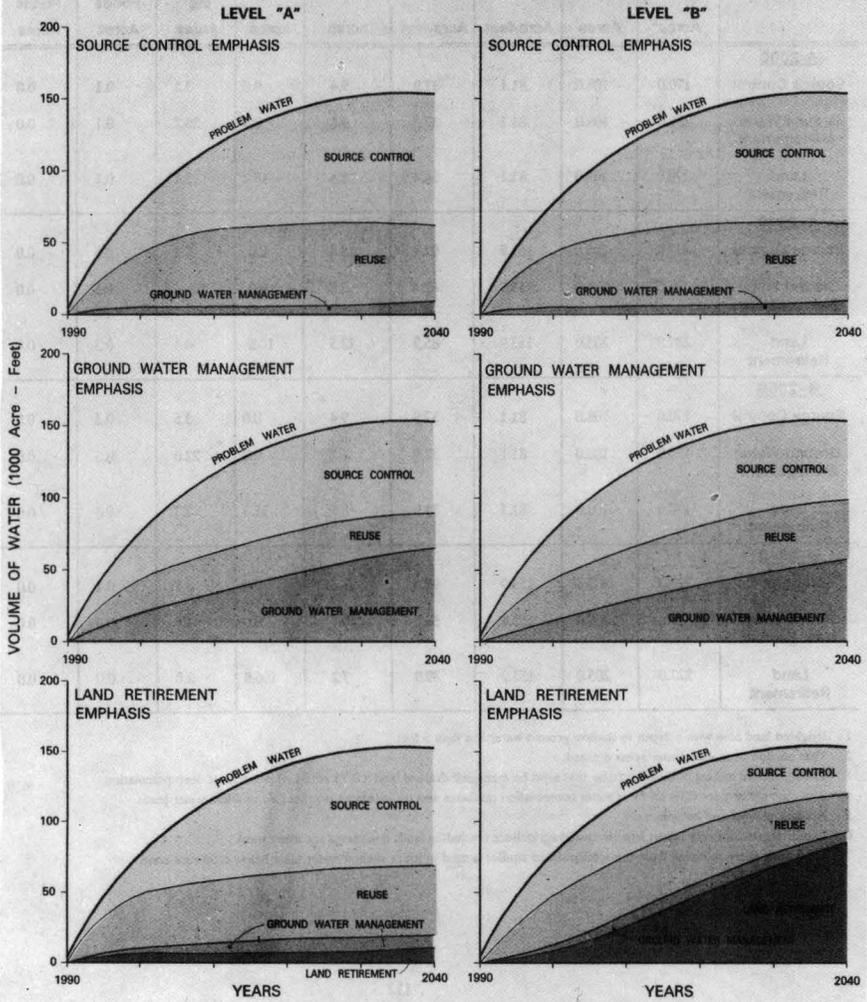
Table 19 shows major features of Westlands Subarea planning alternatives. The maximum water conservation from source control would be 38,000 acre-feet annually by 2000, and 92,000 acre-feet annually by 2040, under either performance Levels A or B.

Reuse of drainage water is a major feature of all alternatives for the Westlands Subarea. Under maximum reuse, 9,000 to 14,000 acres of trees and halophytes would be used to reduce problem water volume in 2000 and 2040, respectively.

Subsurface physical conditions most strongly favor deep pumping from the semiconfined aquifer to lower shallow ground-water levels in water quality zones C and D (Figure 18). Level A criteria, ground-water management alternative, shows the area of maximum pumping would increase from about 26,000 acres in 2000 to 107,000 acres in 2040.

Under Level B criteria for the land retirement alternative (all shallow ground-water areas above 50 ppb selenium), 12,000 acres would be retired from irrigation by 2000 and 107,000 acres by 2040. In contrast to areas suitable for ground-water management in the southeastern part of Westlands Subarea, areas that fit the criteria for land retirement are located primarily in the northern part. No new evaporation ponds would be included under any alternative.

Figure 25
PROBLEM WATER REDUCTION
WESTLANDS SUBAREA



NOTE: Actions that reduce problem water less than 5000 acre-feet annually are not shown, but are discussed in the text.

Table 19. MAJOR FEATURES OF WESTLANDS SUBAREA PLANNING ALTERNATIVES
In 1,000s

Performance Level and Plan Emphasis	Shallow Ground Water Area ¹	Land Affected ²	Problem Water Volume ³	Conserved Water ⁴	Land Re-using Drainage ⁴	Land Retired ⁵	Land Overlying GW Pumping ⁷	Area of Existing Evaporation Ponds	Area of New Evaporation Ponds
	Acres	Acres	Acres-feet	Acres-feet	Acres	Acres	Acres	Acres	Acres
A-2000									
Source Control	170.0	108.0	81.1	37.9	9.4	0.0	3.5	0.1	0.0
Ground Water Management	170.0	108.0	81.1	37.9	5.8	0.7	26.2	0.1	0.0
Land Retirement	170.0	108.0	81.1	34.4	8.4	10.2	3.1	0.1	0.0
A-2040									
Source Control	227.0	205.0	153.9	92.4	13.8	0.0	5.1	0.5	0.0
Ground Water Management	227.0	205.0	153.9	62.4	7.8	0.0	106.9	0.5	0.0
Land Retirement	227.0	205.0	153.9	85.7	12.5	14.5	4.6	0.3	0.0
B-2000									
Source Control	170.0	108.0	81.1	37.9	9.4	0.0	3.5	0.3	0.0
Ground Water Management	170.0	108.0	81.1	37.9	6.2	0.0	22.0	0.5	0.0
Land Retirement	170.0	108.0	81.1	33.9	8.5	11.5	2.7	0.3	0.0
B-2040									
Source Control	227.0	205.0	153.9	92.4	13.6	0.0	5.7	0.1	0.0
Ground Water Management	227.0	205.0	153.9	56.6	10.7	0.0	97.8	0.5	0.0
Land Retirement	227.0	205.0	153.9	39.9	7.2	106.9	2.0	0.0	0.0

1 Irrigated land area with a depth to shallow ground water less than 5 feet.

2 That portion of shallow water areas drained.

3 The forecasted annual drainage volume that must be managed; drained land x 0.75 acre-feet per acre of deep percolation

4 Water supply conserved by on-farm water conservation measures and management practices on problem water lands.

5 Acreage in trees and halophytes.

6 Lands targeted for retirement from irrigated agriculture (excluding lands designated for other uses).

7 Land area where pumping from the semiconfined aquifer is used to lower shallow water table below crop root zone.

Tulare Subarea

Figure 26 shows how various options would be combined in the Tulare Subarea to reduce problem water. Table 20 shows major features of Tulare Subarea planning alternatives. All plans include major reliance on source control for reducing problem water, up to a maximum of about 60 percent in 2040 under the source control alternative. The maximum water conservation through source control would be 44,000 acre-feet annually by 2000 and 156,000 acre-feet annually by 2040, under the source control alternative.

Reuse of drainage water is a major feature of the alternatives presented for the Tulare Subarea. Under the maximum reuse option, from 11,000 to 23,000 acres of trees and halophytes would be used in 2000 and 2040, respectively.

Conditions favorable for deep pumping of the semiconfined aquifer occur largely in areas influenced by the Kings River Delta: water quality zones A, D, and E (Figure 18). The planning criteria would allow pumping under a maximum of about 20,000 acres in 2000 and 135,000 acres in 2040. Ground-water management or evaporation ponds may be used in zone E, where drainage water is generally very low in dissolved selenium. No new evaporation ponds are included in any alternative. Further study may reveal that evaporation ponds in the South Kings River Delta (zone E) would be bird-safe because of low contaminant concentrations in drainage water.

No shallow ground water in the Tulare Subarea is known to be high enough in selenium concentration to exceed the 200 ppb planning criterion for land retirement. Alternatives emphasizing land retirement are included, but they are almost identical to the source control alternatives.

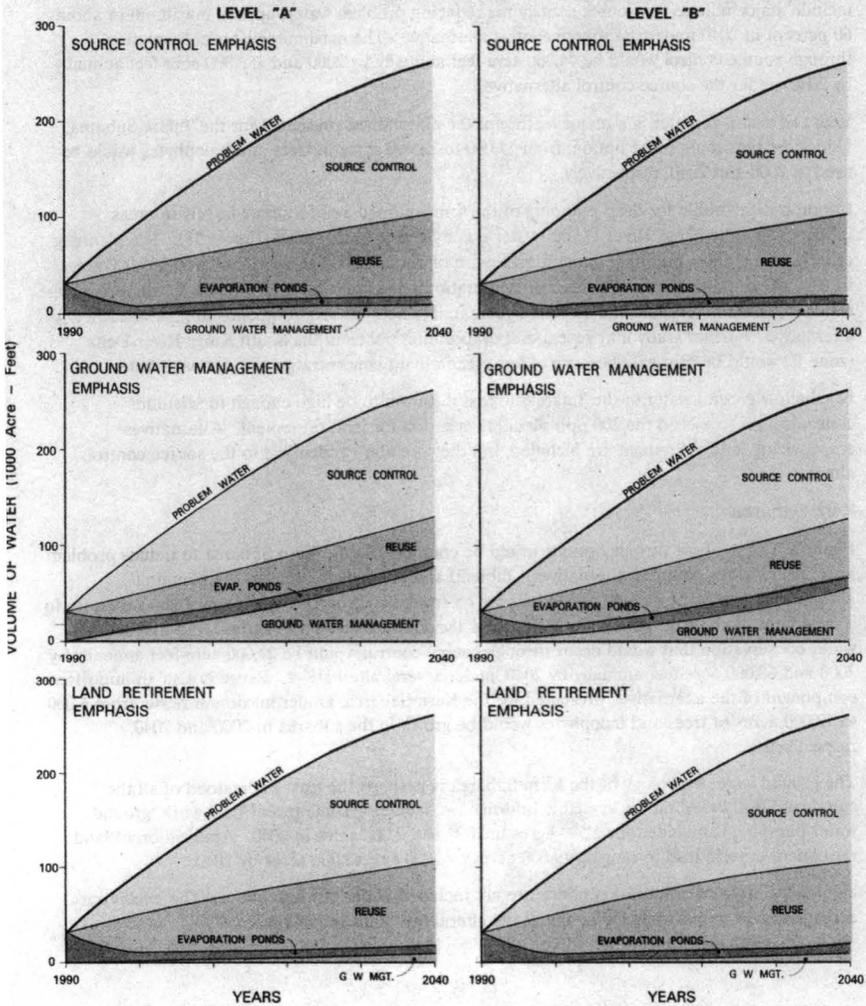
Kern Subarea

Figure 27 shows how various options would be combined in the Kern Subarea to reduce problem water in the three planning alternatives. Table 21 shows major features of the planning alternatives. All plans include major reliance on source control for reducing problem water, up to a maximum of about 55 percent in 2040, under the source control alternative. The maximum water conservation that would occur through source control would be 21,000 acre-feet annually by 2000 and 68,000 acre-feet annually by 2040, under several alternatives. Reuse is also an important component of the alternatives presented for the Kern Subarea. Under maximum reuse, from 6,000 to 12,000 acres of trees and halophytes would be grown in the subarea in 2000 and 2040, respectively.

The ground water hydrology of the Kern Subarea is perhaps the least understood of all the subareas. But, based on the available information, including some recent field work, ground water pumping is included for 1,500 acres in 2000 and 7,000 acres in 2040. Application of land retirement criteria lead to retiring 19,000 acres by 2000 and 43,000 acres by 2040.

Significant areas of evaporation ponds are not included under any alternative. The maximum acreage of new ponds included in any of the alternative plans is 1,600 acres.

Figure 26
PROBLEM WATER REDUCTION
TULARE SUBAREA



NOTE: Actions that reduce problem water less than 5000 acre-feet annually are not shown, but are discussed in the text.

Table 20. MAJOR FEATURES OF TULARE SUBAREA PLANNING ALTERNATIVES
In 1,000s

Performance Level and Plan Emphasis	Shallow Ground Water Area ¹	Land Affected ²	Problem Water Volume ³	Conserved-Water ⁴	Land Re-using Drainage ⁵	Land Retired ⁶	Land Overlying GW Pumping ⁷	Area of Existing Evaporation Ponds	Area of New Evaporation Ponds
	Acres	Acres	Acres-feet	Acres-feet	Acres	Acres	Acres	Acres	Acres
A-2000									
Source Control	359.0	125.0	94.0	43.9	11.3	0.0	0.4	2.4	0.0
Ground Water Management	359.0	125.0	94.0	43.9	7.4	0.0	19.3	2.5	0.0
Land Retirement	359.0	125.0	94.0	43.9	10.7	0.0	1.4	2.4	0.0
A-2040									
Source Control	387.0	347.0	260.4	156.3	23.3	0.0	7.1	2.0	0.0
Ground Water Management	387.0	347.0	260.4	132.5	12.6	0.0	135.4	2.0	0.0
Land Retirement	387.0	347.0	260.4	156.3	23.3	0.0	6.7	2.0	0.0
B-2000									
Source Control	359.0	125.0	94.0	43.9	11.3	0.0	0.8	2.4	0.0
Ground Water Management	359.0	125.0	94.0	43.9	9.5	0.0	8.4	2.4	0.0
Land Retirement	359.0	125.0	94.0	43.9	11.3	0.0	0.4	2.4	0.0
B-2040									
Source Control	387.0	347.0	260.4	156.3	23.3	0.0	5.7	2.5	0.0
Ground Water Management	387.0	347.0	260.4	132.5	17.0	0.0	94.5	2.5	0.0
Land Retirement	387.0	347.0	260.4	156.3	23.3	0.0	5.7	2.5	0.0

1 Irrigated land area with a depth to shallow ground water less than 5 feet.

2 That portion of shallow water areas drained.

3 The forecasted annual drainage volume that must be managed; drained land x 0.75 acre-feet per acre of deep percolation

4 Water supply conserved by on-farm water conservation measures and management practices on problem water lands.

5 Acreage in trees and halophytes.

6 Lands targeted for retirement from irrigated agriculture (excluding lands designated for other uses).

7 Land area where pumping from the semiconfined aquifer is used to lower shallow water table below crop root zone.

Figure 27
PROBLEM WATER REDUCTION

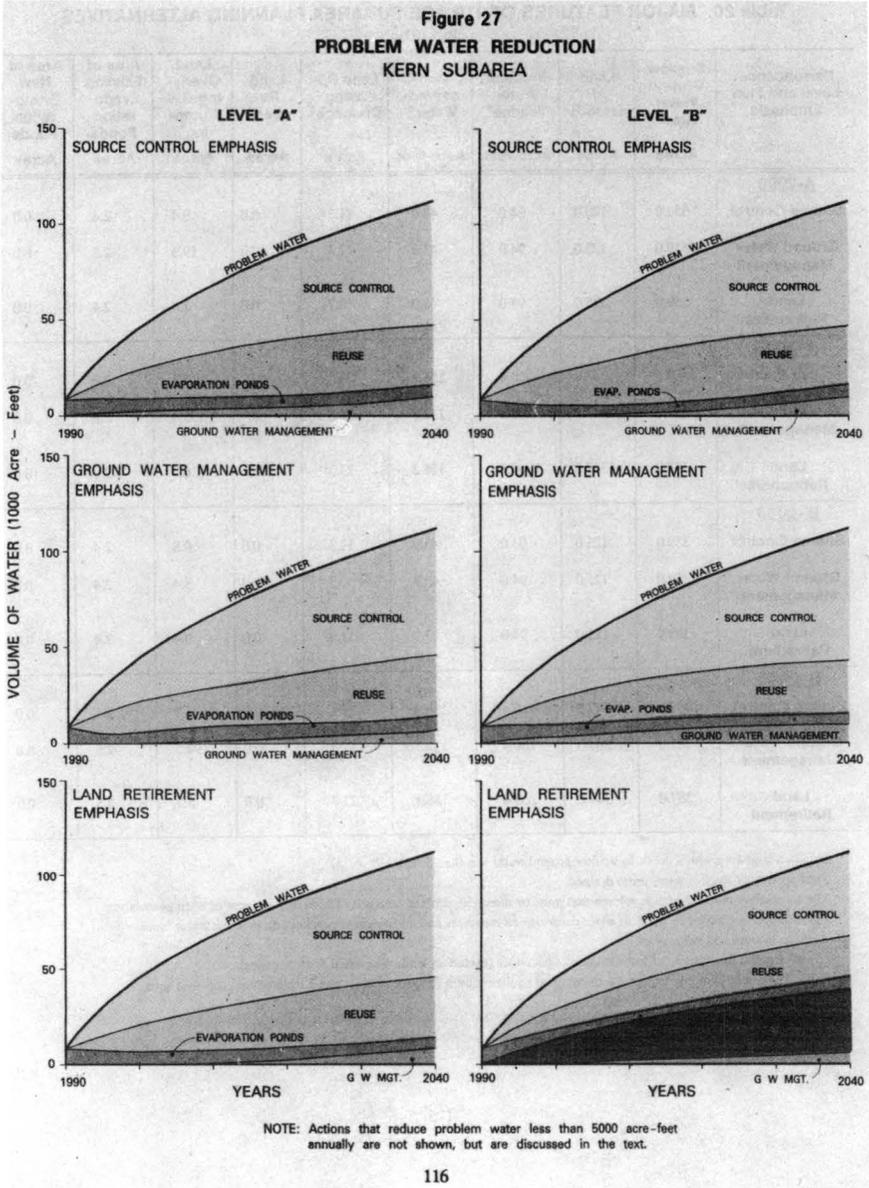


Table 21. MAJOR FEATURES OF KERN SUBAREA PLANNING ALTERNATIVES
In 1,000s

Performance Level and Plan Emphasis	Shallow Ground Water Area ¹	Land Affected ²	Problem Water Volume ³	Conserved Water ⁴	Land Re-using Drainage ⁵	Land Retired ⁶	Land Overlaying GW Pumping ⁷	Area of Existing Evaporation Ponds	Area of New Evaporation Ponds
	Acres	Acres	Acres-feet	Acres-feet	Acres	Acres	Acres	Acres	Acres
A-2000									
Source Control	110.0	61.0	45.8	21.4	6.0	0.0	2.6	1.3	0.1
Ground Water Management	110.0	61.0	45.8	21.4	6.0	3.2	2.5	1.3	0.0
Land Retirement	110.0	61.0	45.8	20.2	5.7	3.2	2.5	1.2	0.1
A-2040									
Source Control	167.0	150.0	112.6	67.5	11.7	0.0	6.9	1.5	0.0
Ground Water Management	167.0	150.0	112.6	67.6	11.2	0.0	6.9	1.6	0.0
Land Retirement	167.0	150.0	112.6	66.2	11.5	3.1	5.6	1.6	0.0
B-2000									
Source Control	110.0	61.0	45.8	21.4	6.0	0.0	2.6	1.2	0.1
Ground Water Management	110.0	61.0	45.8	21.4	6.0	0.0	2.6	1.3	0.0
Land Retirement	110.0	61.0	45.8	14.8	4.1	18.7	1.5	1.0	0.0
B-2040									
Source Control	167.0	150.0	112.6	67.6	11.2	0.0	6.7	1.6	0.0
Ground Water Management	167.0	150.0	112.6	67.6	11.2	0.0	6.9	1.6	0.0
Land Retirement	167.0	150.0	112.6	44.5	8.7	42.6	4.8	1.6	0.0

1 Irrigated land area with a depth to shallow ground water less than 5 feet.

2 That portion of shallow water areas drained.

3 The forecasted annual drainage volume that must be managed; drained land x 0.75 acre-feet per acre of deep percolation

4 Water supply conserved by on-farm water conservation measures and management practices on problem water lands.

5 Acreage in trees and halophytes.

6 Lands targeted for retirement from irrigated agriculture (excluding lands designated for other uses).

7 Land area where pumping from the semiconfined aquifer is used to lower shallow water table below crop root zone.

SUMMARY AND CONCLUSIONS FROM ANALYSES OF SUBAREA PLANNING ALTERNATIVES

Table 22 summarizes the major components of drainage management alternatives for the study area (the four subareas for which alternatives were prepared).

The alternatives were developed to show the effects of emphasizing different strategies for managing drainage water. The conclusions that follow are based on analysis of the alternatives and are used in formulating the recommended plan presented in Chapter 6:

- Few major differences exist among the six alternatives presented in each subarea, due primarily to the narrow ranges of choice actually available when physical constraints, present and likely environmental regulations, and costs are considered. The lack of difference is also due to the inclusion of source control and reuse in all alternatives. These options were included because they are available technologies that could be applied throughout the study area and because of their comparative cost advantage.
- The opportunity for discharge of drainage water to the San Joaquin River causes the Grasslands Subarea to differ considerably from other subareas.
- The planning alternatives show that the amount of water conserved by on-farm methods of drainage-water source control ranges from about 250,000 to 370,000 acre-feet annually by 2040. When land retirement and ground-water management are added to source control, the range of water conserved increases to 530,000 to 950,000 acre-feet annually by 2040. Water conserved by source control and ground-water management would benefit the water user, and values are taken to lower the costs of these options. It is assumed that at least 2.6 acre-feet per acre of water would be freed by land retirement, but no value is taken in this analysis because the value of the water is included in the market value of the irrigated lands to be purchased.
- The analyses show how specific alternatives serve certain objectives that could be considered auxiliary to the objective of all plans of the Drainage Program — solving the drainage water problem. For example, the objective of conserving water at least cost would be served best by maximizing the source control and reuse options. If minimizing risk from toxicants were the dominant objective, then the land retirement component should be maximized.
- A practical mix of drainage management options will not be found by formulating plans to adhere strictly to the criteria for performance Level A or performance Level B. However, analysis of alternatives formulated in that way provides a base for designing a plan that is more efficient than either Level A or B, or the future-without alternative.
- Because of the complexities of the interactive factors involved in solving the drainage problems and the many unknowns, only limited success has been achieved in modeling the natural and cultural features of the problem area. This has prevented asking “what-if” questions that could generate an infinite number of alternatives. Professional judgment, local experience, and public review will evidently continue to be the most important resources in developing a successful plan.

Table 22. MAJOR FEATURES OF STUDY AREA PLANNING ALTERNATIVES
In 1,000s

Performance Level and Plan Emphasis	Shallow Ground Water Area ¹	Land Affected ²	Problem Water Volume ³	Conserved Water ⁴	Land Re-using Drainage ⁵	Land Retired ⁶	Land Overlying GW Pumping ⁷	Area of Existing Evaporation Ponds	Area of New Evaporation Ponds
	Acres	Acres	Acres-feet	Acres-feet	Acres	Acres	Acres	Acres	Acres
A-2000									
Source Control	857.0	410.0	307.4	133.3	29.8	0.0	7.1	4.2	0.1
Ground Water Management	857.0	410.0	307.4	132.4	20.8	5.8	56.9	4.4	0.0
Land Retirement	857.0	410.0	307.4	124.9	26.9	24.1	7.7	4.0	0.1
A-2040									
Source Control	999.0	898.0	673.9	369.9	51.7	0.0	19.7	4.1	0.1
Ground Water Management	999.0	898.0	673.9	286.3	33.9	0.0	310.0	4.2	0.01
Land Retirement	999.0	898.0	673.9	334.8	50.1	49.9	17.7	4.0	0.1
B-2000									
Source Control	857.0	410.0	307.4	133.3	32.1	0.0	8.1	4.0	0.1
Ground Water Management	857.0	410.0	307.4	133.3	27.1	0.0	34.2	4.3	0.0
Land Retirement	857.0	410.0	307.4	114.7	27.6	53.2	4.8	3.8	0.0
B-2040									
Source Control	999.0	898.0	673.9	369.9	53.9	0.0	19.4	4.3	0.1
Ground Water Management	999.0	898.0	673.9	310.3	44.7	0.0	200.5	4.7	0.1
Land Retirement	999.0	898.0	673.9	254.5	42.2	219.7	13.2	4.1	0.1

1 Irrigated land area with a depth to shallow ground water less than 5 feet.

2 That portion of shallow water areas drained.

3 The forecasted annual drainage volume that must be managed; drained land x 0.75 acre-feet per acre of deep percolation

4 Water supply conserved by on-farm water conservation measures and management practices on problem water lands.

5 Acreage in trees and halophytes.

6 Lands targeted for retirement from irrigated agriculture (excluding lands designated for other uses).

7 Land area where pumping from the semiconfined aquifer is used to lower shallow water table below crop root zone.

Chapter 6. THE RECOMMENDED PLAN

The plan presented here is intended as a regional framework for management of drainage and drainage-related problems on the western side of the San Joaquin Valley. It consists of a set of actions that are quantified to the degree possible with information currently available. Actions are planned to continue over the 50-year period, from 1990, through a near-term planning horizon (2000), and on to a long-term planning horizon (2040). Actions are quantified and described for the two planning horizons.

Under the assumptions and conditions of the plan, no decision need be made now on exporting salt from the San Joaquin Valley. As explained in a later section of this chapter, "Rationale on Salt Balance," that decision can be deferred. Most, if not all, of the actions proposed in the recommended plan would be required as the first phase of any out-of-valley export system.

Uncertainties in the scientific information base, plus difficulties in forecasting human events, necessitate that the plan be updated from time to time as monitoring, additional studies, and local actions reveal new facts.

PLAN FORMULATION PROCEDURE

The recommended plan contains some aspects of both A and B performance levels from alternatives presented in Chapter 5. Performance standards used in formulating the recommended plan are shown in Table 23. The applicability of drainage management options in each water quality zone was assessed by using the performance standards (Table 24).

The sequence of plan formulation is illustrated in Figures 28, 29, and 30. The following discussions are provided as a guide to the decision points and places where judgment was applied. A detailed and comprehensive explanation of the technical processes and data used in formulating the plan is set forth in a report by the SJVDP (D.G. Swain, 1990).

Land Retirement Decisions

Land retirement was generally considered for inclusion as a plan component on lands that are saline and/or difficult to drain (class 4, USBR classification, for example) and where shallow ground water contains high selenium levels (50 ppm or more). Such decisions must, however, be based on all factors at the site and on the other alternatives available for managing the drainage problem. They do not preclude the future option of re-establishing irrigated agriculture if circumstances should change.

Source Control Decisions

Measures to control subsurface drainage at the source should generally be applied to all lands with drainage problems, except those that may be retired from irrigated agriculture. The specific

Table 23. PERFORMANCE STANDARDS USED TO FORMULATE RECOMMENDED PLAN

Category	Feature	Planning Criteria
WATER QUALITY (mean monthly)	SAN JOAQUIN RIVER near NEWMAN	BORON ≤ 0.7 ppm SELENIUM ≤ 5 ppb MOLYBDENUM ≤ 10 ppb
	SALT and MUD SLOUGHS	SALINITY $\leq 2,000$ ppm TDS BORON ≤ 2 ppm SELENIUM ≤ 2 ppb MOLYBDENUM ≤ 10 ppb
	AGRICULTURAL WATER SUPPLY	SALINITY $\leq 1,250$ ppm TDS BORON ≤ 1 ppm OR 1,250 ppm TDS \leq SALINITY $\leq 2,500$ ppm TDS BORON ≤ 2 ppm (with dilution or restricted use)
	WETLAND WATER SUPPLY	SALINITY $\leq 1,250$ ppm TDS BORON ≤ 1 ppm SELENIUM ≤ 2 ppb
	REUSE OF SUBSURFACE DRAINAGE ON SALT- TOLERANT PLANTS	EUCALYPTUS TREES $\leq 10,000$ ppm TDS HALOPHYTES $\leq 25,000$ ppm TDS
	EVAPORATION POND	INFLUENT QUALITY SELENIUM ≤ 2 ppb (No alternative habitat required) SELENIUM > 2 and < 50 ppb (Alternative habitat required) SELENIUM ≥ 50 ppb (No traditional evaporation ponds)
WATER QUANTITY	PUMPING SEMICONFINED AQUIFER	INITIAL AQUIFER THICKNESS ≥ 200 feet INITIAL SALINITY $< 1,250$ ppm TDS ^a
	GRASSLANDS WETLAND HABITAT SUBSTITUTE WATER SUPPLY	SUPPLY 129,000 acre-feet per year (74,000 acre-feet per year of fresh water plus facilities to provide at least 55,000 acre-feet of spills and tailwater)
	WATER SUPPLY FOR EVAPORATION POND ALTERNATIVE HABITAT	SUPPLY 10 acre-feet per acre per year
	SUPPLEMENTAL FISHERY FLOWS - MERCED RIVER near STEVINSON	SUPPLY 20,000 acre-feet per year (provided in October)
	DESIGN LIMIT TO REGIONAL DEEP PERCOLATION	LIMIT IS 0.4 acre-foot per acre per year ^b
LAND USE	WILDLIFE HABITAT	ALTERNATIVE HABITAT EQUAL IN SIZE TO EVAPORATION POND AREA WHERE Se INFLUENT > 2 and < 50 ppb
	RETIREMENT OF IRRIGATED AGRICULTURAL LANDS	LANDS WITH ≥ 50 ppb Se CONC. IN SHALLOW GROUND WATER AND RELATIVELY LOW PRODUCTIVITY (CLASS 4) DUE TO HIGH SALINITY AND POOR DRAINAGE CONDITIONS

^a As salinity of pumped water exceeds 1,250 ppm TDS, its use as irrigation water becomes limited; however, it is considered usable for very salt-tolerant crops if salinity does not exceed 2,500 ppm TDS.

^b That portion of applied irrigation water passing the root zone which requires drainage management. An additional 0.1 to 0.3 ac-ft/ac/yr of deep percolation is assumed to move downward through the Corcoran Clay layer.

Table 24. APPLICABILITY OF DRAINAGE MANAGEMENT OPTIONS
(Recommended Plan Performance Standards)

Subareas and Water Quality Zones	Drainage Source Control	San Joaquin River Discharge ¹	Salt-Tolerant Trees	Halo-phytes	Land Retirement ²	Existing Evaporation Ponds	New Evaporation Ponds ³	Ground Water Management
Grasslands								
A	X	Y(21k AF)	X	X	Y(3k Ac.)	Y(0.1k Ac.)	NA(> 2 ppb Se)	Y(9k Ac.)
B	X	Y(15k AF)	X	X	NA(< 50 ppb Se)	NA	X	NA(< 200 ft thick)
C	X	X	NR	NR	NR	NR	NR	NR
D ⁴	X	NR-W	NR-W	NR-W	NR-W	NR-W	NR-W	NR-W
Westlands								
A	X	NA	X	X	Y(5K Ac.)	NA	NA(< 2 ppb Se)	NA(< 200 ft th ick)
B	X	NA	NA(> 10k ppm TDS)	X	Y(15K Ac.)	Y(0.1k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft thick)
C	X	NA	X	X	Y(13K Ac.)	NA	NA(> 2 ppb Se)	Y(38k Ac.)
D	X	NA	X	X	NA(< 50 ppb Se)	Y(0.4k Ac.)	NA(> 2 ppb Se)	Y(24k Ac.)
Tulare								
A	X	NA	X	X	NA(< 50 ppb Se)	Y(0.5k Ac.)	X	Y(916k Ac.)
B	X	NA	NA(> 10k ppm TDS)	X	Y(7k Ac.)	Y(3.6k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft thick)
C	X	NA	X	X	NA(< 50 ppb Se)	Y(0.2k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft thick)
D	X	NA	NA(> 10k ppm TDS)	X	NA(< 50 ppb Se)	Y(0.3k Ac.)	NA(> 2 ppb Se)	Y(31k Ac.)
E	X	NA	X	X	NA(< 50 ppb Se)	Y(0.3k Ac.)	X	Y(90k Ac.)
Kern								
A	X	NA	NA(> 10k ppm TDS)	X	Y(24 Ac.)	Y(1.3k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft thick)
B	X	NA	NA(> 10K ppm TDS)	X	NA(< 50 ppb Se)	NA	NA(2 ppb Se)	NA(< 200 ft thick)
C	X	NA	X	X	NA(< 50 ppb Se)	Y(0.2k Ac.)	X	NA(< 200 ft thick)
D	X	NA	NA(> 10k ppm TDS)	X	Y(8k Ac.)	Y(0.2k Ac.)	NA(> 2 ppb Se)	NA(< 200 ft thick)

¹ Applicability of option depends on selenium criterion (mean monthly concentration of 2 ppb) and critical year hydrology (1986-87) for San Joaquin River near Newman. Selenium load expected to drop up to 50 percent by 2040 as a result of removing salts from the shallow ground water and soils.

² A combination of ≥ 50 ppb selenium concentration in the shallow ground water and relatively low land productivity due to high soil salinity and poor drainage conditions (USBR Class 4 or equivalent SCS soil classification) was used to select lands on which irrigated agriculture would be discontinued.

³ New evaporation ponds can be used when drainage water selenium concentration exceeds 2 ppb and is ≤ 50 ppb; however, mitigation measures including alternative habitat must be provided.

⁴ Manage wildlife wetland area.

X Option is applicable without any limitation in its application.

Y Option is applicable but limited to the quantities and units included in the parentheses.

NA Option not applicable because it failed to meet the performance standard in parentheses (see Table 7) or not physically available in the instances of discharge to the San Joaquin River.

NR Option not suggested because increased conservation with resulting increased salinity will lower the likelihood that drainage water can be used for wetland habitat.

NR-W Option is not applicable since shallow ground water within wetlands benefits waterfowl.

Figure 28
OVERALL PLAN FORMULATION SEQUENCE

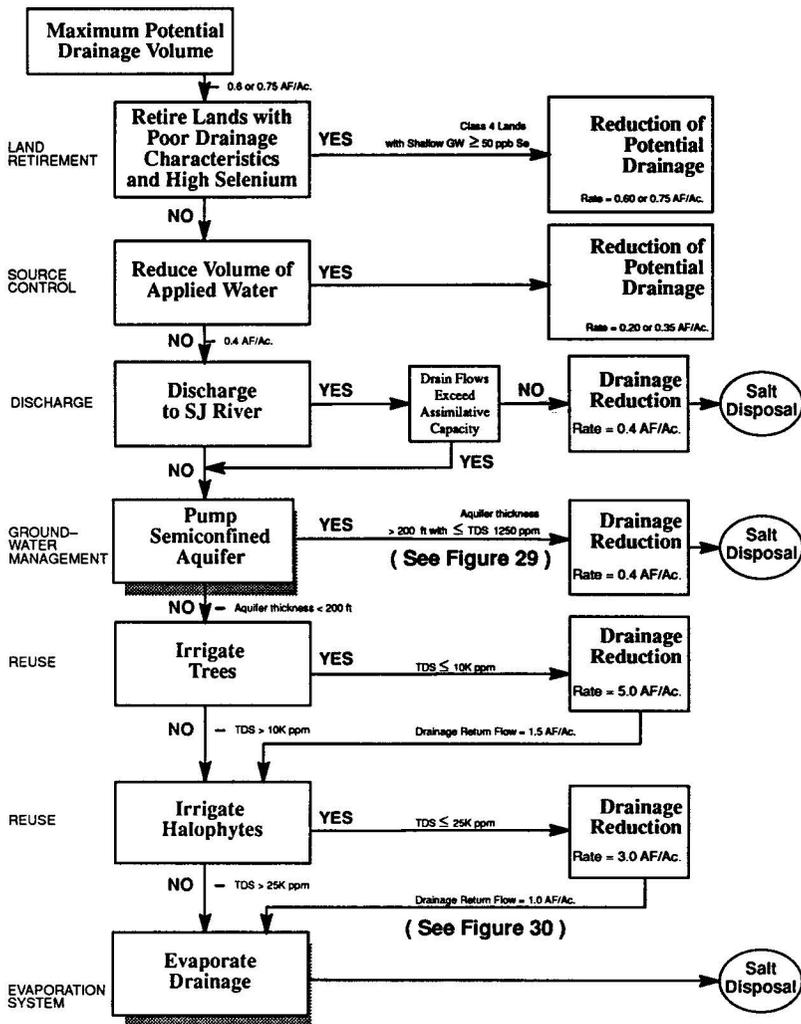


Figure 29
PLAN FORMULATION SEQUENCE
Pump Semiconfined Aquifer

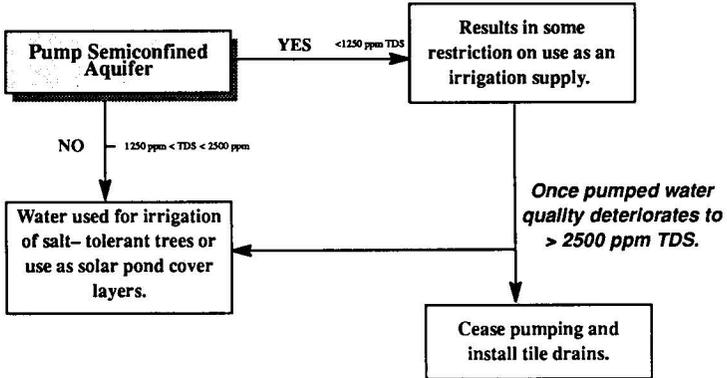
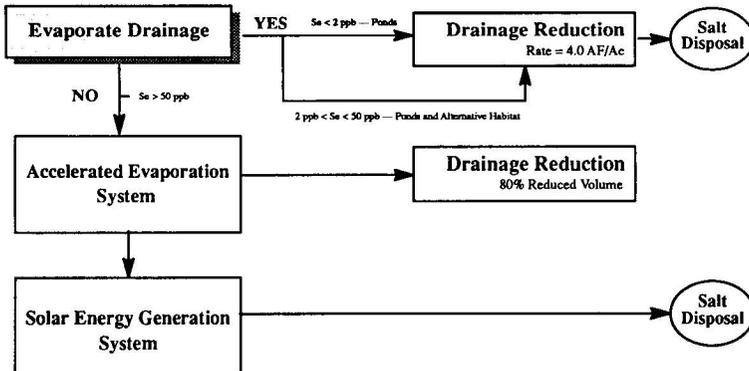


Figure 30
PLAN FORMULATION SEQUENCE
Evaporate Drainage



source control measures adopted will vary according to the types of crops grown and individual grower preference. Application of source control measures could eliminate an average of nearly 50 percent of the total problem water volume (pre-1985 conditions) by reducing deep percolation and, hence, potential drainage water. The rate at which source control can be implemented is generally controlled by the rate at which investments can be made to improve irrigation practices. The recommended plan takes this into account.

In the recommended plan, source control measures were not applied to water-quality Zone C and a portion of Zone B in the Grasslands Subarea. These zones contain low selenium and moderately saline water of a quality suitable for use in wetlands or for direct discharge to the San Joaquin River during much of the year.

The water collected in on-farm drains would have four possible fates: discharge to the San Joaquin River, water supply for wildlife areas (if selenium concentration is low), reuse on salt-tolerant plants, and/or discharge to evaporation ponds.

Decisions on Discharge to the San Joaquin River

The levels of performance required of the recommended plan in affecting the quality of water in the San Joaquin River were determined by State water-quality objectives and by scientific investigations of the U.S. Fish and Wildlife Service. It was determined that the selenium objectives of 5 ppb in the river and of 2 ppb in Mud and Salt sloughs were the most difficult objectives to be met. For planning, it was assumed that, if the selenium objective were met, then the boron and salt objectives could also be met.

Accordingly, the Drainage Program focused on the assimilative capacity of the San Joaquin River. The plan identifies means to collect and isolate (from wetlands) a comparatively small volume of high-selenium water in the Grasslands Subarea. That drainage volume would then be conveyed through a rehabilitated and extended San Luis Drain for discharge to the San Joaquin River below its confluence with the Merced River. It was also decided that the plan should include supplementing the Merced River with fresh water obtained from the eastern side of the San Joaquin Valley.

Replacement of the contaminated agricultural drainage water delivered and used in wetland areas before 1985 is a requirement of all plans. Mud and Salt Sloughs would not be used to convey water to wildlife habitat unless the selenium concentration of the supply is less than 2 ppb.

Reuse Decisions

It was assumed that, with some exceptions for the Grasslands Subarea, all water collected in tile drains would be reused on salt-tolerant trees and halophytes. This component is included in the plan under the conditional requirement that monitoring and analyses of the concentration of toxicants in biota (selenium, for example) would be necessary to give warning of any incipient problem and allow for remedial measures (keeping eucalyptus groves free of forest litter, for example). Reuse would eliminate a significant volume of problem water. The drainage water from trees and halophytes would be disposed of in evaporation ponds and solar ponds.

Evaporation Pond Decisions

The quality of drainage water (primarily selenium concentration) determines the selection, design, and operation of an evaporation system. It was assumed that all evaporation ponds would be designed and built according to criteria of the California Department of Fish and Game, which specify steep side slopes and minimum allowable pond depth (Bradford, et al., 1989). In addition, if influent selenium concentration is greater than 2 ppb, alternative, safe habitat equal to the pond area would be provided to facilitate hazing waterfowl from the pond area. If the influent concentration exceeds 50 ppb, an accelerated-rate evaporation pond would be used to reduce the required pond area because open ponds would not be considered feasible in the long run under these conditions. When possible, evaporation ponds would be located on the least productive agricultural land and at the lowest elevations of the drained areas.

Treatment for Selenium Removal

Although it is probable that an economical biological treatment process to remove selenium from drainage water will become available within the next 10 to 20 years, treatment is not included in the recommended plan. Instead, plan components are based on available technology. Treatment methods to remove selenium should be pursued and, when available, might replace or modify ground-water management or the evaporation processes. Treatment research should be continued not only on selenium removal but also on other toxic substances, such as arsenic, which are sometimes found in high concentrations in drainage water.

Ground-Water Pumping Decisions

Some growers now pump irrigation water from certain zones of the semiconfined aquifer. This pumping could be done in a more systematic and coordinated manner to focus specifically on lowering, and maintaining at lower levels, the shallow water table of drainage problem areas. Criteria for selecting potential pumping areas include adequate thicknesses of aquifers and water quality. Because pumping would eventually draw poor-quality water from higher in the aquifer into the producing wells, the length of time pumping could be continued was determined by the thickness of the aquifer zone and the rate of pumping. For an area to be included in the plan, the estimated life of the well field had to exceed 20 years. Application of planning criteria made a relatively minor amount of problem water area amenable to this component.

Rationale on Salt Balance

Implementation of the recommended plan would allow maintenance of a salt balance in the plant root zone. Primarily, this would be accomplished by source control and by drainage to remove shallow ground water and the salts it contains from crop root zones. This is in contrast to future-without conditions (described in Chapter 5), in which a salt balance could not be maintained and would lead to salinization and abandonment of lands within the next few decades because of problems associated with a persistently high water table.

The main value of actions proposed in the recommended plan would be to reduce or dampen the present effects of the dissolution-evaporation cycle in which salts are precipitated in soils through evaporation of water from a near-surface water table. The present principal source of salts is not imported water but the high concentrations of natural salts that have been leached from soils

(particularly during the last 30 to 40 years) and are now concentrated in shallow ground water (CH₂M Hill, 1988). These salts tend to recycle seasonally through the soil under high water table conditions.

Implementation of the recommended plan would maintain the water levels below the root zone. The problem water would be managed by tile drains, land retirement and ground-water pumping. The shallow water table would be lower and thus contribute less to evapotranspiration.

How long can such a strategy work, since about 3 million tons of salt per year are being added to the shallow ground-water system of the study area? The Drainage Program's answer is based on the assumption that the potential to continue to store salts in the subsurface (as now occurs) will be approaching exhaustion when subsurface water is saturated with salts in concentrations that exceed 2,500 ppm. When that water-quality condition is reached in the semiconfined aquifer, it is theorized, it will also have contributed to increased degradation of the confined aquifer (below the Corcoran Clay layer). Assuming that growers will not pump water of this salt content, most of the beneficial hydraulic stresses that moved drainage water downward will have ended. The water table will rise again, and it will become difficult to manage salt in crop root zones.

As a basis for estimating the useful life of the semiconfined aquifer, available ground-water data were analyzed for 1.7 million acres of land, including all waterlogged areas. Analyses showed that about one-third of these lands already overlie portions of the semiconfined aquifer where ground water generally exceeds 1,250 ppm TDS. Total dissolved solids of 1,250 ppm is considered the maximum allowable limit for most irrigation use. For the remaining two-thirds of these lands, estimates were made of the rate at which saline ground water (greater than 2,500 ppm TDS) would displace the usable ground water by downward movement beneath the problem water areas. It was assumed that the flow in the semiconfined aquifer was essentially vertical and was governed by the rate of movement through the Corcoran Clay.

The rate of downward movement of salts in the semiconfined aquifer was estimated at several locations in each of the subarea water-quality zones. The thickness of the usable aquifer and the rate of movement then determined the aquifer life. Aquifer life was considered to be exhausted when the quality of pumped ground water exceeded 2,500 ppm TDS. From the several locations analyzed in each subarea water-quality zone, the minimum and maximum aquifer thickness and life were based on one location each. The mean aquifer thickness and life were based on all locations analyzed. The number of locations varied from zone to zone. Table 25 shows the estimated useful aquifer life for water-quality zones in the Grasslands, Westlands, and Tulare subareas. The Northern Subarea is considered to be in salt balance, and insufficient information is available to estimate aquifer life in the Kern Subarea.

Under the assumptions and conditions stated above, the western valley has several decades remaining before salt removal and/or export will be required.

The process of salt contamination of ground water was set in motion decades ago with the onset of intense irrigation (Gilliom, et al., 1989a), and it will continue — to some extent — within the realm of probable use and management of water in the valley, regardless of the handling of the regional drainage problems. If it were possible to balance salt inflow and outflow in the valley, this would help slow the rate of salt contamination of ground water.

Table 25. ESTIMATED USEFUL LIFE OF THE SEMICONFINED AQUIFER

Subarea Water Quality Zone	Percent of Water Quality Zone Area with Usable Ground Water ^a	Present Thickness and Remaining Life of Semiconfined Aquifer					
		Mean Thickness ^b (feet)		Minimum Thickness ^b (feet)		Maximum Thickness ^b (feet)	
		Life ^c (years)	Life ^c (years)	Life ^c (years)	Life ^c (years)	Life ^c (years)	Life ^c (years)
Grasslands							
A	35	50	75	350	525	160	250
B	79	50	25	200	100	130	65
C	66	50	150	150	400	90	270
Westlands							
A	33	50	35	200	190	150	110
B	64	50	30	350	210	180	110
C	70	50	30	450	270	190	115
D	781	50	25	400	200	220	110
Tulare							
A	19	50	75	250	375	125	185
D	100	50	25	500	250	330	165
E	88	50	25	450	225	335	170

a Usable ground water contains less than 1250 ppm TDS.

b Thickness refers to that part of the semiconfined aquifer containing usable ground water.

c Life of the aquifer is the estimated time for saline ground water (greater than 2,500 ppm TDS) to completely displace presently usable ground water, in the semiconfined aquifer. It is calculated by dividing the aquifer thickness of usable ground water by the average rate of water movement across the Corcoran Clay. It was assumed that pumping from the confined aquifer beneath the Corcoran Clay will be maintained at current rates.

Management of drainage problems in the manner presented in the recommended plan tends to enhance near-term (up to 50 years) protection of soils and off-site impacts of drainage discharges, while continuing to diminish the life (for direct irrigation) of westside aquifers.

A functionally beneficial aspect of the recommended plan is that it includes the preliminary steps that would likely be needed when salt removal from the valley becomes necessary and feasible. These steps include integrated in-valley systems to collect and reduce the volume of drainage water, accompanied by containment and control of contaminants, such as selenium.

PLAN FEATURES COMMON TO ALL SUBAREAS

Several plan features are common to all subareas. The following discussion is intended to reduce the need for repetitive description of the recommended subarea plans.

The features that are an essential part of the plans for all subareas (exclusive of the Northern Subarea) are: drainage-water source control, reduction of drainage-water volume by reuse, disposal of concentrated drainage-water, changes in water institutions, and monitoring of the drainage-water environment.

Drainage-Water Source Control

Improvement in the application of irrigation water to reduce the source of deep percolation has been shown to be the most effective and least costly means of reducing the amount of potential

drainage problem water. Recognizing the necessity to leach salts past the root zone and the nonuniformity of soils, even in a single agricultural field, there is justifiable argument about the amount of improvement that can be achieved in irrigation water application to reduce deep percolation. Field demonstrations show, however, that irrigation water application can be improved (Boyle, 1990, 1989a, 1989b). Target reductions in deep percolation believed attainable through on-farm water conservation measures by 2000 and sustainable beyond that time are shown, by subarea, in Table 26. The comparatively low target for the Tulare Subarea reflects the average higher efficiencies in water application that prevail in that subarea now.

**Table 26. RECOMMENDED TARGETS FOR
REDUCTION IN DEEP PERCOLATION IN 2000**

Subarea	Target Reduction (acre-feet/acre)
Northern	0.0*
Grasslands	0.35
Westlands	0.35
Tulare	0.20
Kern	0.35

* See discussion for Northern Subarea under "Description and Evaluation of Recommended Plan (by Subarea)" later in this chapter.

The target deep percolation reductions in Table 26 are included as part of the recommended plan for all irrigated lands in each subarea.

Reducing deep percolation on lands lying upslope (up the hydraulic gradient) from drainage problem areas would benefit downslope areas. The results of geologic investigations (Quinn, 1990) suggest that, over decades, the aquifers above the Corcoran Clay function as a set of regional aquifers. Therefore, water conservation on upslope areas is important, even though the impact on a downslope problem water area will probably not be nearly as immediate and direct as will water conservation practiced directly on downslope lands with drainage problems. Even on upslope lands, which are significantly larger in total area than downslope lands, a moderate level of water conservation could have a significant effect on the waterlogging problems — in the long run.

An exception to the universal inclusion of source control in the recommended plan is in the Northern Subarea and parts of the Grasslands Subarea lying in the basin trough. In these areas, source control is not included because of the relatively low levels of selenium occurring in the shallow ground water and the composition of the dissolved salts that are low in gypsum (W.C. Swain, 1990c). Program analyses (D.G. Swain, 1990) indicate that application of source control in these areas would not contribute to meeting present State water quality objectives nor appreciably reduce the salt load in the San Joaquin River — assuming that the present policy agreement requiring releases from New Melones Reservoir remains in effect to dilute the salt load in the San Joaquin River.

Reduction of Drainage-Water Volume by Reuse

The large volume of drainage water that is generated annually¹ (from 0.60 to 0.75 foot per acre in the water-quality zones) presents a difficult but not insurmountable problem for in-valley management. Assuming that source control measures would eliminate from 0.2 to 0.35 acre-foot per acre, the balance of 0.40 acre-foot per acre would have to be collected and reduced in the most economic means available, while meeting acceptable levels of environmental protection.

The first essential collection device in reuse is on-farm tile drains. Presently, there are only 133,000 acres of installed drains in all the westside area. The Drainage Program projects that the area drained by on-farm systems will increase to about 760,000 acres by 2040 (Table 27).

**Table 27. PROJECTED ON-FARM TILE DRAINAGE ACREAGE
(Acres)**

SUBAREA	1990	2000	2040
Northern	24,000	34,000	44,000
Grasslands	50,000	108,000	192,000
Westlands	5,000	69,000	140,000
Tulare	43,000	96,000	277,000
Kern	11,000	53,000	106,000
TOTAL	133,000	360,000	759,000

Subsurface water collected in the farm drains would be transported to the primary water reduction facility used in the recommended plan: salt-tolerant tree plantations and fields of halophytes. These plants would be irrigated with enough drainage water to leach salts from the root zone and meet the maximum capacity of the given species to transpire water. Transpiration is about 5 acre-feet per acre per year for eucalyptus trees and 3 acre-feet per acre per year for halophytes. Drainage from the trees and halophytes would average about 1.5 acre-feet per acre per year for a total application rate of 6.5 and 4.5 acre-feet per acre per year, respectively. An acre of trees would serve an average of about 16 acres of drained cropland. The trees would be located as close to the drained farmlands as possible.² The tree plantations would require subsurface drains, not only to remove salts from the root zone but also to provide feed water for the fields of halophytes, which would be located near the trees. In some parts of the Westlands, Tulare, and Kern subareas, drainage water would be too salty to use on trees and, therefore, halophytes would be the primary drainage reduction mechanism.

The acreages of trees and halophytes required for the recommended plan are given in Table 28. The atypical decline in acreages in the Grasslands Subarea is explained in the Grasslands plan later in this chapter.

¹ If on-farm drains were available, the estimated volume in 1990 would be about 300,000 acre-feet per year. Based on analyses of water table measurements for 1977, 1983, and 1986-87, this volume is forecasted to more than double from 1990 to 2040.

² In addition to proximity to drained croplands, important land suitability criteria for the reduction facilities are: elevation, soils that can be drained, the absence of soil characteristics adverse to the species selected, and soils not suited for high-value crops.

Table 28. PRIMARY DRAINAGE-WATER REDUCTION FACILITIES
(Approximate acres)

Subarea	2000		2040	
	Trees	Halophytes	Trees	Halophytes
Grasslands	2,400	900	1,900	700
Westlands	3,900	2,100	8,000	4,100
Tulare	4,000	4,600	12,300	12,300
Kern	1,600	3,300	3,600	6,000
TOTAL	11,900	10,900	25,800	23,100

Disposal of Concentrated Drainage Water

Other than in the Grasslands Subarea, the primary means of disposal of the residual drainage water and dissolved solids it contains would occur in evaporation and solar pond facilities. These pond systems would bear little resemblance, in structure or operation, to present evaporation ponds. A number of features would be changed to improve their safety and efficiency.

In the staged design of the recommended plan, ponds would follow drainage-water-volume reduction and, consequently, less pond area would be required than would be under current conditions. Compared to present pond acreages, the total acreage of ponds in 2040 would be about half the present, and each unit of pond area would serve about 8 to 10 times as much drained land as do ponds in 1990.

The estimated life of an evaporation pond is 30 years. Old ponds would be closed safely, and new ponds would replace them. The pond area in 2040, by type, in each subarea, is given in Table 43.

Institutional Components

The recommended plan contains several institutional components that are included in all subareas: tiered water pricing, improved scheduling of irrigation deliveries, water marketing, and formation of regional drainage management organizations. These are either new to the subarea or have never been applied at the scale that would be needed to implement this plan.

Tiered Water Pricing

Tiered water pricing means increasing irrigation water rates as more water is applied. This would provide incentives for water conservation. Although water districts are not allowed to make profits, water revenue surpluses could be used to help finance on-farm water conservation measures. Tiered water pricing is already being implemented by three water districts in the Grasslands Subarea.

Improved Scheduling of Water Deliveries

The aim of improved scheduling of water deliveries is to enable growers to obtain irrigation water deliveries when their land and crops need the water, not when the delivering entity can supply the water. In all the subarea plans, costs have been included, under the category of source control, to effect considerable improvements in scheduling water deliveries. These changes would build on the present programs of the California Department of Water Resources and several local water districts.

Water Transfers and Marketing

This would provide incentives for water conservation, wherein local water districts and/or irrigators would be permitted to retain some portion of the increase in the value of water sold for a profit. The portion of the increase in value retained by the suppliers in a transfer would also help fund water conservation measures. The Department of Water Resources and the Bureau of Reclamation are the principal agencies that could develop and implement policies and programs for water transfers and marketing.

Some transfers would require the approval of the State Water Resources Control Board. All transfers of State Water Project and Central Valley Project water would require, respectively, the authorization of the Department and the Bureau as project operator. Thomas and Leighton-Schwartz (1990) declare there are no serious legal impediments to the transfer of water made available by reclamation or conservation from drainage problem areas in the western San Joaquin Valley. Purpose and place of use restrictions in the CVP permits and contracts may be amended to facilitate transfers of project water to other uses or areas. The increases in repayment obligations in moving water from irrigation to municipal and industrial use do not appear to be substantial disincentives, according to Thomas.

Regional Drainage Management Organizations

Regional drainage management organizations are recommended for the Grasslands and Tulare subareas, with all upslope and downslope areas to be included within the boundaries of the organization. Such organizations would coordinate the drainage-related operations of existing local water entities, with respect to activities and issues that transcend local entity boundaries. Local water entities are in the best position to effectively manage the subsurface drainage problem because they deal with water throughout the hydrologic cycle in a given land area. Generally, they have the authority to manage drainage water; where they do not, the authority could be obtained through legislation. However, in recognition of hydrologic and economic linkages and relationships among local water entities, some drainage problems could probably be managed best at a regional level. For such needs, either regional entities or joint-power authorities could be formed.

A regional drainage management organization could reduce drainage management costs, bring about coordination among several local entities, and help internalize the costs of drainage management.

Westlands Water District could serve as the regional drainage management entity for the Westlands Subarea. In the Kern Subarea, Kern County Water Agency, through joint-powers agreement with the water districts or some other organizational arrangement, could serve as the regional drainage management entity.

Monitoring of the Drainage-Water Environment

The drainage problem that affects, or is related to, more than 1 million acres is not presently being monitored in a comprehensive, effective, and efficient manner. An extremely important premise underlying successful implementation of this plan is that the many facets and dimensions of the problem — ground-water levels, soil conditions, land uses, water quality, volume of drainage, conditions of evaporation ponds, impacts on biota, public health risks — must be monitored on a long-term, systematic basis. The objective of monitoring is to determine the effect

of actions and whether they should be changed. In 1990, no one can forecast with certainty what conditions will be in 2040. The strategy presented in this plan will, no doubt, have to be adjusted in response to unforeseen human events and responses of natural systems.

DESCRIPTION AND EVALUATION OF THE RECOMMENDED PLAN

Northern Subarea

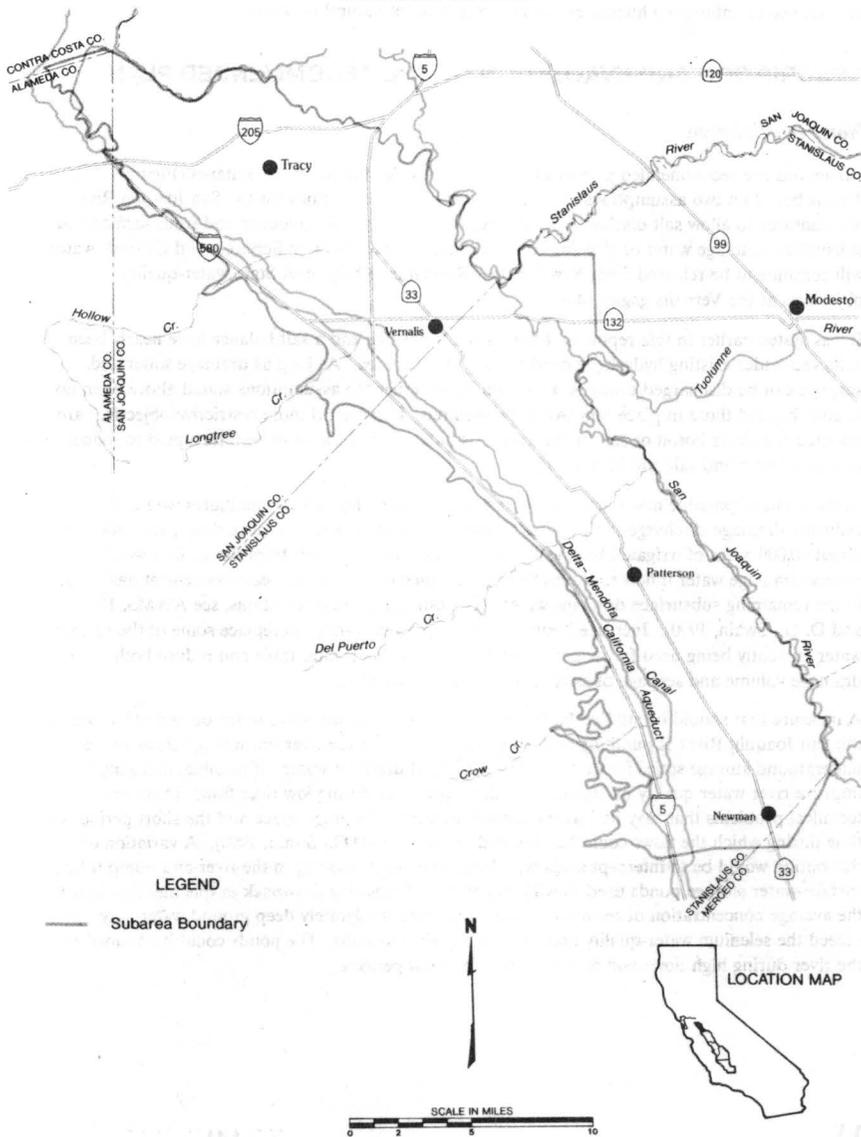
No actions are recommended as part of a regional plan for the Northern Subarea (Figure 31). This is based on two assumptions: (1) State water-quality regulations for the San Joaquin River will continue to allow salt discharge to the river from ground-water seepage and from surface and subsurface drainage water originating from irrigation in the Northern Subarea, and (2) fresh water will continue to be released from New Melones Reservoir to help meet State water-quality objectives at the Vernalis gaging station.

It was stated earlier in this report that both a water balance and a salt balance have nearly been achieved under existing hydrologic conditions in this subarea. As long as drainage water and seepage can be discharged to the San Joaquin River under the assumptions stated above, then no actions beyond those in place now would be required. However, if more restrictive objectives are adopted for either boron or salt in the river, this balance would have to be interrupted to reduce drainage water and salt and boron load.

In the event of possible new water-quality restrictions, the following two measures would aid in reducing drainage discharge to the river. Source control measures to reduce deep percolation on about 50,000 acres of irrigated land with water tables less than 5 feet from the surface would reduce drainage water inflow to the river; however, they would also increase concentrations of salt in the remaining subsurface drainage water. (For estimates and calculations, see AWMS, 1987, and D. G. Swain, 1990). Increased pumping of deep ground water to replace some of the surface water currently being used for irrigation would lower the high water table and reduce both drainage volume and seepage of salty ground water to the river.

A measure that should be studied further in relation to more restrictive water-quality objectives in the San Joaquin River is pumping shallow ground water into the river during high flows to create underground storage space for percolating agricultural drainage water. If feasible, this would improve river water quality by storing salty drainage water during low river flow. There are technical problems that may be insurmountable in terms of storage space and the short periods of time during which the flows could be accepted in the river (D.G. Swain, 1990). A variation of this option would be to intercept shallow, salty ground water moving to the river and pump it into surface-water storage ponds used as wildlife habitat. A possible drawback to this measure is that the average concentration of selenium in the intercepted moderately deep ground water may exceed the selenium water-quality objectives in the river (5 ppb). The ponds could be drained to the river during high flows and refilled during low-flow periods.

Figure 31
NORTHERN SUBAREA



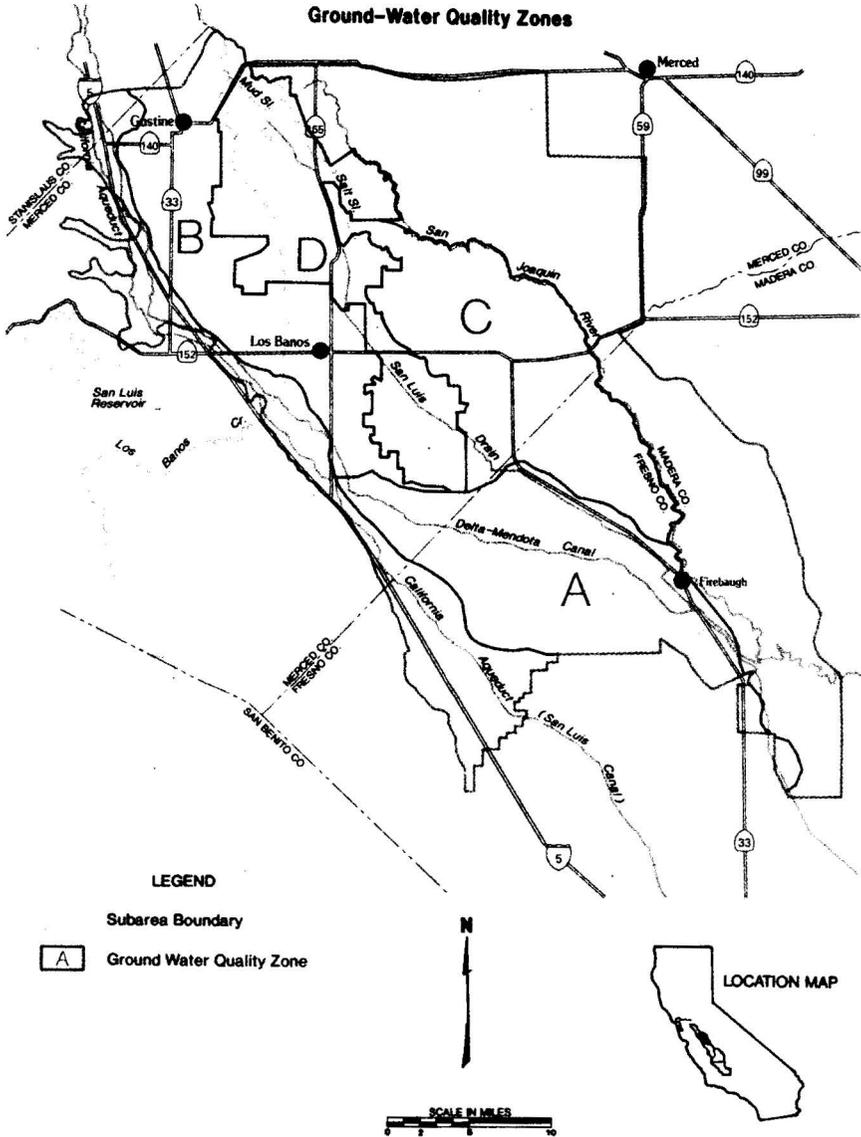
Grasslands Subarea

Figure 32 shows the shallow ground-water quality zones. Agricultural components of the recommended plan for the subarea are listed in Table 29. Selected facilities and flows are shown on Figure 33.

The agricultural components of the recommended plan for 2040 are:

- **Practicing source control on 93,600 acres of irrigated land.** The amount of water applied to irrigate drainage problem areas would be reduced, on the average, by 0.35 acre-foot per acre per year (a total of 32,700 acre-feet) by improving methods of irrigation water application, by improving scheduling of irrigation water application, and by tiered water pricing.
- **Reusing drainage water to irrigate 2,600 acres of salt-tolerant trees and halophytes.** Through installation of on-farm tile drains and conveyance facilities, drainage water would be collected and supplied to trees to reduce the total drainage volume by 10,900 acre-feet. Drains would be installed beneath the trees to collect the brackish water drained for subsequent use by halophytes. This would reduce the drainage volume by another 2,700 acre-feet, for a total reduction of 13,600 acre-feet. These reuse plantations could serve individual farms or an entire water or drainage district and would be located on the least productive soils. Most sites would be located on Storie Index class 4, 5, or 6 soils on the Panoche and Little Panoche Creek fan rim in the eastern part of water-quality Zone A.
- **Operating 120 acres of evaporation ponds and 130 acres of solar ponds.** Pond design and operation criteria would be consistent with State guidelines, and ponds would be located near tree and halophyte plantations. The volume of influent water evaporated annually would be about 700 acre-feet.
- **Pumping the semiconfined aquifer under about 10,000 acres of land.** Due to natural features, this option is most feasible in the southeastern and northwestern portions of the subarea. The design average annual yield would be 0.4 acre-foot per acre of land affected, for a total management of 4,000 acre-feet of problem water. To exert this effect at the land surface, 8,000 acre-feet would have to be pumped from the aquifer. These lands would also have received source control (0.35 acre-foot per acre), but they would not be artificially drained. Pumped ground water of initial good quality could be used for agriculture, or fish and wildlife, or a variety of other uses. If, in future years, influent water to a well should contain dissolved salt in excess of 2,500 ppm TDS, that water would be used for trees and halophytes, or as top water in solar ponds. This component would be applicable only in water-quality Zones A and B.
- **Retiring 3,000 acres of irrigated agricultural lands.** Lands having the combined characteristics of poor drainability, high salinity levels, and high levels of dissolved selenium (greater than 50 ppb) in shallow ground water would be retired. Only lands in water-quality Zone A met this criterion.

Figure 32
GRASSLANDS SUBAREA
Ground-Water Quality Zones



**Table 29. RECOMMENDED DRAINAGE MANAGEMENT PLAN
GRASSLANDS SUBAREA (In 1000s)**

PLAN COMPONENT	YEAR 2000			YEAR 2040		
	AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION		AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION	
	Acres	AF	%	Acres	AF	%
ZONE A						
SOURCE CONTROL	68.9	24.0	44.4	72.0	25.1	44.3
LAND RETIREMENT	0.0	0.0	0.0	3.0	2.3	4.0
GROUND-WATER MGMT	5.0	2.0	3.7	10.0	4.0	7.1
DRAINAGE REUSE ^a	3.1	16.5	30.6	0.8	4.1	7.2
EVAPORATION SYSTEM	0.18	0.8	1.5	0.12	0.2	0.4
DISCHARGE TO SJ RIVER	26.8	10.7	19.8	52.5	21.0	37.0
Total		54.0	100.0		56.7	100.0
ZONE B						
SOURCE CONTROL	6.8	2.4	22.8	21.6	7.6	21.6
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	0.4	1.1	10.0	1.8	9.5	27.0
EVAPORATION SYSTEM	0.01	0.1	0.6	0.12	0.5	1.4
DISCHARGE TO SJ RIVER AND OR WETLANDS	9.3	7.0	66.6	23.5	17.6	50.0
Total		10.6	100.0		35.2	100.0
ZONE C						
SOURCE CONTROL	0.0	0.0	0.0	0.0	0.0	0.0
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE ^a	0.0	0.0	0.0	0.0	0.0	0.0
EVAPORATION SYSTEM	0.0	0.0	0.0	0.00	0.0	0.0
DISCHARGE TO SJ RIVER AND OR WETLANDS	29.3	22.0	100.0	84.7	63.5	100.0
Total		22.0	100.0		63.5	100.0
TOTAL						
SOURCE CONTROL	75.7	26.4	30.5	93.6	32.7	21.0
LAND RETIREMENT	0.0	0.0	0.0	3.0	2.3	1.4
GROUND-WATER MGMT	5.0	2.0	2.3	10.0	4.0	2.6
DRAINAGE REUSE ^a	3.5	17.6	20.3	2.6	13.6	8.8
EVAPORATION SYSTEM	0.2	0.9	1.0	0.2	0.7	0.5
DISCHARGE TO SJ RIVER AND OR WETLANDS	65.4	39.7	45.9	160.6	102.1 ^b	65.7
Total		86.6	100.0		155.4	100.0

^a Includes potential drainage from irrigated agricultural land used to grow salt tolerant crops.

^b Increases in volume from year 2000 to year 2040 are due largely to improvements forecasted to occur over time in the quality of shallow ground water drained from irrigated lands. For data and interpretation supporting this concept, see Gilliom, et al., (1989a) and Deverel and Gallathine (1988).

- **Discharging about 102,000 acre-feet of drainage water³ to wetlands and/or the San Joaquin River (while meeting river water-quality standards).** About 63,500 acre-feet of subsurface drainage water of adequate quality⁴ for fish and wildlife uses would be discharged from water-quality Zone C into Salt Slough, from which diversions could be made to adjacent public and private wetland management areas. About 17,500 acre-feet of subsurface drainage water from west of the wetland area (water-quality Zone B) would also be of adequate quality for use in wetland habitat areas. About 21,000 acre-feet of subsurface drainage water from irrigated land (water-quality Zone A) south of the Grasslands wetland area would be unsuitable for reuse in wetlands and, therefore, would be discharged into the San Luis Drain for delivery to the San Joaquin River below its confluence with the Merced River. The sediments removed from the drain would be placed within the Kesterson Reservoir disposal area and treated as the Kesterson sediments were managed in that cleanup effort. The amount of drainage water discharged is limited by the river criteria near Newman (Table 7). The San Luis Drain would be cleaned of sediments and modified structurally to receive drainage from water quality Zone A at a point near South Dos Palos, and the drain would be extended to the San Joaquin River, below the confluence of the Merced River. The Main, Panoche, Hamburg, and Charleston drains would be interconnected and routed to the San Luis Drain near South Dos Palos. The San Luis Drain thus would become the means by which a portion of the contaminated subsurface drainage now entering the South Grasslands area would be re-routed around the wetlands.

Management of agricultural drainage problems and protection, restoration, and substitute water supplies for fish and wildlife are planned as complementary activities. The interception of contaminated subsurface drainage water currently discharged into waterways of the Grasslands wetland area would make available nontoxic tailwater, operational spills, and nontoxic subsurface drainage for use in the wetlands.

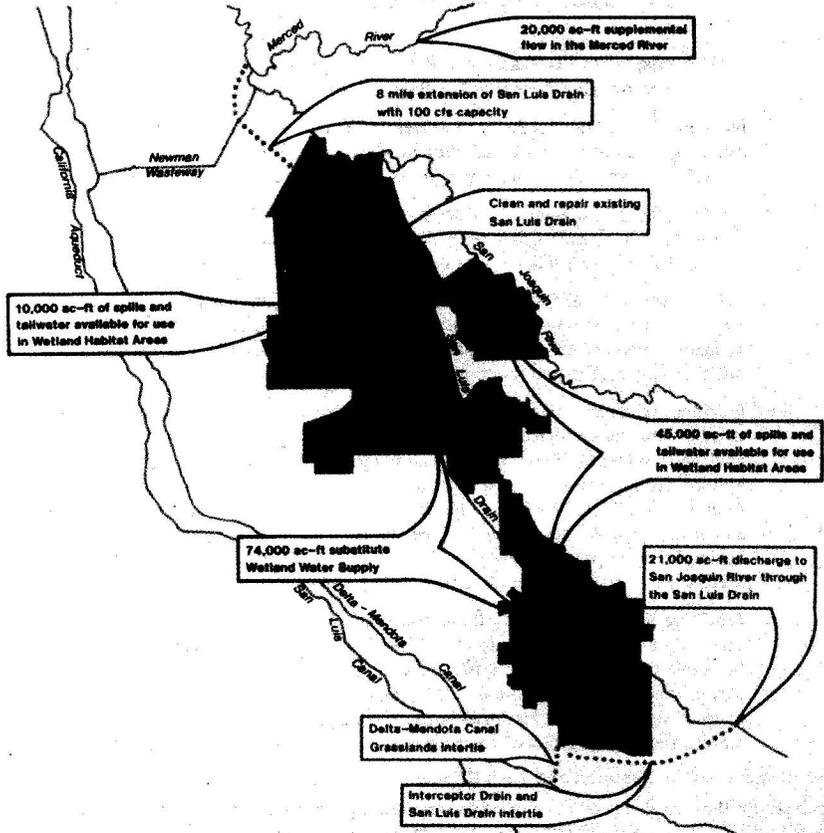
Plan components for protection, restoration, and substitute water supplies for fish and wildlife in the Grasslands Subarea are shown on Figure 33 and discussed in the following subsections.

- Providing, on a firm basis, 129,000 acre-feet per year of adequate-quality water from existing sloughs, ditches, and canals that serve the Grasslands area. This volume is the average amount of surface and subsurface drainage water diverted to the wetlands before 1985, when use of the contaminated drainage water for wetland management was discontinued. It is assumed that the quantity and quality of tailwater, operational spills, and local runoff will continue to be suitable for fish and wildlife water supplies throughout the period of the plan. The 129,000 acre-feet of water could be obtained by:

³ Assumption used to calculate the volume of drainage water discharged: (a) Dry-year hydrology similar to the 1986-87 water year, (b) existing 150 ppb selenium in subsurface drainage water, decreased to 75 ppm by 2040, and (c) 5 ppb selenium criteria in the San Joaquin River near Newman.

⁴ TDS less than 1,250 ppm, boron less than 1 ppm, and selenium less than 2 ppb.

Figure 33
FACILITIES AND FLOWS INCLUDED IN THE RECOMMENDED PLAN
Grasslands Subarea



LEGEND

-  Notes Agricultural Facility
-  Notes Water Supply for Wetlands or Supplement to River



- Providing up to about 74,000 acre-feet from the Central Valley Project through the Delta-Mendota Canal for diversion into wetland areas.
- Delivering an average of 45,000 acre-feet of tailwater, operational spills, and local runoff of adequate quality from water-quality Zone C to Salt Slough for use in wetlands.
- Delivering up to 10,000 acre-feet of tailwater, operational spills, and local runoff from water-quality Zone B to Los Banos Creek and vicinity.
- Providing the facilities necessary to deliver 74,000 acre-feet of substitute water, including a Delta-Mendota Canal Turnout with a capacity of 200 cubic feet per second and 1.75 miles of 200-cfs canal and siphons, to the wetlands of South Grasslands.
- Providing facilities to intercept all subsurface drainage water now being discharged from water-quality zone A into open channels in the Grasslands; facilities would also be provided to convey this water to the San Luis Drain near South Dos Palos.
- Using an estimated 63,500 acre-feet of subsurface drainage water from water-quality Zone C, and 17,500 acre-feet of subsurface drainage water from Zone B, by 2040, in wetlands. Most of this water would flow by gravity to Salt and Mud sloughs, where it would be conveyed to public and private wetlands.
- Providing, on a firm basis, an additional 20,000 acre-feet of fresh water to supplement October flows in the Merced River. This would minimize the straying of migrating adult salmon into the Grasslands instead of into the natural spawning grounds in the Merced River. This water must be obtained by purchasing surface or ground water from water-rights holders in the Merced River drainage or by extending the northern end of the Friant-Madera Canal into the Merced River watershed so that water stored behind Friant Dam could be delivered to the Merced River. Purchasing water in the Merced River drainage appears to be the most economical approach.
- Providing alternative wetland habitat near evaporation ponds. Because the selenium concentrations in the evaporation ponds would exceed 2 ppb, a hazing program would be required to discourage bird use. In addition, wetland habitat (one acre for each acre of evaporation ponds) would be developed close to the evaporation ponds to offer alternative clean habitat for hazed birds. Each acre of alternative habitat would require about 10 acre-feet of water per year.

Assessment of Plan Features and Their Effects

The plan for the Grasslands Subarea relies on the continued discharge of subsurface drainage water to the San Joaquin River, either directly to the river or through sloughs and wetlands. The opportunity for the discharge of contaminated subsurface drainage water depends on the flows in the San Joaquin River, the concentrations of contaminants in the subsurface drainage water, and the limiting water-quality objective at the point of discharge. Interception of contaminated subsurface drainage water south of the Grasslands Subarea and delivery to the San Luis Drain near South Dos Palos for conveyance to the San Joaquin River below the Merced River are key features of the plan. The removal and disposal of sediments within the San Luis Drain are necessary conditions for use of the drain as a plan component.

About half the subsurface drainage water would be suitable as a fish and wildlife water supply. Under conditions of the recommended plan, the quality of water delivered to the wetlands would be the best-quality water delivered since subsurface drainage was first introduced to the marsh area, and the volume (more than 129,000 acre-feet) would approximate the optimal water requirement for wildlife habitat in the subarea. Construction of the proposed wetland water-supply intertie facilities would provide the flexibility needed to ensure that the water would be delivered on an optimal schedule, assuming sufficient water is available in the Delta and sufficient capacity in the Delta-Mendota Canal to deliver the substitute water.

Table 30 compares the recommended plan features with those of the present and projected future-without conditions. The recommended plan would keep about 36,000 more acres of existing irrigated agricultural lands in production than under future-without conditions.

The annualized costs of the components of the recommended plan for the Grasslands Subarea are presented in Table 31. The category "Agricultural Drainage" comprises all drainage-related components of the recommended plan, except on-farm drainage systems. "On-Farm Drains"

Table 30. COMPARISON OF PLAN WITH PRESENT AND FUTURE-WITHOUT CONDITIONS, GRASSLANDS SUBAREA
in 1,000s

Item	Present (1990)	Future- Without (2040)	Recommended Plan (2040)
Agricultural Land Area (acres)			
Irrigable agricultural Land	365	303	339
Drainage reuse	0	2	3
Abandoned and/or retired agricultural land	0	40	3
Evaporation System			
Nontoxic evaporation pond	0.00	0.00	0.00
Toxic evaporation pond	0.10	0.20	0.12
Accelerated evaporation pond	0.00	0.00	0.02
Solar pond	0.00	0.00	0.13
Evaporation pond alternative habitat	0.00	0.00	0.12
Urban expansion	0	20	20
TOTAL ^a	365	365	365
Wildlife Areas (acres) ^b			
Wetlands	68.0	24.0	55.0
Other	29.0	72.4	41.4
Abandoned wildlife areas	0.0	0.6	0.6
TOTAL	97.0	97.0	97.0
Water Freed in Addressing Drainage Problems (acre-feet)	0	122^c	55^d
Firm Water Supply for Wildlife Areas (acre-feet)	97	97	226
Water Supply for Evaporation Pond Alternative Habitat (acre-feet)	0	0	1

^a Evaporation systems are located on existing pond sites or on retired or nonirrigable lands, so are not included in "Total."

^b Federal and State wildlife areas, private duck clubs, and other private wildlife areas.

^c Includes increased conserved water through source control on problem water lands and firm water supply freed by land abandonment and conversion of crop land to salt-tolerant crops.

^d Includes increased conserved water through source control on problem water lands; firm water supply freed by land retirement and conversion of cropland to salt-tolerant crops; and ground water pumped to control water levels within problem water areas.

includes the installation of new on-farm drainage systems from 1991 to 2040 and the annual operation from 1991 to 2040 of the newly installed drains and those already operating in 1990. "Fish and Wildlife" comprises the costs of constructing and operating facilities and purchasing water to deliver clean replacement water to waterfowl habitat formerly supplied with contaminated drainage water.

One-time costs include those for installation of facilities and purchase of land retired from irrigated agriculture. Costs were annualized, using an interest rate of 10 percent to reflect opportunities available to growers and a 50-year planning period. The grand total cost for the Grasslands Subarea would amount to about \$107 per acre of problem farmland served by components of the recommended plan. This includes the cost of the fish and wildlife components. If these costs were separated, the per-acre cost to farmland served would be \$81.

Included in the total cost is a provision necessary to minimize the risks to wildlife from evaporation ponds. The ponds in which the selenium level exceeded 2 ppb (the level assumed to be safe for wildlife) would include special features, such as steep side slopes, increased depth, hazing, and alternative habitat.

Table 31. ANNUALIZED COSTS OF THE RECOMMENDED PLAN FOR THE GRASSLANDS SUBAREA

AGRICULTURAL DRAINAGE		
<u>One-time:</u>		
Source control	\$ 622,000	
Reuse	845,000	
Evaporation	224,000	
Ground-water management	193,000	
Land retirement	55,000	
San Luis Drain	<u>2,300,000</u>	
Subtotal	\$4,239,000	
<u>Operation, maintenance, and replacement:</u>		
Source control	\$1,232,000	
Reuse	145,000	
Evaporation	239,000	
Ground-water management	549,000	
Land retirement	6,000	
San Luis Drain	<u>390,000</u>	
Subtotal	\$2,561,000	
Total		\$ 6,800,000
ON-FARM DRAINS		
Installation	\$2,653,000	
Operation, maintenance, and replacement	<u>584,000</u>	
Total		\$ 3,237,000
FISH AND WILDLIFE		
Installation	\$ 153,000	
Operation, maintenance, and replacement	18,000	
Water supply	<u>2,548,000</u>	
Total		\$ 2,719,000
GRAND TOTAL		\$12,756,000

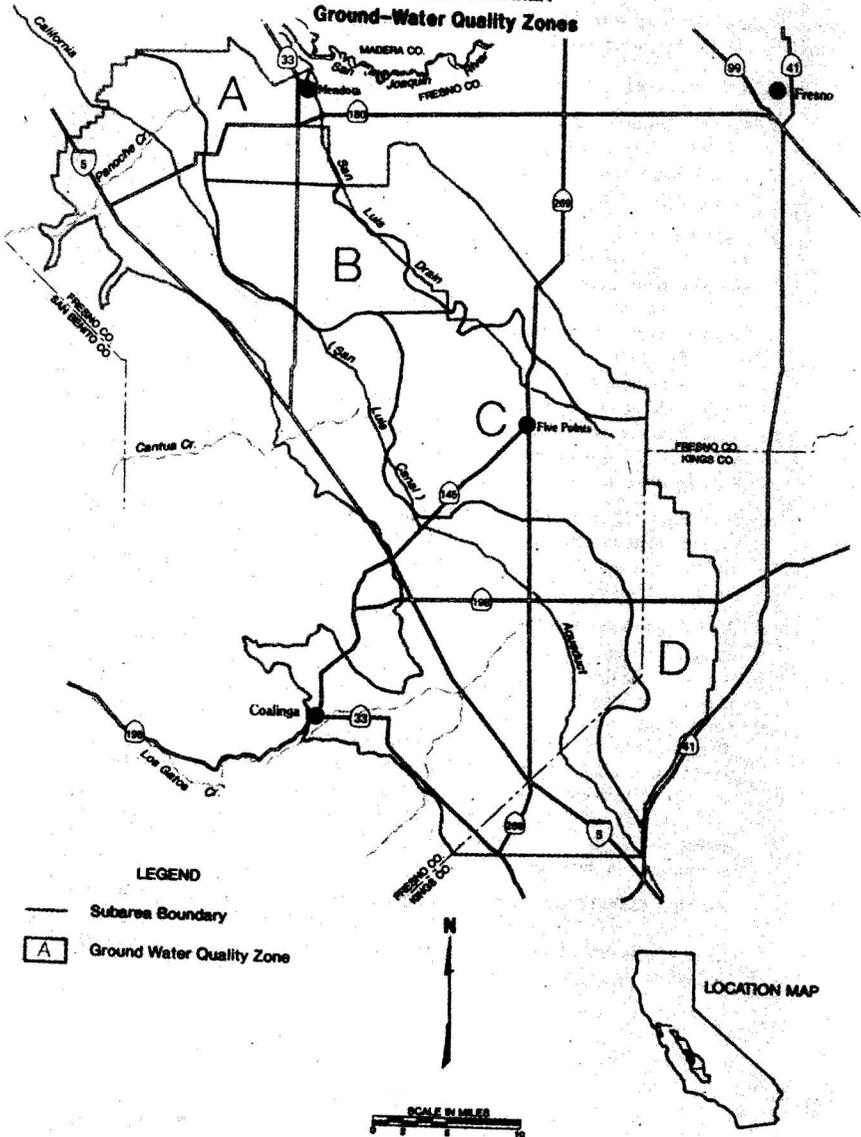
Westlands Subarea

Figure 34 shows the location of the ground-water quality zones within the subarea. Agricultural components of the recommended plan for the subarea are shown on Table 32.

The agricultural components of the recommended plan for 2040 are:

- **Practicing source control on 159,300 acres of irrigated land.** The amount of applied irrigation water would be reduced by 0.35 acre-foot per acre per year (a total of 55,800 acre-feet) by improving methods of irrigation water application, improving scheduling of irrigation water application, and tiered water pricing.
- **Reusing drainage water to irrigate about 12,100 acres of salt-tolerant trees and halophytes.** Through installation of on-farm tile drains and conveyance facilities, drainage water would be collected and supplied to trees to reduce the total drainage volume by 45,700 acre-feet. Drains would be installed beneath the trees to collect the brackish water for direct use by halophytes. This would reduce the drainage volume by another 15,300 acre-feet, for a total reduction of about 61,000 acre-feet. These reuse plantations could serve individual farms or an entire water or drainage district. They would be located on the least productive soils, with most sites on class 4 soils on the alluvial fan rims. These soils occur in the eastern part of the subarea near the San Luis Drain. Existing collector drains and the San Luis Drain would be used to convey drainage water to reuse plantations.
- **Operating 400 acres of evaporation ponds and about 1,500 acres of solar ponds.** Pond design and operation criteria would be consistent with State guidelines, and the ponds would be located close to tree and halophyte plantations. About 200 acres of additional land would be used for accelerated-rate evaporation facilities.
- **Pumping the semiconfined aquifer under about 19,000 acres of land.** Due to natural features, this option is most feasible in the southeastern portion of the subarea. The design average annual yield would be 0.4 acre-foot per acre of land affected, for a total management of 7,600 acre-feet of problem water. To exert this effect at the land surface, 16,000 acre-feet would have to be pumped from the aquifer. These lands would also have received source control (0.35 acre-foot per acre), but they would not be artificially drained. Pumped ground water of initial good quality (some 16,000 acre-feet) could be used for agriculture, or fish and wildlife, or a variety of other uses. If, in future years, influent water to a well should contain dissolved salt in excess of 2,500 ppm, that water would be used as a supply for trees and halophytes, or as top water in solar ponds.
- **Retiring 33,000 acres of irrigated agricultural lands.** Lands having the combined characteristics of low productivity, poor drainability (USBR class 4 lands), and high levels of dissolved selenium (greater than 50 ppb) in shallow ground water would be retired. A part of water-quality Zones A, B, and C would be retired.

Figure 34
WESTLANDS SUBAREA
Ground-Water Quality Zones



**Table 32. RECOMMENDED DRAINAGE MANAGEMENT PLAN
WESTLANDS SUBAREA
(In 1000s)**

PLAN COMPONENT	YEAR 2000			YEAR 2040		
	AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION		AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION	
	Acres	AF	%	Acres	AF	%
ZONE A						
SOURCE CONTROL	11.2	3.9	30.2	25.3	8.9	36.6
LAND RETIREMENT	5.0	3.8	29.4	5.0	3.8	15.4
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE*	1.0	4.9	38.1	2.2	11.1	45.5
EVAPORATION SYSTEM	0.06	0.3	2.3	0.27	0.6	2.5
Total		12.9	100.0		24.4	100.0
ZONE B						
SOURCE CONTROL	12.3	4.3	28.0	21.7	7.6	26.3
LAND RETIREMENT	7.0	5.3	34.1	15.0	11.2	38.8
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE*	1.2	5.0	32.7	2.0	8.8	30.4
EVAPORATION SYSTEM	0.07	0.8	5.2	0.94	1.3	4.5
Total		15.4	100.0		28.89	100.0
ZONE C						
SOURCE CONTROL	44.4	15.5	38.9	81.8	28.6	37.9
LAND RETIREMENT	6.0	4.5	11.3	13.0	9.8	12.9
GROUND-WATER MGMT	10.0	4.0	10.0	11.0	4.4	5.8
DRAINAGE REUSE*	2.7	15.1	37.8	6.0	31.2	41.3
EVAPORATION SYSTEM	0.18	0.8	2.0	0.78	1.6	2.1
Total		39.9	100.0		75.6	100.0
ZONE D						
SOURCE CONTROL	16.2	5.7	44.0	30.5	10.7	44.0
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	5.0	2.0	15.4	8.0	3.2	13.2
DRAINAGE REUSE*	1.0	5.0	38.3	1.9	9.9	40.7
EVAPORATION SYSTEM	0.06	0.3	2.3	0.13	0.5	1.3
Total		13.0	100.0		24.3	100.0
TOTAL						
SOURCE CONTROL	84.1	29.4	36.3	159.3	55.8	36.4
LAND RETIREMENT	18.0	13.6	16.7	33.0	24.8	16.1
GROUND-WATER MGMT	15.0	6.0	7.4	19.0	7.6	5.0
DRAINAGE REUSE*	5.9	30.0	36.9	12.1	61.0	39.9
EVAPORATION SYSTEM	0.4	2.2	2.7	1.0	4.0	2.6
Total		81.2	100.0		153.2	100.0

* Includes drainage from irrigated agricultural land used to grow salt tolerant crops.

Assessment of Plan Features and Their Effects

Table 33 compares the recommended plan features with those of present and projected future conditions without a plan. Compared to future-without conditions, the recommended plan would maintain about 100,000 more acres of existing irrigated agricultural lands in production. By 2040, the plan would result in the conservation or development of 181,000 acre-feet of water through implementation of plan components (such as source control, conversion of land to reuse drainage water, land retirement, and ground-water pumping) on drainage problem areas.

**Table 33. COMPARISON OF PLAN WITH PRESENT AND FUTURE-WITHOUT CONDITIONS
WESTLANDS SUBAREA
In 1,000s**

Item	Present (1990)	Future- Without (2040)	Recommended Plan (2040)
Agricultural Land Area (acres)			
Irrigable agricultural land	640	489	590
Drainage reuse	0	6	12
Abandoned and/or retired agricultural land	0	140	33
Evaporation System			
Nontoxic evaporation pond	0.00	0.00	0.00
Toxic evaporation pond	0.50	0.20	0.40
Accelerated evaporation pond	0.00	0.00	0.20
Solar pond	0.00	0.00	1.52
Evaporation pond alternative habitat	0.00	0.00	0.40
Urban expansion	0	5	5
TOTAL ^a	640	640	640
Wildlife Areas (acres) ^b			
Wetlands	0.1	0.1	0.1
Other	0.4	0.4	0.4
Abandoned wildlife areas	0.0	0.0	0.0
TOTAL	0.5	0.5	0.5
Water Freed In Addressing Drainage Problems (acre-feet)	0	390^c	189^d
Firm Water Supply for Wildlife Areas (acre-feet)	0	0	0
Water Supply for Evaporation Pond Alternative Habitat (acre-feet)	0	0	4

^a Evaporation systems are located on existing pond sites or on retired or nonirrigable lands, so are not included in "Total."

^b Federal and State wildlife areas, private duck clubs, and other private wildlife areas.

^c Includes increased conserved water through source control on problem water lands and firm water supply freed by land abandonment and conversion of crop land to salt-tolerant crops.

^d Includes increased conserved water through source control on problem water lands; firm water supply freed by land retirement and conversion of cropland to salt-tolerant crops; and ground water pumped to control water levels within problem water areas.

The annualized costs of the components of the recommended plan for the Westlands Subarea are presented in Table 34. The category "Agricultural Drainage" comprises all drainage-related components of the recommended plan, except on-farm drainage systems. "On-Farm Drains" includes the installation of new on-farm drainage systems from 1991 to 2040 and the annual operation from 1991 to 2040 of the newly installed drains and those already operating in 1990.

One-time costs include those for installation of facilities and purchase of land retired from irrigated agriculture. Costs were annualized, using an interest rate of 10 percent to reflect opportunities available to growers and a 50-year planning period.

The grand total cost for the Westlands Subarea amounts to about \$136 per acre of problem farmland served through the components stipulated in the recommended plan.

Included in the cost is a provision necessary to minimize the risk to wildlife from evaporation ponds. The ponds in which the influent selenium level exceeded 2 ppb (the level assumed to be safe for wildlife) would include special features, such as steep side slopes, increased depth, hazing, and alternative habitat.

**Table 34. ANNUALIZED COSTS OF THE RECOMMENDED PLAN
FOR THE WESTLANDS SUBAREA**

AGRICULTURAL DRAINAGE			
<u>One-time:</u>			
Source control		\$ 829,000	
Reuse		1,801,000	
Evaporation		702,000	
Ground-water management		319,000	
Land retirement		<u>1,930,000</u>	
Subtotal		\$5,581,000	
<u>Operation, maintenance, and replacement:</u>			
Source control		\$1,588,000	
Reuse		626,000	
Evaporation		596,000	
Ground-water management		903,000	
Land retirement		<u>208,000</u>	
Subtotal		\$3,921,000	
	Total		\$ 9,502,000
ON-FARM DRAINS			
Installation		\$3,008,000	
Operation, maintenance, and replacement		<u>355,000</u>	
	Total		\$ 3,363,000
	GRAND TOTAL		<u>\$12,865,000</u>

Tulare Subarea

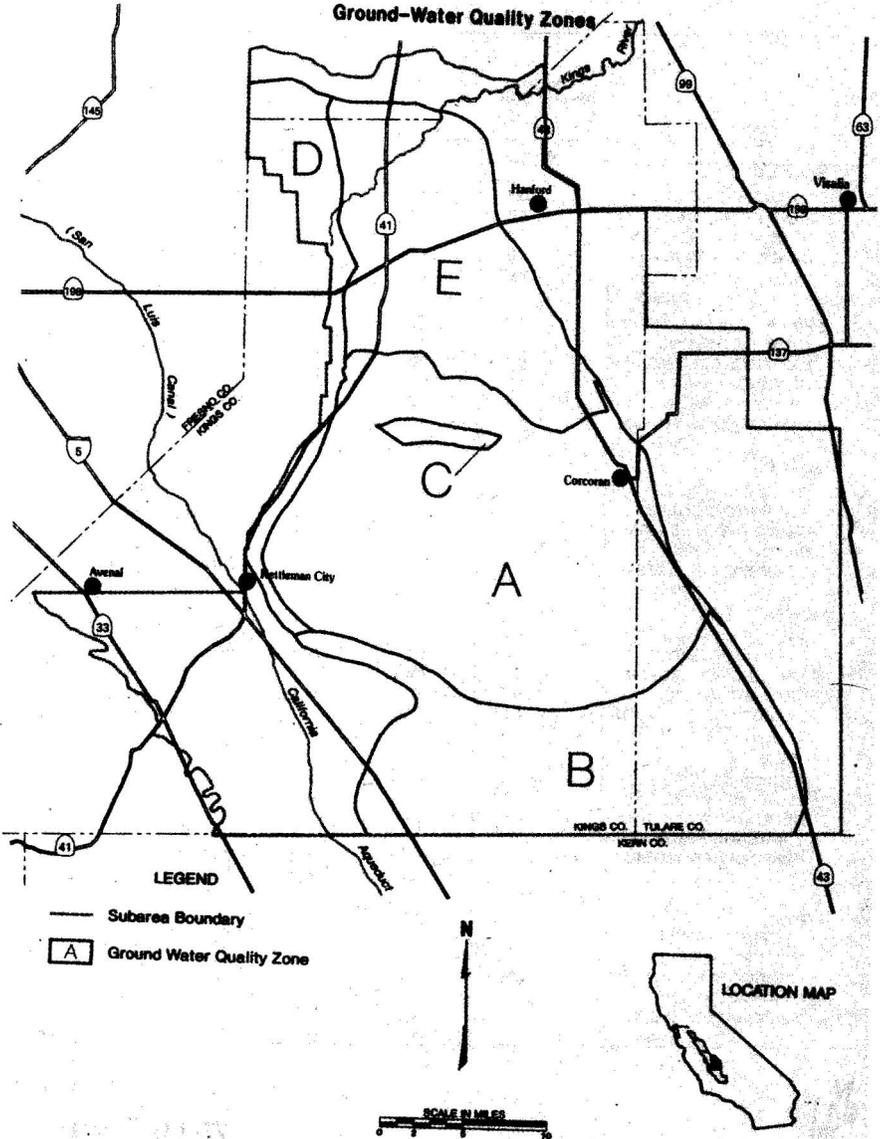
Figure 35 shows the location of the ground-water quality zones within the subarea. Agricultural components of the recommended plan for the subarea are listed in Table 35.

The agricultural components of the recommended plan for 2040 are:

- **Practicing source control on 316,700 acres of irrigated land.** The amount of applied irrigation water will be reduced by 0.20 acre-foot per acre per year (a total of 63,200 acre-feet) by improving methods of irrigation water application, improving scheduling of irrigation water application, and tiered water pricing.
- **Reusing drainage water to irrigate 24,500 acres of salt-tolerant trees and halophytes.** Through installation of on-farm tile drains, drainage water would be collected and supplied to trees to reduce the total drainage volume by 68,900 acre-feet. Drains would be installed beneath the trees to collect the brackish water for direct use by halophytes. This would reduce the drainage volume by another 44,400 acre-feet, for a total reduction of 113,300 acre-feet. These reuse plantations could serve individual farms or an entire water or drainage district. They would be located on the least productive soils, with most sites on class 4, 5, and 6 soils (Storie Index) on the basin rim.
- **Operating 3,000 acres of evaporation ponds.⁵** Pond design and operation criteria would be consistent with State guidelines, and the ponds would be located close to tree and halophyte plantations.
- **Pumping the semiconfined aquifer under about 40,000 acres of land.** Due to natural features, this option is most feasible in the northern part of water-quality Zones D and E. The design average annual yield would be 0.4 acre-foot per acre of land affected, for a total management of 16,000 acre-feet of problem water. To exert this effect at the land surface, 32,000 acre-feet would have to be pumped from the aquifer. These lands would also have received source control (0.20 acre-foot per acre), but they would not be artificially drained. Pumped ground water of initial good quality could be used for agriculture, or fish and wildlife, or a variety of other uses. If, in future years, influent water to a well should contain dissolved salt in excess of 2,500 ppm, that water would be used for trees and halophytes.
- **Retiring 7,000 acres of irrigated agricultural lands.** Lands having the combined characteristics of low productivity, poor drainability (Storie Index 4, 5, and 6 lands), and overlying high selenium (greater than 50 ppb) in shallow ground water would be retired. All the lands lie within water-quality Zone B.

⁵ No solar ponds are included because salinity levels would probably be too low to support them.

Figure 35
TULARE SUBAREA
Ground-Water Quality Zones



**Table 35. RECOMMENDED DRAINAGE MANAGEMENT PLAN
TULARE SUBAREA
(in 1000s)**

PLAN COMPONENT	YEAR 2000			YEAR 2040		
	AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION		AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION	
	Acres	AF	%	Acres	AF	%
ZONE A						
SOURCE CONTROL	60.9	12.2	30.8	169.5	33.9	30.8
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	2.0	0.8	2.0	3.0	1.2	1.1
DRAINAGE REUSE	5.0	25.2	63.7	14.0	71.3	64.7
EVAPORATION SYSTEM	0.34	1.4	3.5	0.96	3.8	3.4
Total		39.6	100.0		110.2	100.0
ZONE B						
SOURCE CONTROL	25.0	5.0	30.3	63.2	12.6	27.4
LAND RETIREMENT	0.0	0.0	0.0	7.0	4.2	9.2
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	2.5	9.0	54.5	6.3	22.8	49.7
EVAPORATION SYSTEM	0.62	2.5	15.2	1.58	6.3	13.7
Total		16.5	100.0		45.9	100.0
ZONE C						
SOURCE CONTROL	1.5	0.3	27.3	4.1	0.8	29.6
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	0.2	0.6	54.5	0.4	1.5	55.6
EVAPORATION SYSTEM	0.04	0.2	18.2	0.10	0.4	14.8
Total		1.1	100.0		2.7	100.0
ZONE D						
SOURCE CONTROL	6.9	1.4	31.1	19.7	3.9	31.4
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	2.0	0.8	17.8	10.0	4.0	32.3
DRAINAGE REUSE	0.5	1.8	40.0	1.0	3.5	28.2
EVAPORATION SYSTEM	0.12	0.5	11.1	0.24	1.0	8.1
Total		4.5	100.0		12.4	100.0
ZONE E						
SOURCE CONTROL	22.1	4.4	32.6	60.2	12.0	31.8
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	16.0	6.4	47.4	27.0	10.8	28.6
DRAINAGE REUSE	0.5	2.6	19.3	2.8	14.2	37.5
EVAPORATION SYSTEM	0.04	0.1	0.7	0.15	0.8	2.1
Total		13.5	100.0		37.8	100.0
TOTAL						
SOURCE CONTROL	116.4	23.3	31.0	316.7	63.2	30.2
LAND RETIREMENT	0.0	0.0	0.0	7.0	4.2	2.0
GROUND-WATER MGMT	20.0	8.0	10.6	40.0	16.0	7.7
DRAINAGE REUSE	8.7	39.2	52.1	24.5	113.3	54.2
EVAPORATION SYSTEM	1.2	4.7	6.3	3.0	12.3	5.9
Total		75.2	100.0		209.0	100.0

Assessment of Plan Features and Their Effects

Table 36 compares the plan features with those of present and projected future conditions without the plan. Compared to future-without conditions, the recommended plan would maintain 166,000 more acres of existing irrigated agricultural lands in production. By 2040, the plan would result in the conservation or development of about 164,000 acre-feet of water through implementation of plan components (such as source control, conversion of land to reuse of drainage water, land retirement, and ground-water pumping) on drainage problem areas.

The annualized costs of the components of the recommended plan for the Tulare Subarea are presented in Table 37. The category "Agricultural Drainage" comprises all drainage-related components of the recommended plan, except on-farm drainage systems. "On-Farm Drains" includes the installation of new on-farm drainage systems from 1991 to 2040 and the annual operation from 1991 to 2040 of the newly installed drains and those already operating in 1990.

One-time costs include those for installation of facilities and purchase of land retired from irrigated agriculture. Costs were annualized, using an interest rate of 10 percent to reflect opportunities available to growers and a 50-year planning period.

**Table 36. COMPARISON OF PLAN WITH PRESENT AND FUTURE-WITHOUT CONDITIONS
TULARE SUBAREA
In 1,000s**

Item	Present (1990)	Future- Without (2040)	Recommended Plan (2040)
Agricultural Land Area (acres)			
Irrigable agricultural land	612	406	572
Drainage Reuse	0	11	25
Abandoned and/or retired agricultural land	0	190	7
Evaporation system			
Nontoxic evaporation pond	0.80	0.50	0.20
Toxic evaporation pond	4.10	0.90	2.90
Accelerated Evaporation pond	0.00	0.00	0.00
Solar pond	0.00	0.00	0.00
Evaporation pond alternative habitat	0.00	0.00	2.90
Urban expansion	0	5	5
TOTAL^a	612	612	612
Wildlife Areas (acres)^b			
Wetlands	1.7	0.0	0.0
Other	7.7	9.3	9.3
Abandoned wildlife areas	0.0	0.1	0.1
TOTAL	9.4	9.4	9.4
Water Freed in Addressing Drainage Problems (acre-feet)	0	454^c	164^d
Firm Water Supply for Wildlife Areas (acre-feet)	0	0	0
Water Supply for Evaporation Pond Alternative Habitat (acre-feet)	0	0	29

^a Evaporation systems are located on existing pond sites or on retired or nonirrigable lands, so are not included in "Total."

^b Federal and State wildlife areas, private duck clubs, and other private wildlife areas.

^c Includes increased conserved water through source control on problem water lands and firm water supply freed by land abandonment and conversion of crop land to salt-tolerant crops.

^d Includes increased conserved water through source control on problem water lands; firm water supply freed by land retirement and conversion of cropland to salt-tolerant crops; and ground water pumped to control water levels within problem water areas.

**Table 37. ANNUALIZED COSTS OF THE RECOMMENDED PLAN
FOR THE TULARE SUBAREA**

AGRICULTURAL DRAINAGE

One-time:

Source control	\$1,312,000
Reuse	3,111,000
Evaporation	396,000
Ground-water management	513,000
Land retirement	<u>112,000</u>
Subtotal	\$5,444,000

Operation, maintenance, and replacement:

Source control	\$2,450,000
Reuse	992,000
Evaporation	241,000
Ground-water management	1,441,000
Land retirement	<u>112,000</u>
Subtotal	\$5,135,000

Total	\$10,579,000
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ON-FARM DRAINS

Installation	\$3,144,000
Operation, maintenance, and replacement	<u>589,000</u>

Total	\$ 3,733,000
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GRAND TOTAL	<u>\$14,312,000</u>
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The grand total cost for the Tulare Subarea amounts to about \$104 per acre of problem farmland served through components included in the recommended plan.

Included in the cost is a provision necessary to minimize the risk to wildlife from evaporation ponds. The ponds in which the influent selenium level exceeded 2 ppb (the level assumed to be safe for wildlife) would include special features, such as steep side slopes, increased depth, hazing, and alternative habitat.

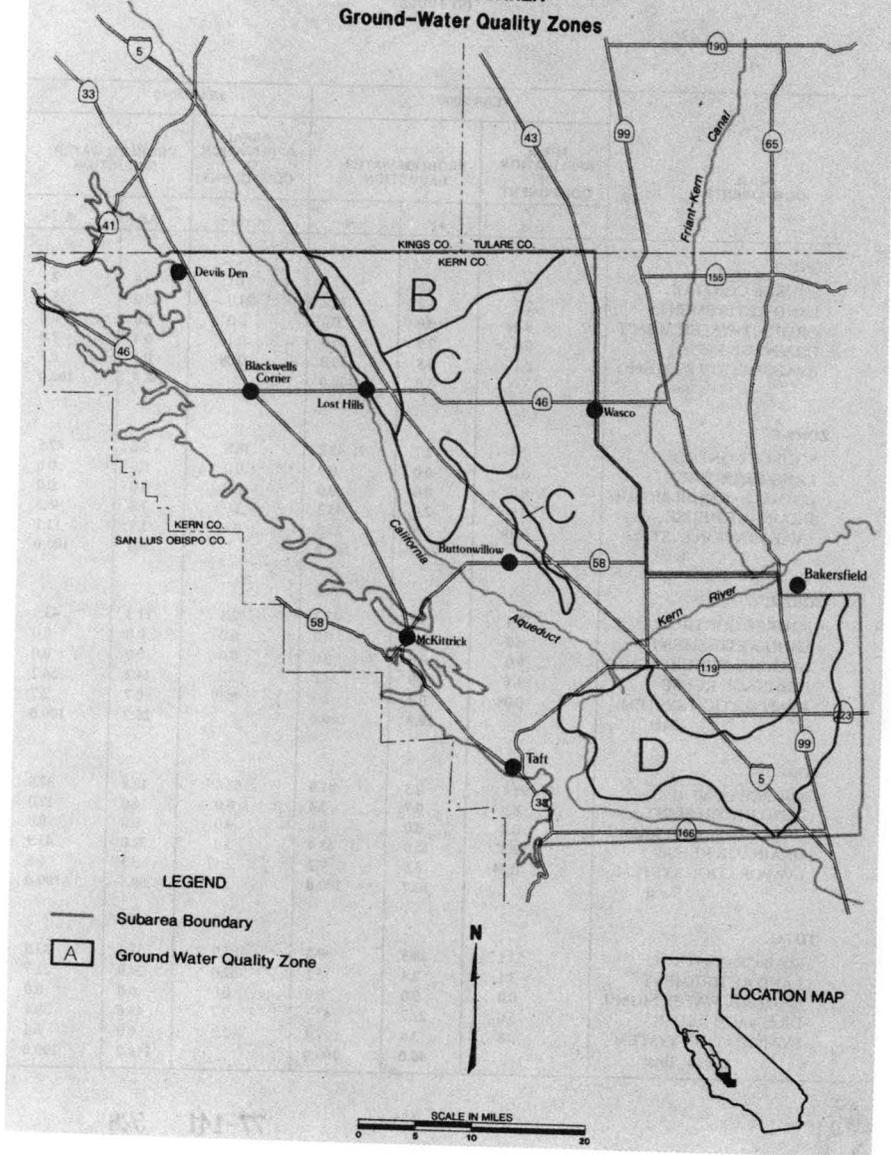
Kern Subarea

Figure 36 shows the location of the ground-water quality zones within the subarea. Agricultural components of the recommended plan for the subarea are shown on Table 38.

The agricultural components of the recommended plan for 2040 are:

- **Practicing source control on 105,900 acres of irrigated land.** The amount of applied irrigation water will be reduced by 0.35 acre-foot per acre per year (a total of 37,100 acre-feet) by improving methods of irrigation water application, improving scheduling of irrigation water application, and tiered water pricing.

Figure 36
KERN SUBAREA
Ground-Water Quality Zones



**Table 38. RECOMMENDED DRAINAGE MANAGEMENT PLAN
KERN SUBAREA
(in 1000s)**

PLAN COMPONENTS	YEAR 2000			YEAR 2040		
	AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION		AREAL APPLICATION OF COMPONENT	PROBLEM WATER REDUCTION	
		Acres	AF		%	Acres	AF	%
ZONE A						
SOURCE CONTROL	7.5	2.6	32.5	1.1	0.4	2.1
LAND RETIREMENT	2.2	1.7	21.2	24.0	18.0	95.4
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	0.8	2.9	36.3	0.1	0.4	2.0
EVAPORATION SYSTEM	0.15	0.8	10.0	0.08	0.1	0.5
Total		8.0	100.0		18.9	100.0
ZONE B						
SOURCE CONTROL	7.8	2.7	42.2	18.8	6.6	42.6
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	0.8	2.9	45.3	1.9	7.0	45.3
EVAPORATION SYSTEM	0.19	0.8	12.5	0.47	1.9	12.1
Total		6.4	100.0		15.5	100.0
ZONE C						
SOURCE CONTROL	13.4	4.7	43.1	32.4	11.3	43.1
LAND RETIREMENT	0.0	0.0	0.0	0.0	0.0	0.0
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	1.1	5.9	54.2	2.7	14.2	54.2
EVAPORATION SYSTEM	0.08	0.3	2.7	0.19	0.7	2.7
Total		10.9	100.0		26.2	100.0
ZONE D						
SOURCE CONTROL	24.4	8.5	41.0	53.6	18.8	37.5
LAND RETIREMENT	0.9	0.7	3.4	8.0	6.0	12.0
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	2.3	10.0	48.4	5.0	22.0	43.9
EVAPORATION SYSTEM	0.34	1.5	7.2	1.57	3.3	6.6
Total		20.7	100.0		50.1	100.0
TOTAL						
SOURCE CONTROL	53.1	18.5	40.2	105.9	37.1	33.5
LAND RETIREMENT	3.1	2.4	5.1	32.0	24.0	21.7
GROUND-WATER MGMT	0.0	0.0	0.0	0.0	0.0	0.0
DRAINAGE REUSE	5.0	21.7	47.3	9.7	43.6	39.4
EVAPORATION SYSTEM	0.8	3.4	7.4	2.3	6.0	5.4
Total		46.0	100.0		110.7	100.0

- **Reusing drainage water to irrigate 9,700 acres of salt-tolerant trees and halophytes.** Through installation of on-farm tile drains, drainage water will be collected and supplied to trees to reduce the total drainage volume by 20,900 acre-feet. Drains would be installed beneath the trees to supply the water to halophytes. This would reduce the drainage volume by another 22,700 acre-feet, for a total reduction of 43,600 acre-feet. These reuse plantations could serve individual farms or an entire water or drainage district. They would be located on the least productive soils, with most sites on class 5 and 6 soils (Storie Index) on the alluvial fans in water-quality Zones A and D.
- **Operating 1,100 acres of evaporation ponds and 1,100 acres of solar ponds.** Pond design and operation criteria would be consistent with State guidelines, and the ponds would be located close to tree and halophyte plantations. An additional 100 acres of land would be required for accelerated-rate evaporation systems.
- **Retiring 32,000 acres of irrigated agricultural lands.** Lands having the combined characteristics of low productivity, poor drainability (Storie Index 4, 5, and 6 lands), and overlying high selenium (greater than 50 ppb) in shallow ground water would be retired. These lands lie within water-quality Zones A and D.

Assessment of Plan Features and Their Effects

Table 39 compares the plan features with those of present and projected future conditions without the plan. Compared to future-without conditions, the recommended plan would maintain about 52,000 more acres of existing irrigated agricultural lands in production. By 2040, the plan would create an opportunity to free at least 753,600 acre-feet of irrigation water for other uses.

The annualized costs of the components of the recommended plan for the Kern Subarea are presented in Table 40. The category "Agricultural Drainage" comprises all drainage-related components of the recommended plan, except on-farm drainage systems. "On-Farm Drains" includes the installation of new on-farm drainage systems from 1991 to 2040 and the annual operation from 1991 to 2040 of the newly installed drains and those already operating in 1990.

One-time costs include those for installation of facilities and purchase of land retired from irrigated agriculture. Costs were annualized, using an interest rate of 10 percent to reflect opportunities available to growers and a 50-year planning period.

The grand total cost for the Kern Subarea amounts to about \$137 per acre of problem farmland served through the components stipulated in the recommended plan.

Included in the cost is a provision necessary to minimize the risk to wildlife from evaporation ponds. The ponds in which the influent selenium level exceeded 2 ppb (the level assumed to be safe for wildlife) would include special features, such as steep side slopes, increased depth, hazing, and alternative habitat.

**Table 39. COMPARISON OF PLAN WITH PRESENT AND FUTURE-WITHOUT CONDITIONS
KERN SUBAREA**
In 1,000s

Item	Present (1990)	Future- Without (2040)	Recommended Plan (2040)
Agricultural Land Area (acres)			
Irrigable agricultural land	762	632	684
Drainage Reuse	0	5	10
Abandoned and/or retired agricultural land	0	90	32
Evaporation system			
Nontoxic evaporation pond	0.00	0.00	0.00
Toxic evaporation pond	1.70	0.70	1.07
Accelerated Evaporation pond	0.00	0.00	0.14
Solar pond	0.00	0.00	1.10
Evaporation pond alternative habitat	0.00	0.00	1.07
Urban expansion	0	35	35
TOTAL^a	762	762	762
Wildlife Areas (acres)^b			
Wetlands	6.1	0.0	0.0
Other	10.9	13.6	13.6
Abandoned wildlife areas	0.0	3.4	3.4
TOTAL	17.0	17.0	17.0
Water Freed In Addressing Drainage Problems (ac-ft)	0	268 ^c	154 ^d
Firm Water Supply for Wildlife Areas (acre-feet)	0	0	0
Water Supply for Evaporation Pond Alternative Habitat (acre-feet)	0	0	11

^a Evaporation systems are located on existing pond sites or on retired or nonirrigable lands, so are not included in "Total."

^b Federal and State wildlife areas, private duck clubs, and other private wildlife areas.

^c Includes increased conserved water through source control on problem water lands and firm water supply freed by land abandonment and conversion of crop land to salt-tolerant crops.

^d Includes increased conserved water through source control on problem water lands; firm water supply freed by land retirement and conversion of cropland to salt-tolerant crops; and ground water pumped to control water levels in problem water areas.

Table 40. ANNUALIZED COSTS OF THE RECOMMENDED PLAN FOR THE KERN SUBAREA

AGRICULTURAL DRAINAGE

One-time:

Source control	\$ 551,000
Reuse	1,391,000
Evaporation	542,000
Land retirement	<u>652,000</u>
Subtotal	\$3,136,000

Operation, maintenance, and replacement:

Source control	\$1,051,000
Reuse	637,000
Evaporation	489,000
Land retirement	<u>68,000</u>
Subtotal	\$2,245,000

Total \$5,381,000

ON-FARM DRAINS

Installation	\$2,051,000
Operation, maintenance, and replacement	<u>288,000</u>

Total \$2,339,000

GRAND TOTAL \$7,729,000

Evaluation of Plan and Comparison to Future-Without

The actions included in the recommended plan for each subarea would reduce the amount of irrigation water used on the lands overlying problem water. The volume would be reduced through: (1) Water conserved through source control measures, (2) water not applied to retired land, and (3) water not applied to lands being supplied through reuse of drainage water (for example, eucalyptus trees replacing a cotton field). In addition, a relatively small volume of water, some 56,000 acre-feet per year, would be pumped from the semiconfined aquifer.

The estimated water potentially available through recommended plan actions to reduce irrigation water application is given in Table 41. Although the water is potentially available with the plan, the water may not be physically available for any given use. That is because of restrictions due to water law (including contracts), economics, or private property rights (for example, pumped ground water). In the Westlands Subarea, for instance, 189,000 acre-feet annually would be conserved or developed in implementing the recommended plan. However, there is currently a shortage of irrigation water for some lands in the Westlands Water District. Consequently, water made available by reduced demand in the drainage problem area would probably be transferred to the area of shortage. Considerations of service area boundaries, priority of rights, availability of funds, and the full array of alternative uses for such water should be examined in more detail.

The water needs for fish and wildlife are shown in Table 42. Comparison of Tables 41 and 42 shows that a possible source of the water needed for fish and wildlife to offset the effects of drainage could be found in the water made available under the plan. It is assumed that 189,000 acre-feet of water freed in the Grasslands Subarea may be used to satisfy the 158,000-acre-foot shortage in the current firm water supply of the Grassland Water District. Additional investigation is required to determine the means of making the needed water available. The investigation should include consideration of marketing part of the available water to help pay for costs of solving drainage problems, including protecting fish and wildlife.

Table 41. WATER POTENTIALLY AVAILABLE THROUGH RECOMMENDED PLAN ACTIONS
In 1,000 acre-feet annually

Subarea	Source Control and Reuse		Ground-Water Management		Land Retirement		Total Water Available	
	2000	2040	2000	2040	2000	2040	2000	2040
Northern	0	0	0	0	0	0	0	0
Grasslands	35	39	4	8	0	8	39	55
Westlands	45	87	12	16	47	86	104	189
Tulare	42	117	16	32	0	15	58	164
Kern	32	64	0	0	9	90	41	154
TOTAL	154	307	32	56	56	199	242	562

Table 43 shows the area of wetlands, evaporation ponds, and solar ponds included in the recommended plan. The new year-round wetlands have been created to provide alternative habitat to unsafe evaporation ponds, and they are necessary for successful hazing. The wetlands would require fresh water at the rate of about 10 acre-feet per acre per year.

Comparison of the recommended plan to the future-without conditions provides a scale for further evaluation of the recommended plan. Selected features of the two courses of action are

displayed in Tables 44 and 45. Table 44 shows that the recommended plan, which emphasizes more planned regional control of drainage water (beginning with intensive drainage water source control measures), provides water that could be made available for other uses, including fish and wildlife. However, by far the largest volume of water would be made available under future-without conditions, in which 1,140,000 acre-feet of water annually would not be used on 460,000 acres of presently irrigated lands because of salinization and abandonment of those lands.

Table 42. SUMMARY OF ANNUAL WATER NEEDS FOR FISH PROTECTION, SUBSTITUTE WATER SUPPLY FOR WILDLIFE AREAS, AND ALTERNATIVE HABITAT FOR EVAPORATION PONDS (As Related to Drainage Problem)
In acre-feet

Subarea	2000	2040
Grasslands ^a	149,300	150,200
Westlands ^b	2,300	4,000
Tulare ^b	11,200	29,000
Kern ^b	4,600	10,700
TOTAL	167,400	193,900

^a Includes 20,000 acre-feet per year for Merced River fisheries, 129,000 acre-feet per year for substitute water supply, and 300 acre-feet per year (2000) / 1,200 acre-feet per year (2040) for alternative habitat for evaporation ponds. Some substitute water supply needs can be met with existing water-district spills and tailwater of adequate quality (about 55,000 acre-feet per year is estimated under the recommended plan on a firm basis).

^b All needs are for alternative habitat to evaporation ponds.

Table 43. AREA OF EVAPORATION AND SOLAR PONDS AND WETLANDS IN THE RECOMMENDED PLAN
In acres

Subarea	Evaporation Ponds						Solar Ponds ^a		New Year-Round Wetlands ^b	
	Nontoxic Ponds (≤2 ppb selenium)		Standard Ponds (2-50 ppb selenium)		Accelerated Rate Ponds ^a		2000	2040	2000	2040
	2000	2040	2000	2040	2000	2040				
Northern	0	0	0	0	0	0	0	0	0	0
Grasslands	0	0	10	120	0	70	0	110	10	120
Westlands	0	0	230	410	20	200	140	1,520	230	410
Tulare	40	200	1,120	2,900	0	0	0	0	1,120	2,900
Kern	0	0	460	1,070	120	140	190	1,100	460	1,070
TOTAL	40	200	1,820	4,500	140	410	330	2,730	1,820	4,500

^a These ponds must be evaluated to determine their effect on wildlife and shallow ground water.

^b Provided as alternative habitat to standard evaporation ponds (new wetlands require 10 acre-feet per acre per year).

Table 44. COMPARISON OF SELECTED WATER FEATURES AND EFFECTS OF THE RECOMMENDED PLAN AND FUTURE-WITHOUT CONDITIONS, 2040
In acre-feet

	<u>Future-Without Conditions</u>	<u>Recommended Plan</u>
Water supplied to wetland areas	97,000	271,000 ^a
Supplementation of Merced River	0	20,000
Water made available by land abandonment	1,140,000	0
Water made available through land retirement	0	195,000
Water pumped from the semiconfined aquifer	0	56,000
Water conserved through source control and reuse of drainage water	54,000 ^b	308,000 ^c

a Includes, approximately: 97,000 acre-feet per year of existing firm supply; 129,000 acre-feet per year of substitute water supply; and 45,000 acre-feet of water to create a wetland habitat that is an alternative to toxic evaporation ponds.

b Conservation rate of 0.2 acre-foot per acre of drained land.

c Conservation rate of 0.35 acre-foot per acre of drained land (except Tulare, which is 0.20 acre-foot); includes freeing of irrigation water supply supplanted by using drainage water on salt-tolerant plants.

Table 45. COMPARISON OF SELECTED LAND FEATURES AND EFFECTS OF THE RECOMMENDED PLAN AND FUTURE-WITHOUT CONDITIONS, 2040
In acres

	<u>Future-Without Conditions</u>	<u>Recommended Plan</u>
Seasonal and permanent wetlands	24,000	55,000 ^a
Reuse areas (salt-tolerant plants)	28,000	49,000
Irrigated land area	1,965,000	2,325,000
Crop land drained ^b	345,000	783,000
Land abandoned ^c	460,000	0
Land retired from irrigation	0	75,000

a Does not include new wetlands created as alternative habitat for evaporation ponds because such lands are an adjunct of the drainage management system, not lands dedicated to wetlands.

b Does not include tile drains that would be installed under salt-tolerant plants.

c Salinization of formerly irrigated lands.

Estimates of the economic benefits of fish and wildlife resources in the San Joaquin Valley have been based on both market (user) and nonmarket (nonuser) values (Loomis et al., 1990). The combined annual market and nonmarket values of fish and wildlife for the recommended plan exceed those values associated with the future-without alternative by a ratio of almost 2 to 1.

Conditions that are expected to prevail with the recommended plan have been analyzed for 2040, and the agriculturally related economic impacts of plan conditions and future-without conditions for 2040 are compared in Table 46. The recommended plan would maintain more land in agricultural production and higher levels of retail sales, employment, and income. About 360,000 more acres would be kept in irrigated agriculture, with an associated crop value of \$285 million. The positive impact on retail sales in neighboring communities would be nearly \$41 million, and personal income would be about \$78 million higher than in the future-without.

Total direct agricultural employment in the four subareas would be about 2,500 jobs higher with the recommended plan than without it. Additional employment of more than 3,200 person-years would occur both in industries that serve agriculture and in the general economies of nearby communities. The overall improvement in employment would exceed 5,700 jobs.

Table 46. INCREASE IN RETAIL SALES, INCOME, AND EMPLOYMENT FROM FUTURE-WITHOUT CONDITIONS TO THE RECOMMENDED PLAN FOR SELECTED SUBAREAS, 2040

<u>Item</u>	<u>Grasslands</u>	<u>Westlands</u>	<u>Tulare</u>	<u>Kern</u>	<u>Total</u>
Increase in irrigated crop area (1,000 acres)	36	101	170	53	360
Crop value maintained	23,788	85,862	139,332	35,877	284,859
Direct retail sales	865	3,125	5,071	1,305	10,366
Indirect and induced retail sales	2,529	9,158	14,932	3,836	30,455
TOTAL RETAIL SALES	3,394	12,283	20,003	5,141	40,821
Direct personal income	2,984	10,888	17,975	4,590	36,437
Indirect and induced personal income	4,054	19,635	11,417	5,975	10,565
TOTAL PERSONAL INCOME	7,038	30,523	29,392	10,565	77,518
Direct employment	223	780	1,206	319	2,528
Indirect and induced employment	568	1,423	812	414	3,217
TOTAL EMPLOYMENT	791	2,203	2,018	733	5,745

Note: Crop value, retail sales, and income are in 1,000s (1990) of dollars per year, and employment is in person-years per year.

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The following abbreviations identify organizations that are cited in the text of this report.

AWMS	Agricultural Water Management Subcommittee, Interagency Technical Advisory Committee
CDFA	California Department of Food and Agriculture
CVRWQCB	California Regional Water Quality Control Board, Central Valley Region
DWR	California Department of Water Resources
IDP	Interagency Drainage Program
NRC	National Research Council
RMI	Resources Management International, Inc.
SJVDP	San Joaquin Valley Drainage Program
SWRCB	State Water Resources Control Board
UCCC	University of California Committee of Consultants on Drainage Water Reduction
USBR	U.S. Bureau of Reclamation
USEPA	U.S. Environmental Protection Agency

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September 25 - October 3, 1989 (Bakersfield, Lost Hills, Corcoran, Fresno, Mendota, Los Banos, Patterson, and Oakland).

July 23-27, 1990 (Sacramento, San Francisco, Los Banos, Fresno, and Bakersfield).

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March 5, 1987 - Stockton	September 26, 1988 - Stockton
April 10, 1987 - Santa Nella	February 13, 1989 - Stockton
May 22, 1987 - Pleasanton	April 3, 1989 - Stockton
June 22, 1987 - Patterson	April 3, 1989 - Stockton
July 27, 1987 - Livermore	July 31, 1989 - Byron
September 28-29 1987 - Coalinga	September 11, 1989 - Stockton
January 11, 1988 - Oakland	November 13, 1989 - Los Banos
February 11, 1988 - Santa Nella	January 17, 1990 - Sausalito
March 28, 1988 - Tracy	April 18, 1990 - Coalinga
April 25, 1988 - Livermore	May 30, 1990 - Stockton
May 23, 1988 - Stockton	July 16, 1990 - Stockton
June 28, 1988 - Coalinga	August 13, 1990 - Stockton
August 29, 1988 - Stockton	

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<u>1985</u>	<u>1986</u>	<u>1987</u>
August 19	January 8	February 23
October 21	January 21	April 2
November 12	February 13	June 15
November 25	March 6	August 17
December 9	April 2	October 21
December 16	April 29	
	May 26	
	June 26	
	August 28	
	October 8	
	November 12	
<u>1988</u>	<u>1989</u>	<u>1990</u>
January 4	March 24	May 7
March 11	July 7	June 13
May 9	December 18	August 15
May 23	August 1	September 22
December 5		

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OR IN COOPERATION WITH
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ABBREVIATIONS

Ac: acre

Acre-ft: acre-feet

AF: acre-feet

CCC: Commodity Credit Corporation

CSWRCB: California State Water Resources Control Board

CVP: Central Valley Project

CVRWQCB: California Regional Water Quality Control Board, Central Valley Region

DFG: California Department of Fish and Game

DWR: California Department of Water Resources

EC: electrical conductivity

EPA: U.S. Environmental Protection Agency

EPOC AG: EPOC Agricultural Corporation

gpm: gallons per minute

GW: ground water

ITAC: Interagency Technical Advisory Committee, San Joaquin Valley Drainage Program

k: thousand

mgd: million gallons per day

NWR: National Wildlife Refuge

ppb: parts per billion

ppm: parts per million

SJVDP: San Joaquin Valley Drainage Program (1984–1990)

SWP: State Water Project

SWRCB: California State Water Resources Control Board

TDS: total dissolved solids

UC: University of California

USBR: U.S. Bureau of Reclamation

USFWS: U.S. Fish and Wildlife Service

USGS: U.S. Geological Survey

WA: wildlife area managed by the State of California

yd³: cubic yards

>: greater than

≥: greater than or equal to

<: less than

≤: less than or equal to

GLOSSARY

- Acre-foot:** The quantity of water required to cover 1 acre to a depth of 1 foot. Equal to 325,851 gallons or 43,560 cubic feet.
- Adsorption:** The surface retention of solid, liquid, or gas molecules, ions, or atoms by a solid or liquid.
- Aerobic:** Referring to a condition requiring the presence of oxygen. Aerobic bacteria require free oxygen for the metabolic breakdown of materials.
- Agroforestry:** As used in this report, it is the practice of growing certain types of trees with drainage water. The trees act to dispose of applied drainage and shallow ground water through foliar evapotranspiration and at the same time produce a marketable commodity.
- Alluvium:** A general term for clay, silt, sand, gravel, or similar unconsolidated material deposited during comparatively recent geologic time by a body of running water.
- Alluvial fan:** A low, outspread, relatively flat to gently sloping mass of stream deposits, shaped like an open fan or a segment of a cone deposited by a stream, especially in a semiarid region at the place where it issues from a narrow mountain valley upon a plain or broad valley.
- Anaerobic:** Referring to the condition of existing in the absence of oxygen. Anaerobic bacteria can survive in the partial or complete absence of air.
- Aquaculture:** As used in this report, refers to the potential use of drainage water for growth of aquatic organisms (fish, etc.) that could have product marketability.
- Aquifer:** An underground geologic formation that stores and transmits water and yields significant quantities of water to wells and springs.
- Attenuation:** In the context of this report, refers to the reduction of the amount of metal species transmitted through a soil column. Research has been conducted on the attenuation of selenium.
- Basin trough:** A long, sediment-filled depression at the center of the valley.
- Bioaccumulation:** The uptake and accumulation of a chemical by plants and animals directly from the environment (that is, from water, sediment, soil, or air) or through the diet. See **Bioconcentration** and **Biomagnification**.
- Bioconcentration:** The uptake and accumulation of a chemical by plants and animals directly from the environment, resulting in whole-body concentrations greater than those found in the environment. See **Bioaccumulation** and **Biomagnification**.
- Biomagnification:** The uptake and accumulation of a chemical by plants and animals through their diet, resulting in whole-body concentrations that increase at successively higher trophic levels of the food chain. See **Bioaccumulation** and **Bioconcentration**.
- Biomass:** As used in this report, refers to plant material that has been grown in drainage water and is suitable for use as a fuel, such as in cogeneration processes.
- Cogeneration:** A process using waste heat from the thermal generation of energy to evaporate drainage water.
- Confined aquifer:** An aquifer bounded above and below by impermeable beds or beds of distinctly lower permeability than the aquifer itself.
- Conjunctive use:** A resource use or management plan in which surface and ground water supplies are used in a manner to maximize use from both without degradation of either.

Contamination: The addition to a given medium, such as water, of substances that adversely affect its beneficial use.

Critical year: A year is classified as critical when unimpaired runoff to the San Joaquin River and key tributaries, as described in Department of Water Resources' Bulletin 120, is less than 3.37 million acre-feet. However, if the previous year was classified as critical, a year is rated as critical when unimpaired runoff is less than 4.13 million acre-feet.

Deep percolation: The downward percolation of water past the lower limit of the root zone of plants, usually more than 5 feet below the surface.

Delta: A low, nearly flat alluvial tract of land formed by deposits at or near the mouth of a river. In this report, Delta usually refers to the delta formed by the Sacramento and San Joaquin Rivers.

Drainage problem area: A land area characterized by waterlogging and related water-quality problems. Includes land areas now drained or land areas that likely will require drainage.

Drainage water: See *Subsurface drainage water*.

Endangered species: Any species or subspecies of bird, mammal, fish, amphibian, reptile, or plant which is in serious danger of becoming extinct throughout all, or a significant portion of, its range.

Electrical conductivity (EC): The ability of a particular parcel of water to conduct electricity. The EC of a water sample is an indirect measure of the total dissolved solids (TDS) or salinity of the sample. Units of reporting are siemens, which are equivalent to the older units, *mhos*. Microsiemens per centimeter are abbreviated as $\mu\text{S}/\text{cm}$.

Evaporation: The change of a substance from the solid or liquid phase to the gaseous (vapor) phase.

Evapotranspiration: Water lost as vapor through the combined processes of evaporation from soil surface and transpiration from plants.

Facultative bacteria: Microorganisms capable of adaptive response to varying environments (for example, adaptive to aerobic or anaerobic conditions).

Furrow: A long, narrow, shallow trench made in the ground by a plow or other implement.

Halophytes: Plants that are well adapted to growing in a saline soil environment.

Hydraulic connections: The situation existing between two aquifers whereby the openings allow water to go from one aquifer to the other.

Immobilization: In the context of this report, the application of processes and procedures to retain toxic elements, especially selenium, in a given (soil) area. This is done to limit the movement and availability of those metal species which may make them environmental hazards.

Ion exchange: A reversible chemical reaction between a solid (ion exchanger) and a fluid (usually a water solution), by means of which ions may be interchanged from one substance to another.

Irrigation efficiency: The ratio of the average depth of water infiltrated and stored in the root zone to the average depth of water applied to the field. Application efficiency of an irrigation system is estimated by dividing the crop water use between irrigations by the amount of water applied during the last irrigation.

Leaching: The dissolution and flushing of salts from the soils by the downward percolation of water.

Methylation: The chemical attachment of one or more methyl (CH_3) groups to an element or compound.

Mitigation: One or all of the following: (a) Avoiding an impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of an action and its implementation; (c) rectifying an impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating an impact over time by preservation and maintenance operations during the life of an action; and (e) compensating for an impact by replacing or providing substitute resources or environments.

Oxidation: A chemical reaction taking place by loss of electrons or addition of oxygen.

Oxidation state: In chemical terms, it is the number of electrons that can be added or subtracted from a chemical atom in a combined state to convert it to elemental form. Also known as the oxidation number or valence and could be positive or negative.

Part per billion (ppb): One part by weight per 1 billion (10^9) parts. In water, nearly equivalent to 1 microgram per liter ($\mu\text{g/L}$), or 1 microgram per kilogram ($\mu\text{g/kg}$) in solids.

Part per million (ppm): One part by weight per 1 million (10^6) parts. In water, nearly equivalent to 1 milligram per liter (mg/L), or 1 milligram per kilogram (mg/kg), also 1 microgram per gram ($\mu\text{g/g}$).

Percolation: In the context of this report, the downward movement of water through the soil or alluvium to the ground-water table.

Potential problem water: Shallow ground water within 5 feet of the surface of irrigated lands during at least part of the year that has chemical characteristics adversely affecting agriculture and, if the water were to be drained, fish and wildlife, public health, or attainment of State surface-water quality objectives.

Principal study area: Primarily the western side of the San Joaquin Valley, comprising lands, waters, and related resources currently affected by problems related to agricultural drainage, as well as lands likely to be affected in the future.

Problem water: That part of potential problem water that, because of its adverse impact on crops, soils, or off-site areas, and water and land uses, requires drainage and associated management.

Recharge: The processes of water filling the voids in an aquifer, which causes the piezometric head or water table to rise in elevation.

Reduction: A chemical reaction taking place by acceptance of electrons, removal of oxygen, or addition of hydrogen.

Riparian: Pertaining to the banks and other terrestrial environs adjacent to water bodies, watercourses, and surface-emergent aquifers (for example, springs, seeps, and oases), whose waters provide soil moisture significantly in excess of that otherwise available through local precipitation. Vegetation typical of this environment depends on the availability of excess water.

Root-zone storage: Water present in the first few feet, usually within 5 feet of the ground surface in field crops and vegetables; within 10 feet for some fruit and nut trees.

Salinity: The salt content of dissolved mineral salts in water or soil. Salinity in water is measured by determining the amount of total dissolved solids (TDS) or by the electrical conductivity (EC); 1,000 $\mu\text{S/cm}$ is approximately equal to 650 ppm as TDS.

Salts: In chemistry, the compound formed when the hydrogen of an acid is replaced by a metal or its equivalent. Examples are sodium chloride, calcium sulfate, and magnesium carbonate. In this report, it generally refers to chemical salts as they are dissolved in water or present in soils. The major components of drainage water salts are sodium, sulfate, and chloride.

Salt balance: The equilibrium established between salts imported to an area and the salts exported from the same area. When used in a regional sense, imported salts are those contained in surface-applied water and may include other inputs such as fertilizer, soil amendments, and precipitation; exported salts are those conveyed from the area through surface and subsurface flows. The term "salt balance" can also be applied to the crop root zone. In this sense, it refers to an equilibrium state of soil salinity where there is no net salt accumulation in the root zone. Net accumulation of salt in the crop root zone can reduce crop yields.

Salt load: The total amount of salts contained in a given volume of water entering or leaving an area.

Seepage: Water escaping from a channel or an impoundment by percolation.

Selenate: Ionized selenium, usually present as a salt, existing in a valence (or oxidation) state of +6. The chemical symbol is SeO_4^{-2} .

Selenite: Ionized selenium, usually present as a salt, existing in a valence (or oxidation) state of +4. The chemical symbol is SeO_3^{-2} .

Semiconfined aquifer: As used in this report, it includes all aquifers above the Corcoran Clay, including the so-called unconfined aquifer.

Shallow ground water: Ground water within 20 feet of the land surface.

Sierran sand: A term referring to a distinct subsurface body of water-bearing material underlying the San Joaquin Valley. These deposits originated from the Sierra Nevada. Term is equivalent to "Sierran sediment" and "Sierra Nevada sediment."

Soil salinization: The accumulation of soluble salts in the soil by the evaporation of water from the soil zone.

Solar ponds: Nonconvective, salt-gradient solar ponds discussed in this report are about 6.5 to 16.5 feet deep with three distinct water salinity/density zones. Short-wave solar radiation penetrates the upper zones into the lower, denser, heat storage zone and raises its temperature. The stored heat can be used as a low-temperature energy source.

Subsidence: A local mass movement that involves principally the gradual downward settling or sinking of the earth's surface with little or no horizontal motion. It may be due to natural geologic processes or mass activity such as removal of subsurface solids, liquids, or gases, and wetting of some types of moisture-deficient loose or porous deposits.

Substance of concern: One of a group of toxic or potentially toxic chemical elements or constituents present in agricultural drainage water.

Substitute water supply: An adequate nontoxic and reliable freshwater supply equal in volume to the agricultural drainage water previously used by wildlife and/or wildlife habitat. In practical application, it is water to replace a supply on which biological dependence has developed.

Subsurface drainage water: Surplus water removed from within the soil by natural or artificial means, such as by drains placed below the surface to lower the water table below the root zone. In this report, unless otherwise qualified, drainage water refers to subsurface drainage water.

Tailwater: Irrigation water that flows over an irrigated field without infiltrating the soil. Synonymous with "surface drainage water" and "irrigation return flow."

Tile drain: An on-farm subsurface drain made of flexible plastic pipe (formerly made of clay tile).

Total dissolved solids: A measure of the amount of dissolved material in a liquid (usually water). It is used to determine salinity. The procedure requires measuring (weighing) the amount of solid remaining after evaporation of the liquid for a given time period and at a specified temperature.

Trace elements: Those elements present in the environment at small but measurable concentrations, usually less than 1 part per million.

Transpiration: The passage of water through the stomata of plant leaves into the atmosphere.

Upland: Generally means a land zone sufficiently above and/or away from freshwater bodies, watercourses, and surface-emergent aquifers to be largely dependent on precipitation for its water supplies. As used in this report, *upland* also refers to lands other than those which are seasonally or permanently wet.

Volatilization: The conversion of a chemical substance from a liquid or solid state to the gaseous (vapor) state.

Waterlogged: Soaked or saturated; said of an area affected by a high water table; that is, where water stands near, at, or above the land surface.

Water table: The area in unconfined subsurface material where hydrostatic pressure equals atmospheric pressure. Generally, the boundary between the saturated and unsaturated subsurface soil zones.

Wetland: A zone periodically or continuously submerged or having high soil moisture, which has aquatic and/or riparian vegetation components, and is maintained by water supplies significantly in excess of those otherwise available through local precipitation.

Wildlife habitat: An area that provides a water supply and vegetative habitat for wildlife.

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A STRATEGY FOR IMPLEMENTATION

OF THE

MANAGEMENT PLAN FOR AGRICULTURAL SUBSURFACE

DRAINAGE AND RELATED PROBLEMS ON THE

WESTSIDE SAN JOAQUIN VALLEY

DRAFT

November 1991

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Fish and Wildlife Service
Soil Conservation Service
Geological Survey

California

Department of Water Resources
Department of Fish and Game
Department of Food and Agriculture
Water Resources Control Board

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**A STRATEGY FOR IMPLEMENTATION
OF THE
MANAGEMENT PLAN FOR AGRICULTURAL SUBSURFACE
DRAINAGE AND RELATED PROBLEMS ON THE
WESTSIDE SAN JOAQUIN VALLEY**

The State-Federal San Joaquin Valley Drainage Program culminated approximately six years of study in September 1990 with a report that focused on in-valley management of the agricultural drainage and drainage-related problems on the westside of the San Joaquin Valley. The State and federal agencies involved in developing the plan recognized that "unattended plans often do not materialize" and initiated an interagency follow-up to the program to prepare a strategy for implementation of the management plan. This document presents the implementation strategy.

Backup materials in support of the information contained in this report have been compiled in a separate report, entitled "Background Documents", that is available in limited numbers. These materials are in the form of memorandum reports, technical information records, papers, and statements. They are listed below.

- o Work Plan for the San Joaquin Valley Drainage Program Follow-up. January 1991
- o Re-draft of Concept Paper on Monitoring. April 19, 1991
- o Draft Technical Information Record for the Development of Strategies to Implement the Various Management Components Presented in the SJVDP's Recommended Plan. April 21, 1991
- o Guide to Information Acquired and Developed by the SJVDP. April 25, 1991

- o **Summary of Agricultural Drainage-Related Monitoring Programs and Studies.** May 1991

- o **Aspects of Monitoring System Design for Assessing the Regional Impacts of Implementation of the SJVDP Recommended Management Plan for the Western San Joaquin Valley.** July 3, 1991

- o **Summary and Analysis of Results of Individual Agency Assessment of Proposed or Preferred Role in Implementing the SJVDP Recommended Plan.** July 24, 1991

- o **Agency Recommendations on Monitoring; A Summary of Discussions in Meetings.** August 15, 1990 - August 22, 1991

CHAPTER 1. BACKGROUND**THE AREA OF CONCERN**

The chief area of concern is the westside of California's San Joaquin Valley from the Sacramento-San Joaquin Delta on the north to the Tehachapi Mountains south of Bakersfield. This area coincides generally with the irrigation service areas of the Federal Delta-Mendota Canal, the Federal San Luis Unit and the State Water Project. The area is predominantly rural. Lands now directly affected by, contributing to, or likely to be directly affected by agricultural drainage problems are shown as the program study area on Figure 1.

The San Joaquin Valley is a gently sloping, nearly unbroken alluvial plain, about 250 miles long and an average of 45 miles wide, that is characterized by a mild, dry climate. Nearly all crops grown commercially in the region require irrigation.

Soils on the western side of the valley are derived from the marine sediments that make up the Coast Range and are generally high in salts and, in some areas, trace elements such as selenium that occur in a marine environment. Irrigation of these soils has dissolved these substances and accelerated their movement into the shallow ground water. Where water tables are high and agricultural drains are necessary, drainage water frequently contains elevated concentrations of salts and, less frequently, trace elements. Under high water-table conditions, these substances are alternately dissolved by irrigation water and then reprecipitated as evapotranspiration removes water from the water table, leaving behind increasing concentrations of salts in the soil and in shallow ground water.

In addition to 2.5 million acres of irrigated agricultural land, the area also contains remnant natural and managed habitats

of importance to a diversity of fish and wildlife species. Natural and managed habitats impacted by agricultural drainage include the Grasslands area, a large grasslands/wetlands complex in the southern San Joaquin Basin where for several decades commingled surface and subsurface agricultural drainage water was used for habitat management, and the San Joaquin River, into which an estimated 35,000 to 56,000 acre-feet per year of collected subsurface agricultural drainage water is currently discharged. Man-made drainage-created habitats include: evaporation ponds (primarily in the Tulare Basin), where subsurface drainage water is discharged and concentrated and which are used extensively by aquatic birds; and agroforestry plantations that are watered with subsurface drainage water and are used by several avian and terrestrial wildlife species.

SAN JOAQUIN VALLEY DRAINAGE PROGRAM

In 1984, the San Joaquin Valley Drainage Program (SJVDP) was established as a joint federal and State effort to investigate drainage and drainage-related problems and to identify possible solutions. The SJVDP adopted the following objectives:

Public Health

Minimize potential risks that may be associated with agricultural drainage water.

Water Quality

Protect existing and future reasonable and beneficial uses of surface and ground waters.

Agricultural Lands and Productivity

Sustain productivity of existing farmlands on the west side of the valley.

Fish and Wildlife Resources

Protect and enhance fish and wildlife resources.

The SJVDP followed earlier studies and efforts that resulted in the construction of approximately 85 miles of a planned 209-mile drainage canal that was to discharge into the Sacramento-San Joaquin Delta. A part of the constructed section discharged into Kesterson Reservoir that was then planned as a storage control and wildlife refuge area.

In 1983, discovery of deformities and deaths of aquatic birds at Kesterson Reservoir altered the perception of drainage problems on the west side of the valley. Selenium poisoning was determined to be the probable culprit. The drainage problem then became a more serious environmental concern as well as an agricultural problem on the west side of the valley. The San Joaquin Valley Drainage Program was directed to investigate the problems and "to formulate, evaluate, and recommend alternatives for the immediate and long-range management of the problems". The program was also subsequently directed to focus on "in-valley" management of the problems, and therefore, although continued discharge to the San Joaquin river was studied, a drain to the Delta was not included in the evaluation of alternatives. However, the proposed plan includes plan components that are necessary first steps regardless of the ultimate choice of a sink for the drainage water and dissolved constituents now accumulating in parts of the San Joaquin Valley.

Program Participants

The San Joaquin Valley Drainage Program was established in August 1984 by the U. S. Secretary of the Interior and the Governor of California. Three Federal agencies -- the Bureau of Reclamation, Fish and Wildlife Service, and the Geological Survey, together with two State agencies -- the Department of Fish and Game and the Department of Water Resources -- were the principal program participants. A Policy and Management Committee comprised of Director and Regional Director level representatives from each of those agencies was formed to provide policy direction to the program.

An interagency study team made up of interdisciplinary representatives of the various agencies together with contract consultants conducted the analytical, planning, and management activities.

Three main committees provided advice to the Policy and Management Committee and the study team. The National Research Council Committee on Irrigation-Induced Water Quality Problems provided scientific oversight. A 14-member Citizens Advisory Committee representing a broad spectrum of organizations and individuals interested in and affected by drainage-related problems provided information, viewpoints, and guidance. An Interagency Technical Advisory Committee and several subcommittees composed of personnel from several federal and State agencies and both California university systems provided technical review and guidance.

Altogether, over one hundred people were involved in the study directly and several hundred more through two series of public meetings held to solicit comments on the preliminary and final program reports.

The Final Program Report

The final program report, "A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley" was published in September 1990. The report outlines the problem, describes what the study revealed or confirmed, presents in-valley management options and planning alternatives, and recommends a plan for in-valley management of drainage and drainage-related problems.

The plan contains eight major components:

- o Source control
- o Drainage reuse
- o Evaporation systems
- o Land retirement
- o Ground-water management
- o Discharge to the San Joaquin River
- o Protection, restoration, and provision of substitute water supplies for fish and wildlife habitat
- o Institutional changes

These plan components complement each other. They may be implemented separately, but there will be interaction between them. For example, source control and drainage reuse actions reduce drainage volumes which in turn reduces the need for evaporation systems.

NEED FOR IMPLEMENTATION STRATEGY

The plan in the final SJVDP report outlines a set of in-valley actions (often regional in scope) that, taken together, will enable management of the agricultural drainage problem for several decades into the future. In the plan report, however, there was no formal agreement on specific actions, responsibilities, implementation schedules, and budgeting or funding.

But, the participants in the San Joaquin Valley Drainage Program recognized the need for a strategy to promote action on the program's recommended plan, and, they set a time period for its accomplishment. They agreed the strategy should define: (1) required actions and priorities, (2) agency responsibilities, and (3) funding sources and amounts. They also agreed that the "Strategy for Implementation" should be presented in a report which should include a memorandum of understanding among participating federal and State agencies.

In addition, it was determined that the strategy would include: (1) A long-term monitoring program for tracking drainage conditions and the impacts of actions to manage drainage problems; and (2) development and execution of a plan for long-term management of the SJVDP data base (which includes reports, files, computer models, computer data storage, a geographic information system, and numerous other items).

CHAPTER 2. PURPOSE OF IMPLEMENTATION STRATEGY

When the follow-up to the San Joaquin Valley Drainage Program was initiated in October, 1990, it was anticipated that the implementation strategy to be developed would serve the following purposes: (1) establish a continuing coordination structure; (2) define and prioritize implementation needs; (3) identify federal, State, local, and private roles in implementation; (4) recommend implementation actions; and (5) seek agreement of involved parties.

ESTABLISH A CONTINUING COORDINATION STRUCTURE

Agricultural drainage studies and activities on the westside San Joaquin Valley have fluctuated considerably since the threat of drainage problems was recognized more than 50 years ago. The two most recent State-federal interagency studies resulted in reports in 1979 and 1990.

Although there has always been some continuing coordination between federal, State, local, and other drainage interests, structured coordination has taken place only during formally-organized, agency-endorsed study programs. There is need for a continuing, formally-organized coordination mechanism that will effectively continue from year to year to deal with the drainage problems. This is more important than ever during the transition from planning and study to implementation of management actions. Establishment of a coordination mechanism is one purpose of the strategy.

SCHEDULE AND PRIORITIZE IMPLEMENTATION ACTIONS

The management plan presented in the final report of the San Joaquin Valley Drainage Program in 1990 described eight plan components and a series of recommendations for action. There

was, however, no schedule for implementation of the actions recommended. This strategy should be a step toward preparation of a schedule for implementation actions and identification of the parties that will implement the actions.

**IDENTIFY FEDERAL, STATE, LOCAL AND
PRIVATE ROLES IN IMPLEMENTATION**

The recommendations for action presented in the SJVDP final report generally identify the entities that should be responsible for implementation of specific actions. A purpose of this strategy is to review current actions and make more specific recommendations regarding implementing entities and schedules for future implementation. Identification of the long-term roles of action entities in drainage management is also included as a purpose.

IDENTIFY REQUIREMENTS TO IMPLEMENT PLAN AND RECOMMENDATIONS

Effective implementation of the management plan will require commitments and actions. These include authorizations at various governmental levels, appropriation of funds, enactment of enabling legislation, promulgation of rules and regulations, more detailed technical studies, and environmental assessments. A purpose of this strategy is to identify those requirements and provide guidance on how they can be accomplished.

SEEK AGREEMENT OF INVOLVED PARTIES

One of the most important purposes of the strategy is to decide and agree among the implementing entities on the specific roles in implementing the management plan. This is especially important among the State and federal agencies. Participation of local and private interests along with the California university systems must also be included. Some type of formal agreement

identifying the role of each interest or entity in plan implementation is the proposed vehicle to gain agreement among key entities. A Memorandum of Understanding endorsed by the participating State and federal agencies adopts this strategy report as a guideline for organizational long-term action.

State and federal agencies have committed to continue providing technical and financial assistance for correcting the drainage problems. Growers and local water districts are facing regulatory requirements which will necessitate their timely action in effecting drainage management. Environmental organizations and fish and wildlife managers also have major interests in drainage management and must be included in organization, planning, and action.

RESULT OF FAILURE TO ACT

It is incumbent on the local agencies and the irrigators to implement effective drainage management measures, or, eventually, stringent regulatory measures will probably be imposed. The State Water Resources Control Board's (SWRCB) Non-point Source Management Plan (1988), for example, outlines three progressively more stringent general management approaches which are scheduled to be applied, as necessary, on agricultural discharges to achieve prescribed performance goals* or objectives:

- (1) Voluntary implementation of best management practices (BMPs).

***PERFORMANCE GOALS** are defined by the SWRCB as concentrations of water quality constituents established for receiving waters that a discharger must make best efforts to meet in discharging waste to waters of the State. For non-point source dischargers, these best efforts must be made pursuant to the Non-point Source Management Plan. Performance goals serve as a measure of success in improving water quality.

- (2) Regulatory-based encouragement of BMPs (e.g., waiver of waste discharge requirements on condition that BMPs are implemented).
- (3) Issuance of waste discharge requirements which establish effluent limitations or discharge prohibitions.

The SWRCB has also established schedules for accomplishing specific tasks. The regional boards are directed to establish accelerated schedules, as appropriate, for agricultural dischargers to implement BMPs and controls to reduce levels of known problem constituents. The following must occur within one year from April 11, 1991, (the date of adoption of the Inland Surface Water Plan):

- (1) Agricultural dischargers shall identify or form drainage entities, and demonstrate, based on available data, that applicable water quality objectives or performance goals are being attained, or begin implementation of BMPs; and
- (2) The Regional Board, with the assistance of agricultural dischargers, shall submit, for State Board approval, a report which defines drainage area entities identified or formed by dischargers, and establishes monitoring sites and a surveillance and compliance monitoring program.

The State Board will approve or disapprove the report within six months of submittal by the Regional Board. If agricultural dischargers do not identify or form drainage entities, the Regional Board shall submit a report to the State Board which describes appropriate drainage entities. If agricultural dischargers do not comply with these requirements, the Regional Board shall immediately pursue regulatory-based encouragement of BMPs or issuance of waste discharge requirements, as appropriate.

Table 1, (which is Table 8 of the SWRCB's Inland Surface Water Plan), defines the implementation timetable.

TABLE 1

**IMPLEMENTATION OF PERFORMANCE GOALS OR OBJECTIVES AND
MONITORING REQUIREMENTS FOR AGRICULTURAL DRAINAGE DISCHARGERS**

WITHIN:	AGRICULTURAL DISCHARGERS ACTIVITY	REGIONAL BOARD OR STATE BOARD TASK
1 year	o Identify or form drainage entities; begin implementation of BMPs	o Regional Board: submit report to State Board which defines drainage entities and establishes monitoring program ^{1/}
6 months of submittal		o State Board: approve or disapprove report
2 1/2 years	o Submit report to Regional Board which describes implemented BMPs and time schedule for further implementation of BMPs	o Regional Board: begin monitoring program
6 months of submittal		o Regional Board: approve or disapprove report
3 years (1st triennial review)	o Implement BMPs, as necessary	o State Board: review progress of BMP implementation ^{2/}
6 years (2nd triennial review)	o Implement BMPs, as necessary	o State Board: review progress of BMP implementation ^{2/}

^{1/} Conducted with technical and financial assistance of agricultural drainage dischargers.

^{2/} State Board will require a more stringent management approach if sufficient progress in the implementation of BMPs has not been made.

CHAPTER 3. IMPLEMENTATION NEEDS BY MAJOR PLAN COMPONENT

The SJVDP's recommended plan includes eight major components designed to: (1) reduce the production of subsurface drainage water, (2) control the remaining drainage water, (3) contain and isolate contaminants such as selenium, and (4) resolve the current and potential drainage-related public health and fish and wildlife problems. This chapter describes the total needs of each plan component, current actions underway, and the future needs and support required.

SOURCE CONTROL

The objective of source control is to reduce the annual volume of deep percolation of water past the crop root zone. The plan includes a regional target of reduction of deep percolation through source control that varies from 0.20 to 0.35 acre-feet per acre per year, depending on irrigation and soils conditions in various areas. This leaves approximately 0.4 acre-feet per acre to be collected as drainage water.

Recent efforts by water districts and irrigators are reportedly reducing deep percolation amounts from those estimated by the SJVDP in the mid to late 1980's. For example, Westlands Water District asserts that source control has reduced deep percolation in that District by approximately 0.5 acre-feet per acre per year from the amount estimated in the SJVDP final report and that there is little potential to further reduce deep percolation in that area. Long-term monitoring of the entire drainage problem area is needed to aid in planning drainage reduction actions.

Significant gains have been made in developing and improving source control methods and techniques. The most effective of

these include improvement of: (1) management of irrigation systems, (2) present irrigation practices (e.g., shortening furrows and using tailwater return systems, thus improving water application uniformity), and (3) irrigation scheduling. Additionally, the beginning of technology transfer to the farmers through education and demonstration programs appears fruitful. Cumulatively, these source control efforts are expected to produce encouraging results in reducing subsurface drainage water volumes and pollutant loads.

Additional effort needs to be applied to source control -- especially in promoting, convincing, and assisting individual farmers to adopt and practice water conservation and source control measures. To make effective valley-wide gains in subsurface drainage water management, source control measures must be more widely implemented.

Besides regulations, positive incentives need to be developed to encourage growers to maximize efficient use of water. Profit-sharing in the marketing of water conserved through local efforts may be a viable incentive in certain service areas.

DRAINAGE REUSE

The SJVDP projected that much of the average 0.40 AF/acre-yr of deep percolation remaining after implementation of source control measures should be collected as drainage water, further reduced in volume, and ultimately disposed of. It was recommended that the drainage water reduction be achieved through sequential irrigation of salt-tolerant crops, salt-tolerant trees, and halophytes. Based on evapotranspiration rates of 5 AF/acre/year and 3 AF/acre/year for trees and halophytes, respectively, the SJVDP projected the need for year 2000 and 2040 acreage for trees and halophytes as shown in Table 2.

TABLE 2
PRIMARY DRAINAGE-WATER REDUCTION FACILITIES
 (Approximate acres)

Subareas	2000		2040	
	Trees	Halophytes	Trees	Halophytes
Grasslands	2,400	900	1,900	700
Westlands	3,900	2,100	8,000	4,100
Tulare	4,000	4,600	12,300	12,300
Kern	1,600	3,300	3,600	6,000
TOTAL	11,900	10,900	25,800	23,100

Source: Table 28, SJVDP, 1990

Presently, over 500,000 salt-tolerant trees have been planted in the valley for purposes related to drainage water volume reduction and lowering of shallow ground-water tables. However, because there is also a need to further advance and refine the technology, much of the present efforts are directed toward research. For example, efforts are being made to: develop sturdier, more freeze-resistant and salt-tolerant tree stock; monitor physical and chemical changes in the soil profile of agroforestry plots and the accompanying impacts; field measure evapotranspiration rates; develop marketable halophytes; and explore markets for agroforestry products.

There is additional need for research and technology development in areas such as tree and plant stock improvement, finding and development of markets for tree and halophyte products, and identifying and correcting salinity problems accompanying irrigation with saline waters. There is also a need for demonstration projects to improve as well as promote and

assist farmers and districts to effectively implement the salt-tolerant trees/halophyte concept, for evaluation of possible public health and wildlife impacts, and for development of management practices that eliminate/reduce adverse impacts.

EVAPORATION SYSTEMS

Evaporation ponds are presently the only disposal system used in the valley. Because of the negative environmental impacts of most ponds they are viewed by water quality, public health, and wildlife agencies as facilities needing corrective actions. The SJVDP proposed that for ponds having incoming drainage water with selenium exceeding 2 ppb, alternative safe wetland habitat would be provided nearby to facilitate aquatic-bird hazing and that where incoming selenium concentration exceeds 50 ppb, accelerated rate evaporation systems would be used to significantly reduce ponding areas and wildlife use. Both of these types of ponds should be constructed and operated to minimize bird use.

There are on-going efforts to more specifically identify the impacts of evaporation ponds on wildlife. There are also on-going investigations of other evaporation or related systems such as the enhanced evaporation spray system developed by ORMAT Turbines, Ltd., and solar ponds.

Because of the serious problems connected with evaporation ponds, there is wide concurrence that further commitment must be made to develop new technologies, improve pond management, improve monitoring, and address the issue of eventual closure of existing ponds. Major research and field demonstration programs are needed to assess and develop a proven, safe disposal technology.

LAND RETIREMENT

The SJVDP defined land retirement as the cessation of irrigation of: (1) lands having poor drainage and overlying shallow ground water that contains elevated levels of selenium or other contaminants, or (2) any areas in which the drainage problems could not be managed safely with any other available options. Areas having shallow ground water selenium levels over 200 ppb were considered "hot spots" and special candidates for retirement. Land retirement is not viewed as necessarily being a permanent measure; it is a land reservation strategy whereby land may be irrigated again in the future if the problems necessitating retirement were to be corrected. Because of the program's deliberate choice of sustained agriculture as one of four planning objectives, land retirement was viewed as an option of "last resort".

Table 3 shows the land area included in the SJVDP plan for retirement.

TABLE 3
LAND RETIREMENT COMPONENT OF THE SJVDP'S RECOMMENDED PLAN

SUBAREA	LAND RETIREMENT AREA (IN ACRES)	
	YEAR 2000	YEAR 2040
Grasslands	0	3,000
Westlands	18,000	33,000
Tulare	0	7,000
Kern	3,100	32,000
TOTAL	21,100	75,000

Source: Tables 29, 32, 35, and 38 (SJVDP, 1990)

GROUND-WATER MANAGEMENT

The SJVDP's recommended ground-water management concept entails pumping from the deeper ground-water bearing zones in the semi-confined aquifer to lower the shallow-water table and thereby alleviate water-logging conditions through induced drawdown. Water produced would replace current surface water being used for irrigation or be made available for other uses. The program identified three conditions necessary for the ground-water management strategy to be technically feasible:

1. Adequate vertical hydraulic interconnection between the deep semi-confined aquifer and the waterlogged lands,
2. Sufficient volume of water in the semi-confined aquifer to allow withdrawal for a reasonable period of time (exceeding 20 years), and
3. Pumped water quality of less than 1250 ppm TDS so the water might be used for irrigation.

Presently, there is no deliberate pumping of the semi-confined aquifer to produce drawdown in the shallow-water table, although there is (especially in drought years) unscheduled extraction of ground water which helps to draw down shallow-water levels and moderate waterlogging conditions. Reliable site-specific information on the above conditions must be developed in order to ensure effective implementation. The USGS believes that in parts of the problem areas that have been studied and modeled, such information may be developed by extension of existing hydrologic models. However, in many areas where data are sparse, more study will be required.

DISCHARGE TO THE SAN JOAQUIN RIVER

The Central Valley Regional Water Quality Control Board is the primary regulatory authority governing the discharge of drainage waters to the San Joaquin River. The Board's water quality objectives for the river are designed to protect the beneficial uses of water in the river and set standards for waste discharges to the river. The objectives adopted by the State Board in 1988 (subject to U. S. EPA approval) for selenium, boron and salinity from the mouth of the Merced River to Vernalis are summarized as follows:

Selenium

- o 5 ug/l monthly mean
- o 8 ug/l monthly mean, critical water year
- o 12 ug/l maximum

Boron

- o 0.8 mg/l monthly mean, 3/15 through 9/15
- o 1.0 mg/l monthly mean, 9/16 through 3/14
- o 1.3 mg/l monthly mean, critical water year
- o 2.0 mg/l maximum, 3/15 through 9/15
- o 2.6 mg/l maximum, 9/16 through 3/14

Salinity

The present salinity objective is 500 mg/l at Vernalis, but no upstream salinity objective has yet been adopted for the immediate drainage producing areas. Upstream salinity objectives will be reconsidered in 1992 in light of newly established water quality objectives for the Bay and Delta.

To date, the principal effort to alleviate the impacts of drainage water on the water quality in the river has been to reduce pollutant loads to the river through source control and best management practice measures. Implementation of these measures has been reported to be effective in reducing the volume of drainage water produced as well as in reducing the waste

loads. Additionally, efforts are underway to reopen the San Luis Drain to convey drainage water to the San Joaquin River and to facilitate the supply of usable water to the wildlife refuges in Grasslands.

The lower San Joaquin River has long been plagued with many problems -- among the more prominent of which have been the interrelated problems of low flows and poor water quality. Two of the more significant programs aimed at correcting problems in the river are: (1) The San Joaquin River Basin Management Initiative and (2) The San Joaquin River Management Program.

The San Joaquin River Basin Management Initiative is a program of the USBR to explore opportunities for environmental recovery in the San Joaquin Basin (USBR, 1990). The management plan of this initiative will focus on the needs of: (1) Chinook salmon, (2) water quality conditions, (3) wetlands for waterfowl, (4) wildlife, and (5) reservoir fishery and recreation. Accordingly, this program ties directly and closely with two components of the SJVDP's recommended plan -- discharge to the San Joaquin River and protection, restoration, and provision of substitute water supplies for fish and wildlife habitat.

Funding for this program is substantial, totaling \$5.07 million over five years (FY 1991 to and including FY 1995). In accordance with current federal funding policies, fifty percent non-federal funding cost sharing is required. Work on this initiative is closely coordinated with the State-sponsored San Joaquin River Management Program.

The San Joaquin River Management Program (SJRMP) is a State legislative sponsored effort to correct natural resource conditions on the San Joaquin River and to enhance it's many uses, including water supply, flood control, fisheries, wildlife habitat, and recreation. Assembly Bill 3603 (Costa/Jones)

established the San Joaquin River Management Program Advisory Council and the San Joaquin River Management Program Action Team.

The SJRMP brings together representatives from organizations representing property owners, water users, federal, State, local, environmental, and recreational interests to coordinate activities to improve river conditions for all beneficial uses. Its objective is to develop compatible solutions to meet water supply, water quality, flood protection, fisheries, wildlife habitat, and recreational needs. Because the discharge of subsurface drainage water and the migration of shallow ground water to the river materially affect the water quality in the river, the implementation of drainage management plans is of critical importance to the SJRMP.

The management of drainage water discharge to the San Joaquin River has many common goals with these State and federal programs and therefore, must be coordinated with those programs. Drainage water management must be an integral part of correcting the problems of the lower San Joaquin River.

**PROTECTION, RESTORATION, AND PROVISION OF SUBSTITUTE
WATER SUPPLIES FOR FISH AND WILDLIFE RESOURCES**

The SJVDP's first objective for fish and wildlife resources is to: "Protect (or, where protection is not practicable, mitigate for the loss of) existing fish and wildlife resources from ongoing and potential impacts associated with subsurface drainage water generated by irrigated agricultural lands." This objective acknowledges past and ongoing impacts upon fish, wildlife, their habitats, and associated public uses caused primarily by toxic contaminants carried in elevated concentrations in subsurface agricultural drainage water. The SJVDP identified drainwater protection needs for Merced River chinook salmon, migratory birds and other trust resources that use evaporation

ponds, and avian and terrestrial fauna that use agroforestry plantations. The following actions are needed to satisfy fish and wildlife protection provisions of the SJVDP recommended plan:

- o Field testing and implementation of modified evaporation pond design, construction, operation and monitoring practices to ensure that ponds greatly minimize impacts on birds.
- o Development of definite plans for evaporation pond closure when closure appears necessary or inevitable.
- o Provisions of alternative, clean wetland habitat (including adequate, clean water supplies) near evaporation ponds that pose a contaminant hazard to birds and require hazing.
- o Based upon findings from additional monitoring, development and implementation of management guidelines for agroforestry plantations to either encourage or preclude/discourage wildlife use of the plantations.
- o Provision of 20,000 acre-feet/year in-stream flows (during October) to the Merced River to entice upstream migrating chinook salmon away from westside tributaries of the San Joaquin River.

Another of the SJVDP's objectives is to: "Restore (or, where restoration is not practicable, mitigate for the loss of) fish and wildlife resources contaminated with subsurface drainage water generated by irrigated agricultural lands in the principal study area." Valuable fish and wildlife habitats that the SJVDP identified as needing decontamination and restoration included the mainstem and westside tributaries of the San Joaquin River, associated riparian zones, and wetlands in the Grasslands Area.

The following actions are needed to satisfy fish and wildlife restoration provisions of the SJVDP recommended plan:

- o Development and field testing of decontamination and restoration techniques for various types of habitats impacted by agricultural drainwater contamination throughout the valley.
- o Implementation of successful decontamination and restoration techniques on public and private lands (e.g., flood and flush habitat with freshwater).

Another of the SJVDP's objectives is to: "Provide adequate, clean, and reliable freshwater supplies to wildlife habitats that previously have relied upon drainage water generated by irrigated agricultural lands in the principal study area." The SJVDP calculated a substitute water supply need of 129,000 acre-feet/year for public and private wildlife areas in the Grasslands Planning Subarea. Substitute water would also improve fish and wildlife protection and assist habitat restoration actions.

The SJVDP's fourth objective for fish and wildlife resources is: "To the extent practicable, improve fish and wildlife resources of the San Joaquin Valley." The following actions are needed to satisfy fish and wildlife improvement provisions of the SJVDP recommended plan:

- o Determination of the feasibility of management of lands retired from agricultural production for use as upland and/or wetland wildlife habitat.
- o Study the feasibility of seasonal storage of agricultural water supplies in wetlands as a means of improving fish and habitat through timed release to the San Joaquin River.

INSTITUTIONAL REMEDIES

The existing institutional framework of federal, State, and local laws, policies, and practices significantly influences what can be done to correct some of the drainage and related problems. Institutional changes are commonly viewed as necessary to effectively manage the subsurface drainage and related problems.

Institutional measures include a wide variety of strategies such as tiered water pricing, water transfer, and establishment of "environmental recovery funds". The institutional issue of primary concern from the standpoint of ensuring continuing efforts to implement the recommended SJVDP plan is, "Who will have the lead responsibility in correcting the drainage problems?"

A State agency such as the Department of Water Resources could assume a central coordinating role among federal and State government agencies in providing technical and monetary support to correct the drainage problem. However, the major responsibility for directly dealing with the problems rests with the local agencies or regional authorities formed by local agencies, because:

- o As the principal local suppliers of irrigation water they can best implement source control. By incorporating the cost of drainage water collection and disposal together with the price of water they can encourage drainage reduction and allocate the cost of drainage services in proportion to each grower's contribution to drainage problems.
- o They can best influence how growers use non-district supplied irrigation water that contributes to drainage problems. Coordinated management is necessary to make

drainage source reduction and the SJVDP's ground-water management strategies effective.

- o They can best promote improvements in irrigation practices on the districts' member farms.
- o They, as local entities, are best able to tailor drainage solutions to local conditions. Drainage and drainage-related problems as well as the best solutions could vary widely with local conditions.
- o The active participation of the districts and the growers are essential to achieve a successful, stable solution.

It must be recognized that the involvement of non-agricultural interests -- local, regional and national -- is essential to assure that institutional means are also available to handle the impacts of drainage problems.

CHAPTER 4. THE IMPLEMENTATION STRATEGY

The strategy presented in this chapter provides the initial steps to be taken in bridging the gap between the agricultural drainage management plan for the westside San Joaquin Valley and implementation of planned actions. It presents some answers to the who, what, when, and how questions that are incumbent in any plan for action. It does not provide complete answers to all those questions, but it does lay the ground work for continuing present activities and initiating other actions to more aggressively manage drainage problems. It also provides an organizational framework in which actions can be tracked, altered and sustained to encourage the management of agricultural drainage and drainage-related problems over the long haul.

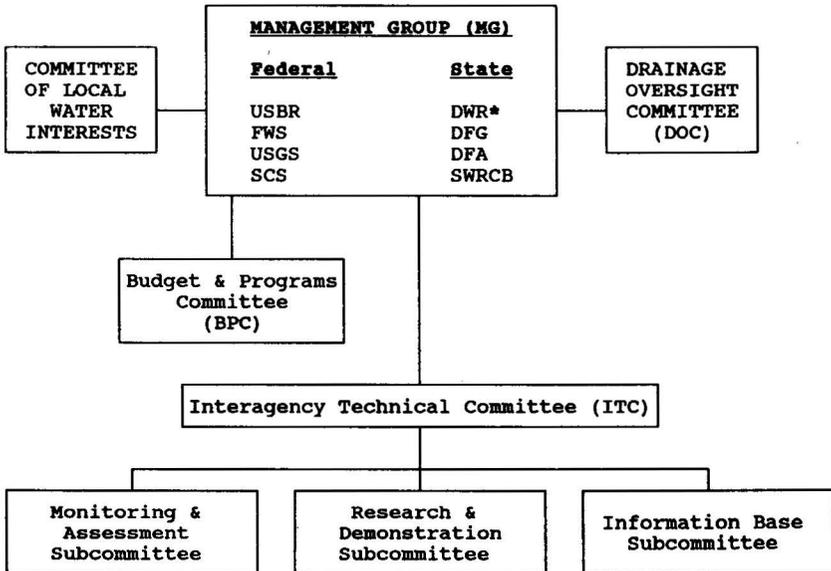
COORDINATION STRUCTURE

A continuing, agency-endorsed structure for coordination of drainage management activities is necessary to maintain collective focus on drainage management and to ensure active participation. The organization shown in Figure 2 is voluntary and would receive no specifically earmarked funds. Different parts of the organization are described in the following sections.

Management Group (MG)

The Management Group is made up of the four State and four federal agencies currently involved in development of the implementation strategy. The California Department of Water Resources has volunteered to initially chair the MG.

FIGURE 2
 ORGANIZATION OF THE INTERAGENCY EFFORT
 FOR
 DRAINAGE MANAGEMENT



*Lead Agency and Group Chair.

The Management Group would be responsible for policy guidance and coordination of agency work activities and funding. There would be no central funding or staff, and each agency would contribute as needed for its accepted assignments, not only for MG activities but also for the activities of the entire organization.

Budget and Programs Committee

Under guidelines set by the Management Group, the Budget and Programs Committee would prepare an annual interagency coordinated budget for activities, programs, and projects designated by the Management Group as necessary to support the management of drainage water.

Drainage Oversight Committee (DOC)

The Committee will provide the State of California with comments, advice and recommendations on interagency activities for management of agricultural drainage problems on the westside San Joaquin Valley. This will include, but not be limited to, activities included in the Implementation Strategy. The Committee will initially be comprised of the 14 members of the SJVDP Follow-up Drainage Oversight Committee. Membership may be changed by the Director of the Department of Water Resources who sponsors the Committee and appoints its members, with consultation by the Director of the Department of Fish and Game.

Committee of Local Water Interests

This Committee will provide the Management Group a direct link to the local agencies and interest groups. It will provide feed-back on the activities of the continuing interagency effort, from those managers who deal directly with agricultural drainage problems and their impacts. The Committee will be comprised of

representatives from irrigation, resource conservation, wildlife management and other locally affected interests. Membership will be voluntary, representative of the entire problem area, and solicited by the Management Group.

Interagency Technical Committee (ITC)

The functions of this Committee are: (1) to provide advice to the MG on technical matters, (2) to coordinate interagency activities in the conduct of monitoring of drainage conditions and impacts, and in so doing -- to oversee the work of the Monitoring and Assessment Subcommittee, (3) to review drainage-related research and study proposals and projects and to recommend to the MG the form and extent of support the MG should lend, and in so doing -- to oversee the work of the Research and Demonstration Subcommittee, and (4) to establish guidelines and procedures for maintaining and making available the information base of the SJVDP (as it is enhanced continually by new data), and in so doing -- to oversee the work of the Information Base Subcommittee. In effect, the ITC provides staff services to the MG.

The presently designated subcommittees of the ITC are: Monitoring and Assessment Subcommittee, Research and Demonstration Subcommittee, and Information Base Subcommittee. Standing work groups can be designated by Subcommittee Chairs with the consent of the ITC Chair. The preliminary organization of the Research and Demonstration Subcommittee includes work groups in agricultural water management, evaporation ponds, treatment and disposal, and agroforestry. New subcommittees may be added by the ITC as needed. The following discussions outline the functions of the subcommittees.

Monitoring and Assessment Subcommittee

The function of the subcommittee should be to determine, designate, and enhance the establishment and operation of gaging stations, networks of monitoring stations, and monitoring programs for tracking: (1) drainage conditions, (2) impacts of drainage, and (3) success of efforts to manage drainage.

The presently designated standing work groups of the Monitoring Subcommittee are:

- o Ground Water
- o Surface Water
- o Soils
- o Demonstration Projects
- o Biota
- o Public Health

Additional details on the organization of work groups are provided later in this Chapter in the section titled "Monitoring of Agricultural Drainage Conditions".

Research and Demonstration Subcommittee

The Research and Demonstration Subcommittee will:

- (1) review the results of related research and studies, summarizing potential applications for the benefit of all drainage water managers;
- (2) facilitate the dissemination of information from these activities (in liaison with the Information Base Subcommittee), while obtaining feedback from users as to utility; and
- (3) inform the Interagency Technical Committee of subject areas that require study to improve opportunities for drainage management.

Information Base Subcommittee

The functions of this subcommittee are: (1) to ensure that the data base of the SJVDP program is continually updated and enhanced with new information so that it comprises a useful and accessible storehouse of information for managing agricultural drainage, and (2) to assure that suitable quality control procedures are in place for all information systems relied upon by the various entities involved in implementing the ongoing interagency effort in drainage management.

IMPLEMENTATION OF PLAN COMPONENTS

In order to implement the SJVDP Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley individual growers and the local water supply and drainage districts must undertake major actions. The implementation role of State and federal agencies is to support those local actions through a coordinated and continuing implementation strategy. Table 4 shows likely participation in management plan implementation by plan component. Table 5 presents an estimate of the current (1991-92 and 1992-93) budgets of Management Group agencies for drainage implementation activities.

The eight plan components are discussed in the following sections, under the topic headings of implementation approach, schedule, funding estimate and source, and legislative and policy needs.

Source Control

Consisting mainly of on-farm improvements in the application of irrigation water to reduce the source of deep percolation. This in turn will reduce the amount of potential drainage problem water.

TABLE 4
PARTICIPANTS IN MANAGEMENT PLAN IMPLEMENTATION

IMPLEMENTING ENTITY	MANAGEMENT PLAN COMPONENT							
	SOURCE CONTROL	DRAINAGE RELIEF	EVAPORATION SYSTEMS	LAND RETIREMENT	GROUND-WATER MGMT.	DISCHARGE TO SAN JOAQUIN RIVER	FISH & WILDLIFE RESOURCES/	INSTITUTIONAL CHANGE
<u>Private</u> Individual Growers, Wetland Owners/Managers	X	X	X	X			X	X
<u>Local</u> Water Districts and Refuge Management Units	X	X			X	X	X	X
<u>State</u> Department of Water Resources Department of Fish and Game Department of Food And Agriculture State Water Resources Control Board	*	*	*	*		*	*	*
<u>Federal</u> U. S. Bureau of Reclamation U. S. Soil Conservation Service U. S. Geological Survey U. S. Fish and Wildlife Service	*	*	*	*	*	*	*	*

1/ Protection, Restoration, Provision of Substitute Water Supplies for Fish and Wildlife Resources.

X = Direct participant in implementation.

* = Commitment to support implementation.

TABLE 5
 IMPLEMENTATION OF SJVDP DRAINAGE MANAGEMENT PLAN
 BUDGET FOR FY 1991-92 AND 1992-93
 (in \$1000)

PLAN COMPONENT/ITEM	STATE OR FEDERAL AGENCY																		TOTALS	
	USBR		USERWS		USGS		SCS		DWR		DFG		DEA		SWRCB		TOTALS			
	91-92	92-93	91-92	92-93	91-92	92-93	91-92	92-93	91-92	92-93	91-92	92-93	91-92	92-93	91-92	92-93	91-92	92-93		
Source Control	28	28					390	390	662	650						1,500	1,080	2,604		
Drainage Reuse	28	528					175	175	135	100			250	250			588	1,053		
Evaporation Systems	28	28	20	20			194	194	975	1,000						2,670	1,217	3,912		
Land Retirement	28	528					26	26									54	554		
Ground Water Mgmt.	28	28					65	65										193	103	
Discharge to San Joaquin River	500										25	25				600	25	1,125		
Fish and Wildlife Resources							60	60			25	25					85	85		
Institutional Change									50									50		
Drainage Water Treatment	28	1,028							743	850							771	1,878		
Monitoring	2,815	4,033	60	60	1,502	2,501	1	1	618	600	50	50			30	417	505	5,463	7,780	
Data Base Management	17	17					1	1			5	5						23	23	
TOTALS	3,000	6,716	80	80	1,602	2,511	3,183	912	912	3,200	105	105	250	250	316	417	5,275	9,549	19,117	

Implementation Approach. The SJVDP identifies regional goals for reduction of deep percolation through source control measures. However, the applicability and potential effectiveness and efficiency of various source measures vary considerably according to localized conditions and irrigation practices. Therefore, this program component must be initiated and developed at the farm and local district level. The proposed implementation approach is to encourage or require, through available mechanisms and programs -- e.g., Section 210 of The Reclamation Reform Act for federal service lands and Best Management Practices Program under the State Inland Surface Waters Plan, the Districts to develop source control plans based on farm-by-farm irrigation audits, including technical assistance and consultations with growers.

Source control programs developed by local districts would include, as appropriate, the land retirement component of the SJVDP plan. Upon adoption of the local programs, State and/or federal financial assistance in the form of financing, grants, loans or other mechanisms as appropriate, would be made available to facilitate implementation.

Support Agency Role. The U. S. Soil Conservation Service and the Department of Water Resources will be principal agencies for providing technical support at the water district and farm level, for irrigation audits and the development of source control plans. The U. S. Bureau of Reclamation and DWR, as well as SCS through currently established programs, will be the principal agencies providing support for demonstration projects. The Department of Food and Agriculture will conduct research in selection of irrigation methods and crops for water and salt management. The USGS, FWS, and CDFG will play a supporting role through associated monitoring activities.

Schedule. Source control actions have already begun at the farm level. DWR has demonstration projects underway. All of these efforts must be continued and expanded, especially during the next ten years. It could require several decades to apply adequate source control to approximately 675,000 acres in the problem area.

Funding Estimate and Source. A rough estimate of the annualized cost of installation, operation, maintenance and replacement of source control methods for the total drainage problem area is \$8,384,000. This estimate includes cost of installation of on-farm drains. It is anticipated that costs will be borne by the growers, but with federal and State cost sharing -- the formula yet to be developed. In definite planning for the San Luis Unit service area, the USBR is proposing that, upon appropriate adoption and approval of local source-control plans, federal financial assistance be provided in the form of project financing loans or grants.

There are present opportunities for cost sharing of some source-control measures through the USDA Agricultural Stabilization and Conservation Service (ASCS).

Legislative and Policy Needs. The SCS needs to adopt a policy that would assign a priority to allow and encourage an expanded and aggressive program of technical assistance in the San Joaquin Valley. Congressional support of appropriation requests would be required. The funding for implementation of adopted source control programs would have to be approached on a case-by-case basis. New legislation and/or policy changes may be required for the USBR which is currently limited in its authority to finance on-farm source control measures.

Drainage Reuse

A planned system of drainage-water reuse on progressively more salt-tolerant plants. This will reduce the volume of drainage water and concentrate salts and trace elements for easier containment and safe disposal.

Implementation Approach. Reduction of water volumes and concentration of dissolved constituents will facilitate containment and disposal of drainage water. Successful implementation of drainage reuse, however, on the scale contemplated in the recommended plan, is dependent on extensive testing and demonstration of reuse technologies, as well as on development of reliable treatment and disposal technologies. It must be remembered that, irrespective of the number of stages of reuse, ultimately there will be solids and liquids that will require final, safe disposal in the valley, or, at an export site.

The proposed implementation approach is to develop integrated reuse and disposal systems through carefully planned and monitored pilot-scale demonstration programs. Reuse might be implemented on an individual farm basis, district-wide system basis, or as a regional system.

Support Agency Role. Six agencies (DWR, DFG, CDFA, USBR, SCS, and USGS) are committed to support this component through research, demonstration and education projects. DWR is funding research on impacts of reuse on public health and wildlife. DFG is conducting field studies of potential impacts on wildlife. CDFA will continue testing and demonstration of agroforestry and halophyte plants and will take the lead in providing quality control and in coordinating the various demonstration projects. The SCS will assist farmers in planning, design and management. The USGS will provide technical assistance and analysis related to ground water and effluent storage to effect reuse of drainage water.

The USBR proposes to implement a pilot-scale demonstration project as part of the provision of drainage service to San Luis Unit water users.

There is evidence of a tendency for local, scattered research demonstration projects to lose some of their effectiveness because of inadequate monitoring and quality control of research methods. The MG should designate an agency to coordinate reuse demonstration projects and studies.

Schedule. Some research and demonstration projects have been in place for several years in the Westlands Subarea. Wildlife studies have been conducted for several years. A project was begun in Tulare Lake Drainage District in 1990 and is progressing well.

Funding Estimate and Source. Federal and State funds for the demonstration projects should come from agency budgets. A combined total of approximately \$2,000,000 per year until 2000 will be required to fund demonstration projects. Operational projects at the farm or district level will be privately funded, but possibly, some help could be provided through ASCS or other State and federal cost-share or loan programs.

Legislative and Policy Needs. All involved agencies should adopt appropriate policies to give priority to demonstration projects in reuse technologies and to coordinate these projects and share the resultant, valuable information.

Evaporation Systems

Drainage-water evaporation ponds planned for storage and evaporation of drainage water remaining after reuse on salt-tolerant plants. Four types of ponds are included: (a) Non-toxic ponds in which selenium in drainage-water inflow is less than two parts per billion (ppb); (b) selenium-contaminated ponds (inflow

water containing selenium in the range of 2 to 50 ppb) that must include safeguards for wildlife and an equivalent surface area of alternative freshwater habitat; (c) small selenium-contaminated ponds equipped with facilities that greatly accelerate the rate of evaporation, thereby reducing the pond surface area; and (d) temperature-gradient solar ponds that generate electricity by using water from other ponds containing very high salt and trace-element concentrations.

Implementation Approach. Evaporation systems are an integral part of the plan because they accomplish the final segregation and containment of salts. Implementation of evaporation systems will require further investigation, testing, and demonstration of enhanced-evaporation ponds, temperature-gradient solar ponds, and wildlife protection measures. The proposed implementation approach is to continue a coordinated effort in developing these technologies through carefully planned and monitored pilot-scale demonstration programs. Ultimate widespread implementation will require site specific planning and linking with other program components, including reuse and treatment technologies.

Support Agency Role. Six agencies are committed to activities supporting work on this component (DFG, DWR, SWRCB, SCS, USBR, and USFWS). DWR will fund studies of impacts on wildlife; DFG and USFWS will conduct the studies. DWR will also support demonstration projects of evaporation pond design improvements. DFG currently has a major coordination role pursuant to the Fish and Game Code to work closely with the CVRWQCB. SWRCB and the CVRWQCB will work with pond owners to make sure ponds are in conformance with CVRB Basin Plan policy. The USBR will fund demonstration projects for new or improved evaporation pond technologies as part of its definite planning for the San Luis Unit. The SCS will work with farmers to develop and evaluate pond design and management criteria. There is also a need for field testing and demonstration projects for measures

to avoid or minimize wildlife hazards associated with evaporation ponds.

Schedule. Evaporation ponds are the only present means for storage and disposal of drainage water in much of the problem area. Ways must be found to improve, reduce and/or safely close evaporation ponds in the shortest time possible. Research and demonstration of accelerated-rate evaporation or solar-energy ponds is needed to replace the conventional ponds. All of these studies should begin now so changes could be made in the systems by 1995.

Funding Estimate and Source. Federal and State funds for studies and demonstrations should come from agency budgets. A combined total of approximately \$3,000,000 per year through at least 1995 will be required to develop the field testing of new technologies.

Legislative and Policy Needs. The USFWS and DFG need to continue the policy of working with pond owner/operators to find solutions to pond problems and ways to mitigate damages from existing ponds.

Land Retirement

Cessation of irrigation of areas in which underlying shallow ground water contains elevated levels of selenium and the soils are difficult to drain.

Implementation Approach. Land Retirement can contribute to management and resolution of drainage problems and should be directed at those lands that are difficult to drain, have low economic returns, and/or contribute disproportionately to drainage problems. The proposed approach is to tie implementation of land retirement to the source control program. Land retirement is, in actuality, a source control measure. The same

decision-making processes employed in deciding whether to implement source control measures are relevant to land retirement decisions. As part of the farm-by-farm audits conducted in developing district source control plans, lands candidate for retirement and the overall acreage targeted for retirement would be identified by the district. Upon adoption of the plan, State or federal financial assistance could be provided to facilitate implementation.

Support Agency Role. Five agencies are committed to aid in implementation of this plan component (DWR, SWRCB, USBR, USGS, and SCS). DWR will monitor hydrologic and social effects of discontinuing irrigation. The SWRCB will be involved if water transfer occurs. USBR will provide technical assistance to water districts to facilitate land use changes. The USGS will provide technical assistance through hydrologic analyses. SCS will provide technical assistance in irrigation audits and source control plans. As part of their assistance, SCS will help farmers evaluate land reserve/retirement options, which could lead to farmer participation in the USDA conservation reserve program.

Schedule. Currently there is local interest in retiring some land by the year 2000. The federal and State agencies should be ready to provide support beginning in 1992. Support activities could be required for 10 to 15 years.

Funding Estimate and Source. Federal and State funds for studies and support activities should come from agency budgets. A combined total of \$500,000 per year through the year 2000 will be required to fund studies and support activities for the extensive audits, classifications, and monitoring that will necessarily accompany retirement decisions.

Legislative and Policy Needs. Current needs are unclear. Land retirement by individual irrigators could potentially be implemented under the USDA conservation reserve program. Participation by other federal agencies and by State agencies in funding land retirement purchases may require new legislation.

Ground-Water Management

Planned pumping from deep within the semi-confined aquifer, in places where near-surface water tables can be lowered and the water pumped is of suitable quality for irrigation or wildlife habitat.

Implementation Approach. Ground water pumping, from deep beneath drainage problem areas, can become an effective interim and, possibly, long-term measure for management of agricultural drainage problems. Although any return to a more balanced surface water/ground water supply -- such as occurred during the drought year 1991 -- helps to ameliorate drainage problems, it is a planned, sustained and coordinated approach, resulting in the right volume of extractions in the right place, that will be most effective in causing shallow ground water levels to fall and remain below crop root zones over the long-term.

The SJVDP approach is to perform the field monitoring, field demonstration projects and the research necessary to guide intelligent implementation of this option. Reliable, scientifically credible monitoring of ground water levels and related ground water extractions is needed to better determine relationships between effort and success (see later section on monitoring). Lack of ground water pumping information is a present constraint on the reliability of estimates of the level of success that can be anticipated through ground-water management.

With a suitable monitoring system, it will be possible to demonstrate the degree of success that can be obtained by pumping both old and new wells -- in both the semi-confined and confined aquifers.

Finally, the approach will require the development of increased scientific understanding of the hydrology of the westside alluvial deposits, and completion and extension of the ground-water models developed by the USGS and DWR.

Support Agency Role. Four agencies (DWR, USGS, USBR, and SCS) are committed to aid in implementation of this plan component. DWR will take the lead in developing a monitoring program and will work with the USGS in necessary studies. The USGS will provide detailed hydrologic analyses required to implement demonstration projects to test the ground-water management component in different parts of the drainage problem area and will provide general scientific overview for implementation of this plan component. The USGS is well suited to these roles because of its extensive experience in the hydrogeology of the area and in quantitative analysis of ground water flow and contaminant transport problems, and its ability to maintain a consistent and credible data base. The SCS can provide technical assistance to local agencies and farmers in development and demonstration of on-farm high water table management. The USDA Agricultural Research Service Water Management Research Laboratory already has one project underway that is related to this component. As part of its program for the San Luis Unit, USBR proposes a program of encouraging ground-water management through incentives provided by water transfers.

Schedule. More detailed study and analyses to identify locations suitable for application of this component are required. Only broad, general areas were identified by the SJVDP. Westlands Water District is currently drilling explora-

tory test wells in one area of the district to investigate potential applications of the concept. Other water supply districts should investigate the potential in areas identified by the SJVDP, as soon as practicable, using the technical expertise of the USGS.

Funding Estimate and Source. The costs of test wells should be borne by the local districts or individual farmers. Technical help presently funded by the USGS is equivalent to approximately \$300,000/yr. This funding level is entirely inadequate for the indicated tasks, which would require annual amounts of approximately \$1 million each for the USGS and SCS.

Legislative and Policy Needs. There is a general need to address how conserved water would be distributed to beneficial uses.

This plan component requires coordination of ground water pumping by multiple land owners over a wide area. Because ground water is controlled by the overlying land owner, implementing legislation may be needed.

Some related issues that may need to be addressed are the legality of: (1) continuing, unofficial -- but real -- degradation of ground water through pumping drawdown of selenium, and (2) official encouragement of this degradation through ground-water pumping programs.

Discharge to the San Joaquin River

Controlled and limited discharge of drainage water from the San Joaquin Basin portion of the study area to the San Joaquin River, while meeting water-quality objectives.

Implementation Approach. The SJVDP has recommended continued use of the river for transport and assimilation of agricultural drainage discharges, under the conditions that: (1) future water quality objectives are met (objectives likely to be more stringent than present objectives), and (2) the actions of drainers in isolating and transporting agricultural water must begin to contribute substantially to the substitute^{1/} water needs of fish and wildlife. The structural and non-structural elements that comprise this component cannot be implemented simultaneously -- in fact, logical scheduling of actions is essential. For example, separation of tailwater and tile water must be a first step. Nor, must the implementation necessarily proceed exactly as outlined in general detail in the SJVDP plan. Various opportunities for funding and cooperation will come along, and they should be utilized, if they meet the above principles.

Because of significant unknowns that persist in terms of the assimilative and transport capacity of the San Joaquin River, and the potential impact of the plan component on beneficial uses, an improved monitoring plan must be adjunctive to any implementation. Subject to the results of this monitoring, operations of planned facilities may have to be modified to meet water quality objectives, judicial decisions, and other mandates.

Support Agency Role. Four agencies have committed to actions related to drainage water discharge to the San Joaquin River (DWR, SWRCB, USGS, and USBR). DWR is currently leading a five-year interagency effort titled "San Joaquin River Management

^{1/} "An adequate nontoxic and reliable freshwater supply equal in volume to the agricultural drainage water previously used by wildlife and/or habitat. In practical application it is water to replace a supply on which biological dependence has developed." (SJVDP, Sept., 1991, A Management Plan ...)

Program" that is charged with developing a scheme for multi-purpose management of the River. The DWR will continue to include in that effort proposed agricultural drainage actions affecting the river. The SWRCB intends to control discharges to the river so as to avoid unreasonable impact on beneficial uses, as defined in the State/Regional Board Basin Plans. The Board also is willing to investigate the concept of a discharger with high productivity soils purchasing another discharger's waste load allocation in the San Joaquin River Basin. The USGS is currently conducting investigations of surface water and ground water interaction in an effort to evaluate the quantity, quality, and timing of ground-water contributions to the San Joaquin River. They will attempt to complete those investigations.

The USBR is advancing a definite plan for the San Luis Unit that, if implemented as presented, could contribute significantly toward satisfying substitute water supply needs (it would contribute 55,000 AF/yr) and to providing the water control facilities needed to control releases of drainage water the San Joaquin River.

In addition, the USBR is conducting a major program, the San Joaquin River Basin Management Initiative, that by the year 1993, will result in action plans for environmental recovery of the river.

As outlined by the SJVDP, and the USBR in San Luis Unit Drainage Program planning, potential sources of substitute water supply could include water made available through water marketing, water conserved through source control, water "freed" through land retirement, and water developed through ground-water pumping.

Schedule. Related activities of designated agencies are currently underway.

Funding Estimate and Source. The San Joaquin River Management Program led by DWR is funded by the State Legislature at approximately \$250,000/yr, and will end on January 1, 1995. SWRCB actions require no special funding. USGS programmed activities are also funded, but the level of funding needs to be re-examined. The San Joaquin River Basin Management Initiative is funded for a total of approximately \$5 million, about half of which is non-federal cost-sharing funds, over five years. The SLUDP planning effort is fully funded, and, for purposes of this strategy, its implementation is considered fully fundable.

Legislative and Policy Needs. Water quality objectives for the Delta are uncertain, and, when firmed up, may necessitate adjustment of this component of the SJVDP plan.

Protection, Restoration, and Provision of Substitute Water Supplies for Fish and Wildlife Habitat

Provision of freshwater supplies to substitute for drainage-contaminated water previously used on wetlands and to allow protection and restoration of contaminated fisheries and wetland habitat.

Implementation Approach. The SJVDP set the following order of priorities to address problems of actual and potential damage to fish and wildlife resources due to management of subsurface agricultural drainage water. The first priority was to so manage drainage and related problems that fish and wildlife would be protected from any additional exposure to elevated concentrations of drainage water contaminants. This would be accomplished, primarily, by implementation of the plan components discussed previously in this chapter. Another high priority measure for fish and wildlife was restoration of drainage-contaminated habitats. A variety of techniques to decontaminate and restore such habitats have been identified (for example, see Moore et al., October 1990; Bradford and Little, January 1990); however, field testing and demonstrations are needed along with

technical and financial assistance programs. Another high priority measure for fish and wildlife was provision of substitute water supplies. Providing clean, fresh waters to substitute for contaminated drainage previously used in Grasslands area wetlands and waterways would satisfy not only the SJVDP's substitute water supply objective, but also substantially assist fish and wildlife protection and habitat restoration objectives. Actions taken to accomplish these three objectives are the highest priority measures of the SJVDP recommended plan.

A second order of priority in the plan is for improvement of fish and wildlife resources. In the plan, improvement actions are those taken over and above measures needed to accomplish the protection, restoration, and substitute water supply objectives. Improvement could occur through any of a broad range of actions including: (1) those related to implementation of the SJVDP recommended plan (e.g., conversion of retired farmland to wildlife habitat or reallocation of waters freed up through on-farm water conservation and land retirement to fish and wildlife); and (2) actions unrelated to resolution of drainage problems, such as acquisition and development of new fish and wildlife habitats and associated public use facilities in the valley.

1. Protection of Fish and Wildlife Resources

(a) Increased Instream Flows for the Merced River

Support Agency Role. In cooperation with the USBR, the FWS and DFG will: (1) determine the source, quality, and cost of the water to be used (some preliminary work has been accomplished); (2) design, construct, operate, and maintain water control and conveyance systems to deliver the water when and where needed; (3) acquire and deliver instream flows during October; and (4) seek funding and legal authority to implement the foregoing.

Schedule. Actions to provide increased instream flows should begin immediately to work in concert with: (1) the Federal San Joaquin River Basin Management Initiative; (2) the State San Joaquin River Management Program; and (3) the reopening of the San Luis Drain, an action that may result in exacerbating Merced River chinook salmon problems by increasing and concentrating drainwater flows in Mud Slough (North).

(b) Management of Evaporation Ponds to Greatly Minimize Adverse Impacts on Birds.

The SJVDP recommended plan identified the provision of 18,400 acre-feet/yr and 44,900 acre-feet/yr for creation and maintenance of alternative habitat in the years 2000 and 2040, respectively. For the purposes of the analysis in the recommended plan, the SJVDP assumed that creation of alternative wetland habitats -- equivalent in acreage and productivity to evaporation ponds in the >2 ppb selenium range -- would greatly minimize adverse impact on birds. The actual water needed to create and maintain alternative wetland habitat, however, may be greater than or less than that estimated in the recommended plan, depending on the outcome of field demonstrations of this alternative. A potential, reliable and clean source of water for use on alternative habitat identified by the SJVDP could be that water freed-up by implementation of source control/land retirement actions.

Support Agency Role. With the assistance of the FWS, USBR, SCS, DWR, CVRWQCB, and DFG, pond owners/operators will: (1) haze birds from toxic ponds; (2) establish and manage alternative habitat; and (3) initiate a comprehensive field program to demonstrate and evaluate measures to eliminate/minimize bird exposure to hazards at the ponds. In addition, an interagency effort should be initiated among USBR, SCS, DWR, CVRWQCB, DFG, and pond owners/operators to: (1) establish field demonstration

projects for modifying ponds; (2) continue a field biological research program; (3) develop and implement a technical and financial assistance/outreach program; and (4) seek funding to implement the foregoing.

Schedule. The support agencies should immediately pursue implementation of alternatives to minimize the exposure of migratory and resident birds (and other affected wildlife species) to drainwater contaminants.

(c) Manage Agroforestry Plantations to Protect Wildlife Resources

Support Agency Role. The SCS, DWR, DFG, FWS, and DFA, should continue the on-going program to evaluate wildlife use of the plantations. A cooperative effort among SCS, DFA, DWR, and DFG should be continued: (1) for field studies to determine if wildlife are being adversely affected by their use of the plantations; (2) to identify management practices to either encourage or discourage wildlife use of the plantations (based upon the findings of the effects studies); (3) to develop and implement a technical and financial assistance/outreach program; and, (4) to seek funding to implement the foregoing.

Schedule. Actions to minimize adverse effects of agroforestry plantations should be pursued immediately, and prior to large-scale implementation of agroforestry systems throughout the San Joaquin Valley.

2. Restoration of Fish and Wildlife Resources

Support Agency Role. With the assistance of USBR, FWS, SCS, DWR, CVRWQCB, and DFG, private wetlands owners/operators should: implement decontamination and restoration techniques on private wetlands. In addition, an interagency effort should be initiated

to: (1) field-scale test and evaluate decontamination and restoration techniques in various types of habitats throughout the valley; (2) implement successful decontamination and restoration techniques on public lands; (3) develop and implement a technical and financial assistance/outreach program to encourage decontamination and restoration of private lands; and, (4) seek funding, and potentially new authority, to implement the foregoing.

Schedule. Decontamination and restoration techniques should be identified and implemented as soon as possible to reduce the extent and severity of drainwater contamination impacts on fish and wildlife resources.

3. Substitute Water Supply for Wetlands.

The SJVDP objective for substitute water supplies included the restoration of drainage-water-contaminated fish and wildlife habitats by ensuring that 129,000 acre-feet/yr (by the year 2000) of adequate, reliable, and non-toxic water supplies be made available to public and private wetlands in the Grasslands Planning Subarea. Although the recommended plan identified operational spills and tailwater as possible sources of substitute water supplies, these water supplies may potentially be inadequate due to water quality concerns (e.g., pesticides in tailwater return flows), reliability of supply, and timely availability for wetlands uses. A potentially reliable, clean water supply identified in the recommended plan could be water freed-up by source control and/or land retirement actions.

Support Agency Role. The FWS and DFG in cooperation with USBR will: (1) determine the source, quality, reliability and seasonal availability, and cost of the water to be used (some preliminary work has been accomplished); (2) identify the water management and operations (facilities seem adequate) to deliver

water to fish and wildlife; (3) acquire and deliver the substitute water; and (4) seek funding and potentially new authority to implement the foregoing.

Schedule. Provision of substitute water supplies should be pursued immediately to mitigate for drain water contamination that has occurred in public and private wetlands of the Grasslands Planning Subarea.

4. Improvement of Fish and Wildlife Resources

Support Agency Role. An interagency effort should be initiated in cooperation with USBR, SCS, DWR, FWS, and DFG to: assess feasibility of use of retired farmlands for use as potential wildlife habitat -- including appraising the contaminant hazard potential and other management issues.

Schedule. Assessment of the feasibility of the use of retired farmlands as potential wildlife habitat should occur prior to full-scale implementation of the land retirement component of the SJVDP recommended plan.

5. General Statement on Funding Estimate and Source.

(Applicable to strategy elements for fish and wildlife.) Funding to accomplish the indicated activities for fish and wildlife is either unavailable or insufficient. Member agencies of the Management Group established by the Memorandum of Understanding will cooperate in attempting to obtain adequate funds.

6. General Statement on Legislative and Policy Needs.

(Applicable to strategy elements for fish and wildlife.) It is likely that federal legislative authority, and new policy, in general, will be necessary to implement the indicated activities for fish and wildlife. Member agencies of the Management Group will cooperate in attempting to assure or obtain authority

sufficient to implement SJVDP plan components for fish and wildlife.

Institutional Change

Includes tiered water pricing, improved scheduling of water deliveries, water transfers and marketing, and formation of regional drainage management organizations to aid in implementing other components.

Implementation Approach. Major changes and improvements in drainage conditions are not likely to result from employing existing institutional measures, or through enacting new institutional measures, to focus on particular problems. Institutional measures, however, are an important part of the answer to drainage problems, and, trial and application of measures -- such as tiered water pricing, water marketing, changes in water scheduling and deliveries, and forming special districts -- should be encouraged. As a general principle, the involved parties should try to solve drainage problems within the boundaries of present laws and institutions, before resorting to new legislation.

There has been sufficient experimentation by local water districts with tiered water pricing to show the advantages (and disadvantages) of this measure.

Successful experiences in water transfers and water salvage by the Imperial Irrigation District have shown the specific viability of this measure in a setting in Southern California. Analysts cannot guarantee that similar measures would be successful, if implemented, on the westside San Joaquin Valley. Nevertheless, there needs to be experimentation with water transfers and water marketing in the San Joaquin Valley, as related specifically to obtaining the funds necessary to finance drainage plans and to ameliorate drainage impacts.

Presently, there are several instances in which new local governmental arrangements are proceeding, in which regional drainage districts are forming (e.g., use of the San Luis Drain) and joint power agreements are occurring (water users' management of the Delta-Mendota Canal).

It is the intent of this strategy to support all reasonable attempts in experimenting with non-structural measures to improve water management, as related to drainage problems. If it is revealed that new laws and arrangements are needed, then, the member agencies should stand ready to help in the drafting and support of such legislation.

Support Agency Role. Four agencies (DWR, SWRCB, USBR, USFWS) are committed to supporting some institutional changes necessary for plan implementation. The DWR will encourage and support devices such as tiered water pricing and water marketing. The SWRCB will participate in study of an environmental recovery fund (means of funding fish and wildlife measures), and a study of price controls in water markets. The USBR will seek to initiate trial arrangements for funding drainage projects. The FWS would assist in drafting comprehensive legislation to authorize and fund the SJVDP drainage management plan.

Schedule. Some activities are underway now, scheduled for completion before the year 2000.

Funding Estimate and Source. The source of funds is from individual agency budgets, but the amount of funds is presently unknown.

Legislative and Policy Needs. Unknown at this time. Needs will be determined as the strategy for implementing individual plan components unfolds.

Other Actions

Other actions recommended in the SJVDP final report -- namely, use of the SJVDP plan, treatment of drainage water, detailed planning studies, and out-of-valley disposal of salts -- should also be pursued as part of the overall implementation strategy.

Use and Update of the Management Plan. The SJVDP Drainage Management Plan is a regional framework that provides a long-range guide for actions in both the private and public sectors to manage the agricultural drainage problem on the westside San Joaquin Valley. The SJVDP plan is not meant to be a static plan, but a flexible guide that should be updated and improved as conditions change and the effects of actions taken are assessed. As the SJVDP information base is updated with data from the monitoring system, that information should be used to revise and update the Management Plan. The interests of all affected parties should be considered in the updating process. Local experience with implementation of the various plan components will be invaluable in revising and updating the plan.

The Management Group will sponsor an effort to periodically update the Management Plan, say at 5-year intervals. Updating is necessary to maintain a framework for guiding actions of individuals and organizations involved in drainage management.

Treatment of Drainage Water. Treatment of drainage water is not included as an actual component in the SJVDP plan, but the potential of treatment is recognized in a recommendation (page 11, SJVDP Plan, 1990) that additional study should be devoted to developing a "cost-effective treatment method to remove selenium from drainage water".

Implementation of this recommendation began in 1991 with the construction of an anaerobic-bacterial selenium-removal pilot treatment plant at the Adams Street experimental station, under federal/State/local funding. This plant will be operated under the direction of the California State University at Fresno.

Successful technical operation will conceivably lead to the construction of a larger treatment plant. Success of such a plant, in turn, could well lead to the construction of a full-scale treatment plant that would be integrated optimally into the drainage-water management processes of an operating local water district.

The planned schedule of implementation of selenium treatment plant demonstration program is as follows:

- o pilot treatment plant phase: 1991-93
- o half-scale treatment plant phase: 1994-97
- o planning, design, EIS and funding of a full-scale plant: 1995-2000
- o begin operation of a full-scale plant: Post-2000

Fund sharing for all the experimental phases of the treatment plant (to year 2000) should be one-third each; federal, State, and local.

Detailed Planning Studies

"The general plan for reducing or solving drainage and drainage-related problems outlined in this report provides a framework into which many actions can be fitted. However, before many of the actions can move forward, additional work is needed to refine estimates of their scope and effects."

The SJVDP plan of 1990 was developed to serve as a regional framework for long-term management of drainage problems. More

definite and locally-specific planning projects will have to be conducted in most local areas, before certain parts of SJVDP plan implementation can occur, e.g., centralized collection of drainage water for concentration, treatment and/or disposal.

The practical boundaries for detailed planning depend upon a number of factors, including water-supply service areas, common characteristics of lands, and drainage management opportunities. The scheduling of such studies depends upon instigating factors and the urgency of the need.

Definite planning is now underway for a large area of land that comprises approximately one-third of the total land area in the SJVDP plan. This is the USBR definite plan for all or parts of the following water districts: Westlands, Broadview, Panoche, Pacheco, and San Luis. This planning project is proceeding on a fast pace because of a completion date (12/31/91) stipulated in a court settlement, the Barcellos judgement.

The "Barcellos judgement" plan will rely heavily upon information developed in the SJVDP plan, however, it may differ in certain respects based upon different needs and capabilities that arise as specific places, times, and payers are identified in a more definite plan.

As a general practice, the Management Group, of the continuing regional effort, should review and comment on definite plans, endorsing those aspects of definite plans which help to implement the SJVDP regional plan, and recognizing those facets of the definite planning which suggest that the regional plan should be revised.

It is not possible to draw precise boundaries or to set exact boundaries for definite planning exercises, however, the

following content and schedule is recommended for general programming and budgeting activities:

CONTENT AND SCHEDULE

PLANNING AREA	RECOMMENDED LEAD AGENCY	SCHEDULE (BEGIN-COMPLETE)
Remainder of Grasslands Subarea (minus San Luis Unit)	USBR	1992-94
Tulare Subarea	DWR	1992-94
Kern Subarea	KWA*	1994-96
Northern Subarea	DFG	1995-97

*Kern County Water Agency

Funding. Costs of definite planning should be distributed on the basis of 50/50, federal/local or State/local.

Out-of-Valley Disposal of Salts

"The study and resulting plan focus on in-valley management of the drainage and drainage-related problems. It appears that in-valley actions can manage the problems for several decades without a means of exporting drainage-related salts to the ocean. Ultimately, it may become necessary to remove from the valley."

As a policy procedure, and to place investigations in a logical sequence, the SJVDP chose to concentrate on in-valley management of drainage problems. Neither the Policy and Management Committee of the SJVDP nor the advisory committees of SJVDP disclaimed a possible future need to dispose of concentrated agricultural brine in the Pacific Ocean. To the contrary, the coordinated units of the SJVDP -- policy makers,

advisors and staff -- have separately addressed the probable need for future investigations of out-of-valley salt disposal to complement and finish off in-valley actions.

Before out-of-valley disposal of salts could be developed as even a technically workable option, much more information needs to be collected and various study themes need to be pursued.

Such studies are not scheduled in this strategy document; rather, we adopt the following general principle to guide the initiation of any future studies: Any study of out-of-valley disposal of salts, conducted under the auspices of or in cooperation with the Management Group, will be initiated only with the support and involvement of California communities that would tentatively be affected by such disposal. It is expected that the respective policy-setting bodies which will choose to cooperate in joint studies of ocean disposal, will look for ways to co-manage both in-valley and coastal wastes so that net environmental, economic and social benefits will accrue to both San Joaquin Valley and coastal community participants.

MONITORING OF AGRICULTURAL DRAINAGE CONDITIONS

Background

The need for a monitoring plan is described on page 133 of the SJVDP Final Report, September 1990:

"The drainage problem that affects, or is related to, more than 1 million acres is not presently being monitored in a comprehensive, effective and efficient manner. An extremely important premise underlying successful implementation of this plan is that many facets and dimensions of the problem ground water levels, soil conditions, land uses, water quality, volume of drainage, conditions of evaporation ponds, impacts on biota, public health risks - must be monitored on a long-term systematic basis. The objective of monitoring is to determine the effect of actions and whether they should be changed."

This section lays out the components of a monitoring plan. This plan will have to be revised and improved periodically, to fit changing circumstances.

The monitoring process is generally in two parts: measurement of certain indicators of drainage conditions and their effects (usually in the field), and assessment of the significance of the cumulative measurements. A sound monitoring plan would provide information on: (1) drainage conditions and accompanying effects on a continuing, long-term basis, and (2) the success of plans and efforts to correct these conditions and effects.

The SJVDP Follow-up Task Force has inventoried the existing monitoring programs of various agencies and has canvassed many technical experts on their recommendations for a monitoring strategy and activities to be focused on agricultural drainage conditions and effects.

The task force has developed concepts for guiding the design and implementation of a monitoring plan. The Program managers and the chair of ITC have discussed with agency managers and technicians their priority needs and possible monitoring roles. The designation of roles is tentative at this time and assumes: a willingness to cooperate, a need for additional funds, and continued availability of specific expertise in the agencies designated for technical leadership.

Basic Management Principles for Monitoring

Coordination and Cooperation. A successful monitoring plan will require close cooperation between individual water users and water districts, between water districts and major water suppliers, and between all the agencies having the responsibility to manage some aspect of the drainage problem (and its effects)

and the technical and financial means to carry out the given responsibilities. Specific responsibilities will have to be defined and accepted. Both administrative and technical coordination are vital to the monitoring strategy.

It is understood that the eight-agency Management Group will provide oversight for the administrative arrangements laid out in this section. The MG may recommend joint budgeting and administration of programs and will provide oversight for the interagency technical activities essential to conducting a regional monitoring system.

Building on Existing Programs. Because of the universal funding problems of agencies, as well as specific technical expertise vested in certain agencies, much of the information needed will have to be obtained through building on existing programs -- while enhancing these programs as needed.

Tying Monitoring to Maintenance of a Coordinated Data Base. The September 1990, report of the SJVDP, and the many back-up documents and files of data, comprise a rather extensive current data base of great utility over the long-term -- if the data base can be updated with information gathered from interagency monitoring activities. The monitoring system should be designed so that the data collected can be stored (under proper quality control) in the SJVDP data base. It is understood that the SJVDP data base will be maintained as an accessible, computerized, GIS-based system.

Beginning with a "Bare-Bones" Plan of Action. Extensive staff discussions have shown that the "laundry list" of parameters and places to monitor can be exhaustive. Although it is desirable to recognize ideal circumstances -- as a long-term administrative goal, it is essential to lay out the absolute minimum level of regional monitoring that must be implemented in

the near future as part of the continuing follow-up to the SJVDP effort.

Basic Elements of the Strategy

Scope of Monitoring. The primary emphases for regional monitoring are: (1) the land area that had a free ground water level within 20 feet of land surface in the year 1986-87 as shown on page 31, Figure 6 of the SJVDP final report; (2) all water bodies affected adversely by agricultural drainage from such land; (3) all species (including humans) and habitats that are, or might be, impacted by agricultural drainage waters, and (4) beneficial uses of ground water and surface water, that are affected by agricultural drainage waters. The primary media to be monitored are: (1) ground water; (2) surface water; (3) soils; and (4) biota (including certain crops). The conditions of primary concern are: (1) water-logging of crop root zones; (2) evidence of damage to some species and; (3) contamination of media, in some places, with substances of concern as listed on page 40 of the SJVDP final report, or contamination of the media with any substance in violation of State or federal law.

Designers of the monitoring plan will be guided by the SJVDP plan performance standards.

Minimum Required Monitoring by Media

The following is a "bare-bones" listing of subjects and conditions to be monitored to provide a continuing basic level of understanding of drainage - affected environments in the San Joaquin Valley.

Monitoring Ground Water. The monitoring plan should focus on measuring and assessing the following conditions occurring in the subsurface of drainage-problem lands (present or potential):

- o the depth to the shallow water table prior to, and following, each irrigation season
- o the quality of the shallow ground water, in terms of the dissolved substances of concern and major ions, especially in those parts of the shallow ground water body and semi-confined aquifer that may eventually contribute flow to tile drains (generally, depth zones to 50 feet below any land having a shallow ground-water table within 20 feet of the land surface)
- o the depth to water (potentiometric surface) in index wells developed solely in the semi-confined aquifer and the quality of their water produced, in terms of dissolved substances of concern
- o in those land areas flagged in the SJVDP as candidate areas for ground water pumping, the quality of the water, in terms of dissolved substances of concern
- o the depth to the water table under land retired from irrigation

Monitoring Surface Water. Compared to the monitoring of ground water, the monitoring of surface water is relatively well-organized by agency and standardized by fairly uniform technique. But, analyses by the Follow-up task force suggest that changes will need to be made in some technical aspects (e.g., frequency of measurement, location, associated data

collection). Some specific problems with the existing network are:

- o a need for new stations and networks to serve new drainage water management (e.g., use of the San Luis Drain)
- o a general paucity of gaging stations on the San Joaquin River and its tributaries (only three sites measuring flow and salt)
- o a present lack of a statement of the minimum permissible monitoring network for evaporation ponds. (The many different kinds of biochemical pond environments are a challenge.)

The existing surface-water networks must be utilized and improved to fashion a suitable monitoring program for surface water bodies.

A suitable surface-water monitoring program must accomplish, at least, the following with respect to the SJVDP recommended plan. It must allow statistically reliable assessments of:

- o the volume and quality of subsurface drainage water flow as measured in collection or main conveyance facilities
- o the changing geochemistry of evaporation ponds, primarily to measure the hazard to wildlife
- o the net effect (contaminating or diluting) of drainage-water flows on water in streams, rivers, and wetlands
- o the extent and conditions under which drainage-related substances of concern in streams and canals affect beneficial uses of these water bodies

Monitoring Soils. In the long-term monitoring of soil conditions, two major questions need to be answered. They are: (1) At what rate is soluble selenium -- and other substances of concern -- continuing to leach from soils and contribute to the contamination of shallow ground water? (2) What seasonal and long-term geochemical effects are occurring in soils as a result of the presence of a high water table contributing to evaporative concentration of salts and trace-element contaminants in soils? (3) What are the effects of different irrigation management strategies on the concentrations of salts and other substance of concern in the root zone?

With respect to determining the local impact of SJVDP plan components on soils, the following situations require monitoring of plan implementation sites:

- o the possible build-up of substances of concern in soils having inadequate leaching due to limitations on water application (source control impact)
- o the likely build-up of substances of concern in soils at re-use sites (e.g., agroforestry)
- o possible leaching, wind driven, or other escape of substances of concern from evaporation systems
- o impact on soils of retiring land from irrigation in water-logged areas.

Some associated questions and conditions are less straightforward than the actual testing of soils. It will be important to know the rate of land abandonment and land retirement, and the suitability of those lands for non-irrigation uses, especially for any use as wildlife habitat -- planned or unintentional.

In designing the monitoring plan, it would also be wise to consider how to assess the long-term sustainability of land affected by salinization of soils and a general salt imbalance in the San Joaquin Valley.

Monitoring Biota and their Habitats. A monitoring plan must track the effects of contaminated drainage water and soils across the trophic levels of the food web prevailing in the drainage-affected environments of the San Joaquin Valley. During the period 1985-90 (see Bibliography in SJVDP Final Report), a considerable amount of research and monitoring was conducted under the auspices of SJVDP. Analysis of the results of these drainage-related efforts, however, suggest that additional staff work will be needed before all of the biologic element of the monitoring plan can be designed. To guide such work, the Follow-up staff came up with the following "bare-bones" listing of elements for a biota and habitat monitoring plan.

In evaporation ponds and wetlands, monitor concentrations of substances of concern* in surface soil, water, and biota (including food chain items and aquatic birds); populations and health characteristics of key species that use the sites, and; use of any freshwater alternative habitat that has been developed to mitigate hazards.

In agroforestry plantations and demonstration project areas, monitor concentrations of substances of concern in soils and biota; populations and health characteristics of key species feeding on or dwelling in tree and halophyte areas (especially small mammals, migratory birds, threatened or endangered species

*For fish and wildlife, these are: arsenic, boron, chromium, molybdenum, selenium and total dissolved solids (salts). In some areas, the following additional elements must be considered: Cd, Cu, Li, Mn, Hg, Ni, Sr, U, V, and Zn.

or others with declining populations, and game species), and sample nectar and honey resulting from bee culture at agro-forestry sites.

In artificial and natural surface water courses, monitor levels of selenium and boron in selected indicator species of native fishes, game fishes, wildlife, and invertebrates such as clams and crayfish.

In production and marketing of foodstuffs, monitor crops and livestock and their products produced from drainage-affected areas (especially areas that are selenium hot spots), to determine potential bio-concentration of selenium in such crops or livestock.

Designation of "Drainage Management" Monitoring Programs, Networks and Stations

Recognizing that the availability of certain information is essential for successful management of drainage conditions in the San Joaquin Valley, the MG should endorse steps toward ensuring that the programs, networks or stations needed for gathering this information are: (1) available, or; (2) can be made available -- over time -- through designating, revamping or improving existing data-collection arrangements, or, establishing new arrangements.

In keeping with the basic principles of this strategy, the present, acceptable parts of existing programs and networks, should be designated by the MG -- upon the advice of ITC -- as "Drainage Monitoring Networks", or "Drainage Monitoring Stations". Networks and stations so identified should be enhanced by the MG through policy support of the agency programs that fund the given networks and stations, or, through participatory funding by members agencies of the MG.

The designation of "Drainage Management" stations or networks would be analogous to designations which the USGS and its cooperators have found administratively useful, over decades of time, in maintaining the NASQAN network and the Hydrologic Benchmark network of stations.

One of the major assignments of ITC should be to develop a means to implement technical aspects of the monitoring strategy. To begin the process of designating and of enhancing the designations, standing subcommittees and work groups should be established by ITC.

Establishment of Work Groups

The roles essential in the work groups are: chair of the work group, technical lead in a given field, and membership on the work group. The work proposed would be to: (1) develop a specific work plan; (2) make preliminary designations of the basic networks and/or stations; (3) quantify the extent to which designated systems need to be supplemented, or new systems established, in order to meet the objectives laid out in the monitoring plan, and; (4) make arrangements for QA/QC for these processes. The result of the work groups activity should be recommendations on monitoring stations, in terms of kind, number, location, frequency of measurement, and fate of the data collected (where to obtain lab analyses and where to store data for use) and development of a means to assess whether implementation strategies are having an effect on drainage management -- or should be changed.

The work groups should initially meet monthly, and then perhaps quarterly, to make recommendations for ITC to convey to MG for consideration and action.

Ground-Water Work Group.

Chair: DWR

Discipline lead: USGS

Membership: Above; CVRWQCB, representatives of appropriate water districts, and others invited by chair.

Focus of the work group: The objective of the Work Group is to guide monitoring of the physical and chemical aspects of ground water in the drainage problem area to assess the impact of drainage reduction measures recommended by the SJVDP. The approach to monitoring this large and complex system is to integrate on-going programs to the extent possible and minimize unnecessary new data-collection. The basic tasks that must be accomplished for a successful monitoring and assessment effort can be summarized as follows:

- (1) Develop a clear statement of the key questions that need to be answered. These must be specific and include identification of specific constituents or land use practices of concern. Questions will range from regional to site-specific in scope.
- (2) Review on-going monitoring of water levels and water quality and determine the adequacy of this data for answering the questions.
- (3) Design monitoring networks for quality and water levels using existing stations to the extent possible. Because of the high costs of assessing water quality, representative subareas (as well as known problem areas) will be selected within which specific questions can be answered.
- (4) Coordinate data collection to ensure that the field protocols and laboratory methods that are used result in

high-quality data. High quality data make assessment easier.

- (5) Develop a strategy for coordinating and conducting the assessment once the data are collected.

Surface Water Work Group.

Chair: CVRWQCB

Technical lead: DWR, USGS, water districts

Membership: Above; USBR, USFWS, DFG, representatives of appropriate water districts, and others invited by chair.

Focus of the work group: The purpose of the Work Group is to coordinate existing monitoring efforts on surface waters done by various agencies. Members should discuss successes or problems with existing sampling sites, techniques, planned sites and needs for additional information. The work group should coordinate requests for additional data and help to avoid duplication of effort. The group will recommend actions to change and improve the data collection effort, based on the results of monitoring. Actions will be the responsibility of individual agencies.

Soils Work Group.

Chair: University of California, Davis

Technical lead: SCS

Membership: Above; USBR, DFA, CVRWQCB, representatives of appropriate water districts, and others invited by chair.

Focus of the work group: A need exists to establish long-term monitoring programs for the chemical, physical and biological characteristics of surface soils and subsoils under various land uses such as irrigated croplands, grasslands,

wetlands, agroforestry, idle/retired lands, wildlands, ground-water recharge, and other lands used for treatment/disposal of problem drainage waters (e.g. evaporation ponds). The monitored soil data base should be assessed for changes in the chemical reactivity, availability, and transport of salts, and other constituents of concern (Se, As, Mo, Cr, U, V, etc.) as impacted by the land use. When soils acquire adverse/deleterious properties, remedial/or reclamation measures may be needed to restore soil quality.

Biota Work Group.

Chair: DFG

Technical lead: USFWS/DFG

Membership: Above; DFA, USBR, SWRCB, CVRWQCB, DWR, CSUF, SCS, UCD, representatives of appropriate water districts, and others invited by chair.

Focus of the work group: The major purpose of the group is to implement a short-term/long-term monitoring plan to track efforts to correct adverse effects of contaminated drainage water and soils through trophic levels of the food web prevailing in drainage-affected environments of the San Joaquin Valley. The monitoring plan must be designed to track the success (or failure) of implemented drainage management elements identified in the SJVDP Final Plan. The media which must be monitored include: evaporation ponds; drainage re-use systems (including crops, trees, halophytes, and solar ponds); Westside San Joaquin Valley wetlands; and streams and water courses in the lower San Joaquin River/Upper Delta. The plan should specify appropriate indicator species of wildlife, fish, and invertebrates to be sampled; representative areas to be sampled; and frequency of sampling. It should also establish a data base system including an access agreement, QA/QC, standardized methods, both for collection (sampling protocol) and for reporting (in standard

terminology). The plan should also identify funding needs for monitoring and research.

Additional duties of the Work Group should include developing a system for gauging the success (or failure) of reducing and managing drainage problems. In some cases little is known about what level of contamination constitutes a hazardous level; hence, additional research needs must also be identified. Finally, the Work Group should identify agency responsibility for funding monitoring and research programs.

Public Health Assessment Work Group.

Chair: California Environmental Protection Agency

Technical lead: DHS, DFG, FWS

Membership: Above, all entities having a direct interest in public health, and others invited by chair.

Focus of the work group: The Work Group will assist in planning for collection and subsequent evaluation of monitoring data for public health protective purposes. Previous work of the SJVDP has determined that contaminated wild biota are currently the likeliest source of human exposure to agricultural drainage water contaminants, and, hunters, fishermen, foragers, and subsistence gardeners are populations at greatest risk from over-exposure to these substances. Implementation of the Management Plan, including the introduction of treatment technologies, may generate new exposure scenarios or concentrations and may alter these conclusions.

The Public Health Assessment Work Group will interact with other work groups to assure that collected data will serve the purposes of health evaluation and that potentially important exposure routes are not overlooked. Once data are compiled, the

Public Health assessment Work Group will prepare an Annual Report to the Monitoring and Assessment Subcommittee. This report will evaluate potential public health concerns that could result from contamination as environmental conditions change.

**MAINTAINING AN INTEGRATED COMPREHENSIVE INFORMATION
BASE FOR DRAINAGE MANAGEMENT**

Introduction

The San Joaquin Valley Drainage Program (SJVDP) has created a comprehensive data base that is both hard copy and computerized, and, is stored and made available through the offices of the Mid-Pacific Region of the U. S. Bureau of Reclamation, in Sacramento, California. That data base has been described in a report titled "Description of the Data Directory of the San Joaquin Valley Drainage Program", May 1990. The temporary offices of the SJVDP Follow-up have been assisting the USBR in continuing to make this data base available to a large body of requestors (400 individual requests in the period from October 1, 1990 to August 1, 1991).

Permanent arrangements must be made to continue to protect and make available the SJVDP data base. Furthermore, activities of the Monitoring Subcommittee (discussed elsewhere, this report), and studies and data-collection not under the auspices of the Management Group, will continue to produce data which should be integrated into the original SJVDP database -- or related to it in a suitable manner -- so that the base remains useful for current purposes.

It is the purpose of this section to describe these tasks in more detail and to prescribe a solution and assignment of responsibility and function.

Recommendations on Handling the Existing SJVDP Data Base

The existing drainage related data base currently resides with the U. S. Bureau of Reclamation. The following are

suggested assignments of responsibility for storing, maintaining, and updating the data base:

SUGGESTED ASSIGNMENTS FOR UPDATING DATA BASE

<u>WORK ITEM</u>	<u>ASSIGNMENT</u>	<u>LEAD RESPONSIBILITY</u>	<u>ASSISTED BY</u>
1.	Updating and maintaining the SJVDP Data Directory	USBR	MG ^{1/} agencies as contributors of bibliographic material & other items
2.	Providing public access to Directory	USBR	DWR and UCD ^{2/} through co-location of compatible terminal facilities
3.	Storing and providing access to historical maps, reports & files	USBR	MG agencies as holders of information
4.	Indexing the accretion of hard-copy reports, maps, and files	USBR	MG agencies accumulating material and notifying USBR for entry in to Data Directory
5.	Responding to public inquiries on data base	USBR	MG agencies referring inquiries to USBR Office
6.	Maintaining the SJVDP Geographic Information System and meeting data requests	USBR	MG agencies, as financial participants
7.	Maintaining the SJVDP biological residue base	USFWS	MG agencies, as financial participants
8.	Entering monitoring data into the G.I.S. and related data files	USBR	MG agencies, as financial participants
9.	Making available the G.I.S. system as an analytical tool (e.g., for thematic overlays and analysis)	USBR	MG agencies as financial participants

^{1/} MG = The Management Group for continuing interagency coordination .

^{2/} UCD = University of California (Davis)

NOTE: Computer data files are both sources of information and analytical tools. The USBR will provide copies of the data files to the "public" at nominal cost. The use of the files for data analysis, however, will be substantially more expensive. The SJVDP Data Directory will be maintained to provide "current" listings of data gathered by other agencies, i.e. -- to reference other sources of that data, that are important to drainage management efforts.

Estimated Administrative Burden of Work Outlined

Burden on USBR. The space requirements are: maintain rooms W-1407 and W-1409 in the Sacramento, Cottage Way Federal Building; continue to hold space in central files for reports and files; maintain overflow storage in warehouse; and maintain user space in library and map storage in library.

The system requirements are: Avilion Work station (under the existing USGS contract) with connection to the USBR TCP/IP network; access and use of ARC/INFO software to maintain and update the GIS database; maintenance of the data link and access to USGS systems for data exchange; provision for updating the Macintosh and PC systems and programs currently running data bases from SJVDP; access to the INTERNET under the Drainage Program account for data exchange to other agencies and universities; and computer equipment such as terminals, digitizing tablet, printers in order to access systems, update data files, and prepare reports and studies.

The personnel requirements are: A full-time person with the ability to respond to requests for hard copy reports and studies and with the ability to produce reports and maps from the computer data files, and with the ability to import and export computer data files on request from other agencies or the general public; a full-time person to coordinate with other agencies, and other on-going Bureau activities in the San Joaquin Valley, and; a part-time person to assist in the development of user friendly

systems for the rapid search and query of Program data files for future analysis.

Burden on USGS. Provide access to USGS computer system and relevant data files. Provide coordination with USBR personnel on on-going USGS activities in the San Joaquin Valley including reports and the development of data sets.

Burden on FWS. Maintain and update data on contaminants in Biota that is presently in BIORES. Coordinate any activities related to drainage conditions in wildlife refuges in the San Joaquin Valley.

Burden on SCS. Coordinate with USBR personnel via their Resource Inventory Specialist any on-going activities in the San Joaquin Valley. Provide any data or other information related to the on-farm monitoring program as it is available.

Burden on DWR. Coordination with USBR personnel on on-going activities in the San Joaquin Valley, particularly on the monitoring program and land use.

Burden on DFG. Coordination of on-going monitoring activities in the San Joaquin Valley. Provide access to appropriate data files related to monitoring activities.

Burden on SWRCB. Coordination of on-going monitoring activities by SWRCB with USBR personnel. Provide access to appropriate data files related to monitoring activities. This includes sites used for regulatory requirements and for base line studies.

Burden on DFA. Coordination of on-going monitoring activities by DFA with USBR personnel. Provide access to appropriate data files related to these monitoring activities.

Burden on UCD. Indexing of current materials held by SJVDP for cross referencing with the SJVDP system. Storage space for SJVDP documents and maps. Maintenance of data link to USBR for access to appropriate data files. Coordination with USBR personnel on current and proposed studies related to drainage or trace elements in the San Joaquin Valley by the UC system.

Discussion

Coordination of each agency's activities with USBR personnel, as described in the previous section, includes sharing in the responsibility for identifying what data are to be retained in the SJVDP data sets and in funding the development and maintenance of those data sets. The G.I.S. system and related data files are on a cost recovery basis.

Agencies responsible for collection of a particular data set should be responsible for maintaining and updating the data set. This should reduce the cost of maintaining and updating the SJVDP data set. It will also free up resources for any data analysis desired by the participants.

**MEMORANDUM OF UNDERSTANDING (MOU)
FOR IMPLEMENTATION OF
THE SAN JOAQUIN VALLEY DRAINAGE PROGRAM'S RECOMMENDED PLAN**

The U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service, U. S. Soil Conservation Service, U. S. Geological Survey, Department of Water Resources, Department of Fish and Game, Department of Food and Agriculture, and the State Water Resources Control Board agree to the following:

1. **Background.** A management plan for agricultural subsurface drainage and related problems on the westside San Joaquin Valley was developed by the Federal-State San Joaquin Valley Drainage Program (SJVDP) during the period 1985-1990, and published in a September 1990 report by the same name.
2. **Purpose.** All parties to this agreement adopt the program described in the September 1990 final report of the San Joaquin Valley Drainage Program (SJVDP Recommended Plan) as the principal guide for remedying subsurface agricultural drainage and related problems. All parties agree to work together to identify and define specific tasks and associated responsible parties, needed funding and authorities, and schedules for accomplishment, as necessary to implement all components of the SJVDP Recommended Plan.
3. **Program.** The parties adopt the foregoing report describing a strategy for implementing the SJVDP Recommended Plan as the initial step in developing an action plan. Based on it, the parties will adopt an annual plan of work, commencing in 1992, to establish priorities and coordinate activities to accomplish the objectives of the Recommended Plan. Subsequently, the parties will annually evaluate accomplishments and adopt a revised plan of work.

4. Funding and Legal Authority. It is understood by all parties that implementation of this MOU and the SJVDP Recommended Plan are subject to the availability of funding and legal authority. All parties to this agreement agree to support attempts by signatory agencies to secure the funding and authority necessary to implement work plans adopted pursuant to this MOU.

In order to enhance efficiency and economy, and reduce duplications or conflicts in efforts, all parties to this agreement agree to coordinate requests for funding and authority.

5. Amendments. This MOU may be modified by mutual agreement as necessary to accomplish drainage management objectives.
6. Withdrawal. Any party to this MOU may withdraw by submitting a written notice to each of the other parties 120 days in advance of the intended withdrawal.
7. Term of MOU. This MOU shall remain in effect until all components of the SJVDP Recommended Plan have been fully implemented or until it is dissolved by unanimous agreement of the signatory parties.

SIGNATURES

U. S. Bureau of Reclamation

Department of Water Resources

U. S. Fish and Wildlife Service

Department of Fish and Game

U. S. Soil Conservation Service

Department of Food and Agriculture

U. S. Geological Survey

Water Resources Control Board



United States Department of the Interior

OFFICE OF INSPECTOR GENERAL
Washington, D.C. 20240



AUG 9 1993

MEMORANDUM

TO: The Secretary

FROM: Acting Inspector General

SUBJECT SUMMARY: Final Audit Report for Your Information - "Department of the Interior Irrigation Drainage Programs" (No. 93-I-1302)

DISCUSSION: We concluded that the Department of the Interior had not taken actions necessary to ensure recovery of funds expended for irrigation drainage studies and for the cleanup of contamination at the Kesterson Reservoir. As a result, none of the \$110 million spent since 1981, including \$87 million reported to be specifically repayable under Reclamation law, had been reimbursed to the U.S. Treasury, and the Government is incurring about \$7 million annually to finance this unreimbursed cost.

In addition, despite spending \$50 million of the \$110 million to study drainage problems at the San Luis Unit, the Bureau of Reclamation was unable to develop an irrigation drainage plan that satisfied the terms of a court settlement reached between the Bureau and the Unit's water users. We attributed the lack of an acceptable plan to the fact that the Bureau agreed to pursue the development of a plan that was conceptually unworkable or unacceptable to State of California officials and to the general public. By not meeting the settlement terms, the Bureau lost the water users' commitment to finance as much as \$100 million of the costs of constructing the San Luis Unit drainage facilities. Additionally, litigation was renewed against the Government over the drainage problems experienced in the Unit. This litigation could hinder the Bureau's ability to fully comply with the Reclamation Projects Authorization and Adjustment Act of 1992, which contains specific provisions addressing the drainage problems in the Unit.

The Assistant Secretary for Water and Science concurred with three of the report's four recommendations and provided sufficient information for us to consider two

Prepared by: Harold Bloom
Extension: 208-4252

recommendations resolved but not implemented. The Assistant Secretary was requested to provide additional information for one recommendation and to reconsider the recommendation to require repayment or cost-sharing agreements for all reimbursable costs before engaging in further drainage-related programs or studies.



Joyce N. Fleischman

Attachment



U.S. Department of the Interior
Office of Inspector General

AUDIT REPORT

DEPARTMENT OF THE INTERIOR
IRRIGATION DRAINAGE PROGRAMS

REPORT NO. 93-I-1302
JULY 1993

This report may not be disclosed to anyone other than
the auditee except by the Assistant Inspector General
for Administration, Office of Inspector General,
U.S. Department of the Interior,
Washington, D.C. 20240



United States Department of the Interior

OFFICE OF INSPECTOR GENERAL
Headquarters Audits
1550 Wilson Boulevard
Suite 401
Arlington, VA 22209

JUL 26 1993

Memorandum

To: Assistant Secretary for Water and Science
Commissioner, Bureau of Reclamation

From: Assistant Inspector General for Audits

Subject: Final Audit Report on Department of the Interior Irrigation Drainage Programs (No. 93-I-1302)

This report presents the results of our review of the Department of the Interior's irrigation drainage programs. The objective was to determine whether the Department was (1) identifying and resolving irrigation drainage problems relating to selenium and other water contaminants and (2) establishing adequate repayment and/or cost-sharing policies to obtain reimbursement of program costs by water users as appropriate. The audit was performed primarily at the Department's headquarters in Washington, D.C., and at the Bureau of Reclamation's Mid-Pacific Region in Sacramento, California.

Overall, we concluded that the Department had progressed in its efforts to identify and resolve drainage problems in that 33 contamination sites had been identified and were in the various program stages of investigation, study, and development of corrective action plans. In addition, the resolution of the drainage problems at one site, the Kesterson Reservoir, was pending determination of final cleanup requirements. However, we concentrated our audit efforts on the Department's actions relating to repayment and planning because neither the Kesterson Reservoir Cleanup Program nor the National Irrigation Water Quality Program had sufficiently progressed so that we could determine the programs' effectiveness in resolving the irrigation drainage problems identified.

Regarding repayment, we concluded that the Department had not ensured that Federal expenditures of \$110 million for drainage studies and the cleanup of Kesterson Reservoir would be recovered in accordance with applicable statutory requirements. As a result, the Department has not recovered any of the \$110 million it has spent since 1981, and we estimate that the Government is incurring over \$7 million annually to finance those unreimbursed costs. We also found that the Bureau of Reclamation had not developed a drainage plan that conformed with criteria specified in a negotiated court settlement, despite spending \$50 million of the \$110 million for drainage studies related to the resolution of the drainage problems

involving the San Luis Unit. As such, the courts relieved the Westlands Water District of its obligation to finance up front an additional \$100 million of the costs to construct the facilities needed to resolve the drainage problems in California's San Joaquin Valley.

To correct the problems noted, we recommended that the Department identify all non-Federal parties responsible for repayment, expedite the development of a repayment policy consistent with existing law for all drainage-related costs, and report on that policy in accordance with Congressional direction. In addition, we recommended that appropriate repayment or cost-sharing agreements be required as necessary to help ensure timely recovery of future drainage-related costs and that future drainage plans involving the San Luis Unit be developed in accordance with appropriate planning instructions and guidelines.

The June 18, 1993, response (Appendix 5), from the Assistant Secretary for Water and Science concurred with three of our four recommendations. The response was sufficient for us to consider two of the three recommendations resolved, and additional information is needed to resolve one recommendation. The response disagreed with our recommendation to require appropriate repayment or cost-sharing agreements prior to engaging in any further drainage-related programs or studies. We have asked the Assistant Secretary for Water and Science to reconsider this recommendation. The status of the recommendations and the information needed for resolution are in Appendix 6.

In accordance with the Department Manual (360 DM 5.3), we are requesting your written response to this report by September 27, 1993. Your response should provide the information requested in Appendix 6.

The legislation, as amended, creating the Office of Inspector General requires semiannual reporting to the Congress on all audit reports issued, the monetary impact of audit findings (Appendix 1), actions taken to implement audit recommendations, and identification of each significant recommendation on which corrective action has not been taken.


Harold Bloom

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INTRODUCTION

BACKGROUND

Since the early 1900s, the Department of the Interior has constructed about 600 irrigation projects in 17 western states, converting millions of acres of previously nonarable lands into productive farmland. However, the drainage water from some irrigation projects has been known to cause serious health and environmental problems. For example, inadequate drainage of irrigation water from farmlands can build up the salt in the soil, which can subsequently reduce or destroy the productivity of the land. Conversely, the transportation and disposal of the drainage water can result in the accumulation and concentration of toxic elements and chemicals such as selenium, arsenic, boron, and pesticides at the disposal site. The concentration of such toxins in areas inhabited by fish and wildlife can endanger their health and survival and create public health risks through the consumption of contaminated fish, wildlife, plants, and livestock.

In 1983, the discovery of high rates of deformity, mortality, and reproductive failure among aquatic birds at Kesterson National Wildlife Refuge in California brought the drainage problem to national attention. The damaging effects on the waterfowl were traced to high levels of selenium, a natural element found in soil, which was carried by irrigation drainage water flowing into the Kesterson Reservoir, located within the Refuge. This discovery prompted concern that toxic levels of selenium in irrigation drainage water from Federal water projects presented a nationwide health risk for both humans and wildlife. In response to this concern, the Department of the Interior Irrigation Drainage Program (renamed the National Irrigation Water Quality Program) was established in 1985 under the direction and management of the Assistant Secretary for Water and Science¹ to identify and evaluate agricultural drainage-related problems throughout the western United States. Through January 1992, the Program had identified 33 sites in 15 states that were considered to have a high potential for contamination from irrigation drainage flows (see Appendix 2). However, the Kesterson Reservoir was the only site that had advanced to the stage where actions had been taken to resolve the contamination problem. Specifically, the drainage flows into the Kesterson Reservoir were completely terminated in 1986, and the low-lying areas of the Reservoir were filled with soil in 1988. At the time of our audit, further activities at the Kesterson Reservoir were pending determination of the final cleanup requirements.

¹Other Department of the Interior agencies have participated with the Bureau of Reclamation in funding and providing technical personnel for the study efforts under the Department's irrigation drainage programs. The other participating agencies were the U.S. Fish and Wildlife Service, the U.S. Geological Survey, the Bureau of Indian Affairs, and the Bureau of Land Management.

The Kesterson National Wildlife Refuge was established in 1976 on lands purchased by the Bureau of Reclamation. The Bureau planned to use the site as part of a system to dispose of irrigation drainage water from farmlands on the west side of California's San Joaquin Valley. The main feature of the planned system was the San Luis Drain, which was originally designed to transport drainage water 188 miles for discharge into the Sacramento-San Joaquin Delta. The construction of the San Luis Drain was authorized in 1960 under the San Luis Unit Act (Public Law 86-488), which also authorized, as part of the Central Valley Project, the construction of facilities to deliver irrigation water to farmlands on the west side of the San Joaquin Valley. The service area of the San Luis Unit comprised approximately 700,000 acres of farmland, about 600,000 acres of which fall within the boundaries of the Westlands Water District, the single largest water contractor in the Central Valley Project. Given the poor natural drainage of these farmlands, it was considered essential to dispose of the irrigation drainage water to maintain the productivity of the lands. Despite this critical need, construction of the San Luis Drain was halted in 1975 because of funding constraints and concern that untreated drainage water would materially degrade the water quality of the Delta and the San Francisco Bay.

In August 1984, the San Joaquin Valley Drainage Program was established to identify measures to help solve the drainage-related problems caused by irrigated farming on the west side of the San Joaquin Valley and to develop a comprehensive plan for the long-term management of the problems, particularly those involving the San Luis Unit. The Program received Federal funding from appropriations under the San Luis Unit Act and was conducted jointly by the Department of the Interior and the State of California. A final report on the results of the Program was issued in September 1990. In December 1991, eight agencies from within the Department of the Interior, the Department of Agriculture, and the State of California entered into a memorandum of understanding that provided for the use of the management plan described in the final report as the principal guide for remedying agricultural drainage problems in the San Joaquin Valley. In October 1992, the Congress enacted the Reclamation Projects Authorization and Adjustment Act of 1992 (Public Law 102-575), which authorized the implementation or further study of at least four of the eight measures recommended in the final report.

OBJECTIVE AND SCOPE

The objective of the audit was to determine whether the Department of the Interior was (1) identifying and resolving irrigation drainage problems relating to selenium and other water contaminants and (2) establishing adequate repayment and/or cost-sharing policies to obtain reimbursement of program costs by water users as appropriate.

This performance audit, completed in February 1993, was conducted at the Department's headquarters in Washington, D.C., and at the Bureau of Reclamation's Mid-Pacific Region in Sacramento, California. We also visited the Kesterson National Wildlife Refuge near Los Banos, California. To accomplish our objective, we reviewed laws, legislative history, Congressional hearings, program studies and reports, correspondence, court documents, and legal opinions relating to the Department's irrigation drainage programs. We also interviewed officials from the Office of the Assistant Secretary for Water and Science, the Office of the Solicitor, the Bureau of Reclamation, the U.S. Fish and Wildlife Service, the Bureau of Indian Affairs, the U.S. Geological Survey, the California Department of Water Resources, the California Regional Water Quality Control Board, the California Department of Fish and Game, and the Westlands Water District concerning their responsibilities with the drainage programs. In addition, we obtained and reviewed data on the drainage programs from several of these entities.

The audit was made, as applicable, in accordance with the "Government Auditing Standards," issued by the Comptroller General of the United States. Accordingly, we included such tests of records and other auditing procedures that were considered necessary under the circumstances. The scope of our audit did not include an evaluation of the technical aspects of the Department's drainage-related studies.

As part of our audit, we evaluated the system of internal controls related to the Department's irrigation drainage programs. We identified internal control weaknesses in the areas of repayment of program costs and development of drainage plans. The weaknesses and recommended corrective actions are discussed in the Finding and Recommendations section of this report. We also reviewed the Department's Annual Statement and Report, required by the Federal Managers' Financial Integrity Act, for fiscal years 1989 through 1992 to determine whether any reported weaknesses were within the objective and scope of our audit. We determined that none of the reported weaknesses were directly related to the objective or scope of our audit.

PRIOR AUDIT COVERAGE

Neither the Office of Inspector General nor the General Accounting Office has issued a report on the Department's irrigation drainage programs within the last 5 years. However, the General Accounting Office issued a report that dealt, in part, with the irrigation drainage problem in California's Central Valley.

The General Accounting Office report "Changes Needed Before Water Service Contracts Are Renewed" (No. GAO/RCED-91-175), issued in August 1991, stated that agricultural drainage water had degraded the quality of central California's water supply and soil, poisoned wildlife, and threatened agricultural production. The report recommended that the Secretary of the Interior determine the impacts of

renewing Central Valley Project water service contracts for long time periods for the same quantities of water.

On October 30, 1992, the Central Valley Project Improvement Act (Title XXXIV of Public Law 102-575) essentially incorporated some of the General Accounting Office's recommendations into law. Specifically, the Act shortened the length of long-term water service contracts from 40 to 25 years, required environmental impact statements to be completed prior to renewing any long-term contracts, and mandated that the provisions of the Act be included in all long-term contracts.

FINDING AND RECOMMENDATIONS

REPAYMENT OF IRRIGATION DRAINAGE PROGRAM COSTS

The Bureau of Reclamation and other Department of the Interior agencies have not recovered the reimbursable portion of the \$110 million expended since 1981 on irrigation drainage studies and the cleanup of the Kesterson Reservoir. According to Bureau officials, more than \$87 million (79 percent) of the \$110 million is repayable by non-Federal beneficiaries under Reclamation law. The Bureau has not determined how much of the remaining \$23 million was reimbursable under existing laws and policies. However, despite the passage of over a decade and the significance of the amount involved, the Department has not taken sufficient actions to ensure that these costs would be recovered in accordance with applicable law, nor has it submitted a report required by the Congress in 1991 detailing the Department's recommendations concerning the repayment of these drainage-related costs. As such, none of the \$110 million has been recovered, and the Government is incurring an estimated \$7 million annually to finance these unreimbursed program costs.

In 1983, selenium contamination was discovered at the Kesterson Reservoir, which prompted the California State Water Resources Control Board to issue a series of orders directing the Bureau to take immediate actions at the Reservoir. This contamination raised questions as to whether conditions at the Reservoir represented a violation of the Migratory Bird Treaty Act. In light of these questions and in response to the resultant media attention and Congressional hearings that were convened, the Department initiated efforts, the Kesterson Reservoir Cleanup Program, to address the Kesterson problem and began an extensive study program, the San Joaquin Valley Drainage Program, with the State of California to investigate the overall drainage problem in California's San Joaquin Valley. Subsequently, the Congress and the media began to question whether conditions similar to those found at the Kesterson Reservoir existed at other locations throughout the West. To address this concern, the Department assembled scientists and technicians from several of its agencies and established a national program, the National Irrigation Water Quality Program, to search for other irrigation-induced contamination problems within the 17 western states.

From fiscal years 1981 through 1992, the Department expended about \$110 million to conduct drainage studies in the San Joaquin Valley, to identify other contaminated sites throughout the West, to resolve the Kesterson contamination problem, and to accomplish other drainage-related activities. The Department funded its drainage programs using existing legislative authorities. Through fiscal year 1992, the Department had obtained and expended approximately \$83.3 million from construction appropriations, \$13.3 million from Bureau of Reclamation operation

and maintenance appropriations, and \$13.4 million from other Departmental appropriations (see Appendix 3). Of the \$110 million expended for drainage activities, the Bureau considers \$87 million (79 percent) to be fully reimbursable by project beneficiaries under Reclamation law. At the time of our review, the Department had not determined how much of the remaining \$23 million was reimbursable under existing law or policy and the responsible beneficiaries if repayable.

According to the Acting Regional Director for the Bureau's Mid-Pacific Region, the Department initially did not address the issue of who should be held responsible for the repayment of drainage-related program costs in order to concentrate all its efforts on remediating contamination problems, which could result in a violation of the Migratory Bird Treaty Act. However, despite the passing of almost 11 years, the Department has continued to postpone action on this important repayment issue, even though the issue has surfaced numerous times in Departmental correspondence during the study period. For example:

- A July 17, 1987, information memorandum from the Offices of the Assistant Secretaries for Water and Science and for Fish and Wildlife to the Office of the Secretary stated that the Department's National Irrigation Water Quality Program "has now progressed to the point where attention should be turned to the development of cost-sharing arrangements with appropriate State and local entities."

- A September 21, 1987, memorandum from the Office of the Assistant Secretary for Policy, Management and Budget to the Assistant Secretary for Water and Science stated, "Repayment for the Drainage Program is complicated by the fact that major expenditures have already been incurred without having a repayment agreement or contract in place."

- An April 17, 1989, memorandum from the Project Investment and Repayment Officer to the Mid-Pacific Regional Director stated, "An important but as yet unresolved issue concerns the responsibility for the repayment of costs incurred by the Drainage Program in the conduct of its studies and development of alternatives."

Since 1985, the Congress also has questioned the Department about who should be responsible for paying the costs of remediating the drainage problem. The Congress subsequently directed the Department, in Conference Report 101-889, dated October 1990, to formally address the issue and to submit a report by March 31, 1991, on the Department's repayment policies for the Kesterson Reservoir cleanup and other drainage-related costs, including recommendations for the allocation of costs between the Federal and the non-Federal interests. A Departmental official advised us that the Department did try to collect \$2.8 million of the program costs from some of the beneficiaries through Reclamation's water rate-setting policy. However, the official

further stated that the Congress restricted the recovery of any costs pending submittal of the repayment policy report to the Congress. During testimony before the House Appropriations Subcommittee on Energy and Water Development on April 19, 1993, the Acting Assistant Secretary for Water and Science stated that the report had been held up by the prior administration but that Congress would have the report by the end of the year.

In Conference Report 101-889, the Department was also directed to make recommendations for allocating future drainage-related costs between the Federal and the non-Federal interests. The Department plans to spend over \$10 million for its fiscal year 1993 drainage program activities (see Appendix 3). Also, substantial expenditures will be required in future years to execute the Department's plans to clean up the irrigation-induced contaminants at the Kesterson Reservoir and at other identified sites throughout the West and to implement measures to minimize the damaging effects of salt accumulation on farmlands within California's San Joaquin Valley. To facilitate timely recovery of these costs, we believe that the Department should secure either repayment or cost-sharing agreements with appropriate non-Federal parties to the maximum extent practical. Further, we believe that the Department should consider recommending, in its report to the Congress, that cost-sharing agreements be sought from the non-Federal parties to help limit the future financial burden on Federal funding. Cost-sharing agreements that provide for up-front contributions from the non-Federal parties are generally more advantageous to the Government than repayment agreements, which typically allow for 100 percent Federal financing before cost recovery begins. Through fiscal year 1992, the Bureau has provided nearly 90 percent of the Federal financing for the Department's drainage activities. In 1987, the Bureau adopted a new policy, which called for appropriate non-Federal cost sharing in all aspects of the Reclamation program. Accordingly, the use of cost sharing between the Bureau and non-Federal parties for future drainage activities would be consistent with existing Reclamation policy and would help reduce the amount of Federal financing needed. It could also help alleviate some of the attendant repayment problems that have been encountered.

According to Bureau officials, the recovery of future drainage-related costs involving the Central Valley Project can be effected through the existing rate-setting policy without the need for new contractual agreements. However, the Government could incur substantial additional interest costs depending on how and when the Bureau implements its rate-setting policy. For example, a Discussion Paper issued by the Bureau in July 1991 states that the repayment of the drainage-related costs (except operation and maintenance costs) would not begin until the drainage solutions are implemented and until the Kesterson Reservoir cleanup is completed at some unknown future date. In our opinion, this delay will result in an undue burden on the Federal taxpayer because the costs of financing the program would be borne by the Government over an extended period of time. For example, we estimated that

the Government would incur about \$5.6 million² in financing costs annually if the repayment of the \$83.3 million already expended under the San Luis Unit Act were postponed until the costs were placed into repayment, as specified in the Discussion Paper. Furthermore, the recovery of future costs could be adversely affected because the water users may not have the ability to pay these costs when their water rates are increased under their renewed water service contracts. As such, we believe that the reimbursable-type costs of any future studies or activities involving the Central Valley Project should be scheduled for recovery in a more timely manner, through negotiation of new repayment or cost-sharing agreements, whenever it is apparent that the Bureau's existing rate-setting policy would jeopardize future repayment or result in substantial interest costs for the Government.

When the extent of the irrigation drainage problem became evident at the Kesterson Reservoir in 1983, the Department had immediate and pressing responsibilities to mitigate the contamination problem that may have taken precedence over concerns about repayment. However, after nearly 11 years, we do not believe that the Department should continue to delay the repayment of millions of Federal tax dollars spent on drainage activities. In this regard, we estimated that the Government is incurring costs of about \$7.4 million³ annually to finance the \$110 million spent on drainage activities. Since sufficient actions have not been taken to recover the \$110 million, we believe that the Department should expedite the submission of the report required by Conference Report 101-889 and ask the Congress to help affix responsibility for these costs. In requesting the Department's "recommendations" for repayment in Conference Report 101-889, we believe that the Congress indicated that it intended to answer the questions of how Federal and non-Federal costs would be allocated and which functions would be reimbursable or nonreimbursable.

San Luis Unit Drainage Studies

In addition to the repayment issue, the Bureau of Reclamation did not develop an irrigation drainage plan that satisfied the terms of a court settlement between the Bureau and water users in the San Luis Unit despite spending \$50 million of the \$110 million studying the drainage problems of the area. Under a 1986 negotiated settlement, the Bureau agreed to develop and adopt a plan for drainage service facilities that would dispose of irrigation drainage water from the Westland's Water District in the San Luis Unit. However, the Bureau agreed to pursue development of a drainage plan based on a concept that appeared unworkable and unacceptable to State officials and the general public. This occurred because the Bureau did not

²Our computation of the interest cost is based on the 15-year Treasury rate estimated by the Department of the Treasury for October 1992 (6.75 percent).

³Ibid.

perform sufficient analyses or take the action necessary to fully assess the "viability" of the settlement requirements in accordance with the Federal Principles and Guidelines for water resources planning and Reclamation Planning Instructions. Since the Bureau was unable to meet the terms of this settlement, (1) the District was refunded over \$17 million deposited in a trust account and was relieved of an obligation made to finance up front as much as \$100 million toward the future cost of resolving the drainage problems and (2) litigation against the Government was renewed, which may obstruct the Bureau's ability to comply with the Reclamation Projects Authorization and Adjustment Act of 1992 in resolving the drainage problems in the San Luis Unit. The background and events leading to the current status of drainage studies associated with the San Luis Unit and our analysis of the deficiencies in the Bureau's planning process are presented in Appendix 4.

At the time of our audit, the Bureau was attempting to reach a new settlement with the District and the other parties to the lawsuits. The Bureau has spent several years and millions of dollars studying the area's drainage problems, but these efforts have not resulted in an acceptable drainage service plan. Accordingly, we believe that the Bureau should not agree, in the current negotiations, to pursue the development or adoption of any drainage plan until actions are taken to reasonably ensure that the planning concept is viable in accordance with all applicable planning instructions and guidelines.

Recommendations

We recommend that the Assistant Secretary for Water and Science:

1. Identify all the non-Federal parties considered responsible for repaying the reimbursable costs of drainage studies, the cleanup of Kesterson Reservoir, and the other contaminated sites.
2. Expedite the development of a repayment policy consistent with existing laws for all drainage-related costs, past and future, and submit the policy report stipulated in Conference Report 101-889 to the Congress.
3. Require a repayment or cost-sharing agreement, as appropriate, for all reimbursable costs before engaging in any further drainage-related programs or studies unless it has been determined that recovery can be effected through existing rate-setting policies in a timely manner without jeopardizing recovery of the Government's future investment or resulting in additional interest costs to the Government.
4. Direct that future drainage plans for the San Luis Unit be developed in conformance with the requirements set forth in the Reclamation Planning

Instructions and the Federal Principles and Guidelines established for water resources planning.

Assistant Secretary for Water and Science Response

The June 18, 1993, response from the Assistant Secretary for Water and Science (Appendix 5), stated concurrence with Recommendations 1, 2, and 4 and nonconcurrence with Recommendation 3.

Recommendation 1. The response stated that the Bureau would identify the non-Federal participants having obligations to repay the reimbursable costs of Kesterson and the San Joaquin Valley Drainage Program. The response identified the target date for implementation as December 31, 1993, and the Regional Director, Mid-Pacific Region, as the responsible official. The response further stated that the non-Federal participants responsible for repaying the costs of studies in process under the National Irrigation Water Quality Program would also be identified. According to the response, as current and future studies conducted under the Program move to the planning phase, the participants responsible for repayment will be identified in the individual planning documents, but a target date for identifying participants in future studies could not be established.

Recommendation 2. The response stated that a repayment policy that takes into account existing laws for all drainage-related costs, past and future, is being developed for submission to the Congress as provided in Conference Report 101-889. The response identified the target date for implementation as December 31, 1993, and the Secretary of the Interior as the responsible official.

Recommendation 3. The response disagreed with the recommendation and stated that the participating Departmental agencies provide the funding for problem identification and for determination of the severity of irrigation-induced water quality problems from Departmental irrigation projects. The response further stated that the U.S. Geological Survey, the U.S. Fish and Wildlife Service, and the Bureau of Indian Affairs are not covered by Reclamation law and thus have no mechanisms to require cost recovery under Reclamation's authority and that these Bureaus should seek voluntary cost sharing for any remediation costs.

The response also stated that the Bureau of Reclamation is responsible for the four National Irrigation Water Quality Program study areas currently in remedial planning and that Reclamation law provides for securing repayment or cost-sharing agreements. The response stated that in most areas, however, the non-Federal parties considered responsible for repaying reimbursable costs may not agree that they should be held financially responsible. The response further stated that the planning process includes educating non-Federal parties on the extent, magnitude, and causes of the problem, which may make it possible to achieve repayment or cost-

sharing agreements. As such, the response alternatively proposed that our recommendation be changed to require a repayment or cost-sharing agreement for reimbursable costs "prior to implementing remediation."

Recommendation 4. The response stated that the Commissioner, Bureau of Reclamation, would be directed to ensure that future planning activities for the San Luis Unit be developed using National Irrigation Water Quality Program guidelines, which reflect both Reclamation Planning Instructions and the Federal Principles and Guidelines. The response identified the target date for implementation as July 30, 1993, and the Assistant Secretary for Water and Science as the responsible official.

Office of Inspector General Comments

Based on the Assistant Secretary for Water and Science's response, Recommendations 2 and 4 are considered resolved but not implemented, and Recommendation 3 is unresolved. Although the response concurred with Recommendation 1, it did not provide sufficient information to resolve the recommendation. The status of the recommendations and the information needed for resolution are in Appendix 6.

Recommendation 1. The response, as written, did not include the costs incurred on the San Luis Unit Drainage Program and the other San Luis Unit studies. These costs are, according to Bureau officials, also reimbursable and as such are obliged to be repaid.

Recommendation 3. Our report discussed substantial expenditures of about \$87 million that were made for planning studies, such as the San Joaquin Valley Drainage Program and the San Luis Unit Drainage Program, from funding sources that are reimbursable under Reclamation law. However, none of these costs have been recovered from non-Federal parties to date. This is due, in part, to the fact that the Bureau of Reclamation believes that non-Federal parties considered responsible for repaying reimbursable costs may not agree that they should be held financially responsible or that mechanisms are not available to initiate repayment actions. To preclude similar situations from occurring on future studies, we believe that the Government's financial interests would be best served if repayment or cost-sharing agreements were obtained before substantive expenditures are made from funding sources which statutorily require reimbursement. Such advance repayment agreements would also be consistent with existing requirements for other Bureau planning studies, such as those conducted under its General Investigations Program. Accordingly, we request that the Assistant Secretary for Water and Science reconsider the response to Recommendation 3.

CLASSIFICATION OF MONETARY AMOUNTS

<u>Finding</u>	<u>Funds To Be Put To Better Use</u>	<u>Potential Additional Revenues</u>
Repayment of Drainage Program Costs		\$109,937,121*
Annual Financing Costs	\$7,420,756**	

*According to Departmental officials, \$83,308,665 of this amount is reimbursable under Section 9 of the Reclamation Project Act of 1939, and \$3,852,802 is reimbursable under Section 6 of the Reclamation Act of 1902. The Department had not determined the extent to which the remaining \$22,775,654 is either reimbursable or nonreimbursable under existing law or policy.

**This amount represents the Government's annual cost of borrowing to finance the \$109,937,121 at a rate of 6.75 percent based on the 15-year Treasury rate estimated by the Department of the Treasury for October 1992.

STATUS OF NATIONAL IRRIGATION WATER QUALITY PROGRAM AS OF JANUARY 1992

Program Phase Descriptions

1. Site identification is the examination of existing information to determine sites likely to have irrigation-induced contamination problems. The five sites in the identification phase of the program were as follows:¹

Bostwick Division, Nebraska/Kansas
Fort Sumner, New Mexico
Colorado-Big Thompson, Colorado
Central Nebraska, Nebraska
Middle Rio Grande, New Mexico

2. Reconnaissance investigations are field sampling studies to determine levels of potentially toxic chemicals in water, sediment, plants, fish, and waterfowl. The 18 sites in the reconnaissance investigation phase of the program were as follows:

Middle Arkansas River, Colorado/Kansas
Pine River, Colorado
Lower Colorado River, Arizona/California
Sacramento Refuge, California
American Falls Reservoir, Idaho
Milk River, Montana
Bosque del Apache, National Wildlife Refuge, New Mexico
Malheur, National Wildlife Refuge, Oregon
Angostura Unit, South Dakota
Belle Fourche Unit, South Dakota
Laguna Atascosa, National Wildlife Refuge, Texas
Riverton Unit, Wyoming
Delores-Ute Mountain, Colorado
Grand Valley, Colorado²
San Juan, New Mexico
Humboldt, Nevada

¹More sites may be identified as a result of independent investigations by participating agencies.

²This site was incorporated into the Gunnison River detailed study (see Item 3).

Owyhee-Vale, Oregon/Idaho
Middle Columbia Basin, Washington

3. **Detailed studies** are field studies to gather all information necessary to identify and evaluate remediation alternatives. Detailed studies include the identification of sources, transport mechanisms, and fate of potentially toxic chemicals and quantification of adverse impacts. The three sites in the detailed study phase of the program were as follows:

Klamath Basin, California/Oregon
Gunnison River, Colorado
Sun River, Montana

4. **Planning** is the development of coordinated plans of action with appropriate Federal, state, and local agencies. The six sites in the planning phase of the program were as follows:

San Joaquin Valley, California³
Salton Sea, California
Tulare Lake, California³
Stillwater, National Wildlife Refuge, Nevada
Middle Green River, Utah
Kendrick Project, Wyoming

5. **Remediation** is the implementation of corrective actions. The only site in the remediation phase of the program was the Kesterson Reservoir in California.⁴

³These sites were included in the San Joaquin Valley Drainage Program.

⁴In 1988, in voluntary compliance with an administrative order by the State of California Water Resources Control Board, the Bureau of Reclamation filled the temporary pools at Kesterson Reservoir to reduce any immediate threat to wildlife. The Bureau has continued to monitor the area and conduct research into effective means to manage and dissipate the selenium. The Bureau may undertake additional cleanup activities depending on evolving conditions at Kesterson Reservoir and on State Water Resources Control Board administrative actions.

**IRRIGATION DRAINAGE PROGRAMS
SOURCES AND APPLICATIONS OF FUNDING
FOR FISCAL YEARS 1981 THROUGH 1993**

<u>Sources of Funding Through Fiscal Year 1992</u>	<u>Amount</u>
Reclamation Construction Appropriations	\$83,308,665
Reclamation Operation and Maintenance Appropriations	13,252,802
Other Interior Appropriations	<u>13,375,654</u>
Total	<u>\$109,937,121</u>

Applications of Funds Through Fiscal Year 1992

Kesterson Reservoir Cleanup Program	\$30,292,409
National Irrigation Water Quality Program	22,775,654
San Joaquin Valley Drainage Program	47,032,017
San Luis Unit Drainage Program	3,323,148
Other San Luis Unit Studies*	<u>6,513,893</u>
Total	<u>\$109,937,121</u>

*These studies are additional studies and related costs funded from reimbursable construction appropriations under the San Luis Unit Act, including (1) a Reclamation study to fulfill State of California requirements to obtain a discharge permit for the San Luis Drain, (2) a Reclamation study seeking authorization to complete the San Luis Drain, and (3) capitalized movable equipment.

Sources of Funding Budgeted for Fiscal Year 1993

Reclamation Construction Appropriation	\$1,000,000
Reclamation Operation and Maintenance Appropriation	7,350,000
Other Interior Appropriations	<u>1,946,000</u>
Total	<u>\$10,296,000</u>

Budgeted Applications of Funds for Fiscal Year 1993

Kesterson Reservoir Cleanup Program	\$2,800,000
National Irrigation Water Quality Program	6,496,000
San Luis Unit Drainage Program	<u>1,000,000</u>
Total	<u>\$10,296,000</u>

SAN LUIS UNIT DRAINAGE STUDIES

In April 1985, after the Kesterson problem surfaced, the Department of the Interior and the Westlands Water District agreed to begin a phased termination of the irrigation drainage flows into the Kesterson Reservoir from the partially completed San Luis Drain. Under a 1986 negotiated settlement, the Bureau of Reclamation agreed to develop, adopt, and submit a drainage plan to the District for drainage service facilities that, in the aggregate, had sufficient capacity and capability to transport, treat as necessary, and dispose of between 60,000 and 100,000 acre-feet¹ of agricultural drainage water annually from the District. The settlement required that the plan be submitted by December 1991 and that the drainage facilities be cost effective; financially feasible; and capable of construction, acquisition, and operation in compliance with all applicable laws. The settlement was signed and entered as a court judgment, referred to as the Barcellos Judgment, on December 30, 1986.

The San Joaquin Valley Drainage Program was completed in September 1990, ending 6 years of study in search of a solution to the irrigation-induced drainage problems of the San Joaquin Valley. The principal area of Federal concern was the San Luis Unit, and one of the goals of the Program was to prepare a drainage plan meeting the requirements of the 1986 settlement. Over 100 ideas and concepts for solving part or all of the area's drainage problems were generated, and approximately 80 drainage options were studied or evaluated during the course of the Program. However, despite these efforts, Bureau officials decided prior to completion that the Program would not result in the development of a drainage plan that satisfied the terms of the settlement. Consequently, the Bureau began funding another study effort, the San Luis Unit Drainage Program, for the express purpose of developing a drainage plan that met the criteria specified in the settlement. The Bureau spent an additional \$3 million on this second study effort, which, according to the Bureau, built upon the investigations performed under the San Joaquin Valley Drainage Program. This included an evaluation and screening of all previous plans and options for the collection, treatment, and disposal of drainage water, including out-of-valley disposal.

In December 1991, the Bureau submitted a proposed drainage plan to the Westlands Water District. Shortly thereafter, the District rejected the Bureau's proposed

¹The quantity of water required to cover 1 acre of land to a depth of 1 foot. An acre-foot is equal to 325,851 gallons or to 43,560 cubic feet.

drainage plan, and in May 1992, a Federal District Court agreed with the District that the proposed drainage plan did not meet the specific criteria of the judgment. In a court deposition, a Bureau official stated that every effort had been made to develop a plan consistent with the criteria specified in the judgment but that the criteria were found to be mutually incompatible with current knowledge and technology.

Based on our review, we concluded that the Bureau did not perform sufficient analyses as contemplated in the Federal Principles and Guidelines for water resource planning and Reclamation Planning Instructions. These criteria prescribe procedures for evaluating a proposed plan of study and use the term "viable" to refer to a plan that has been tested and found to be adequate with respect to acceptability, completeness, effectiveness, and efficiency to accomplish the specified objectives. The tests for viability help ensure that Government resources are not expended in developing plans that have little or no chance for success. However, rather than fully adhering to this testing process, the Bureau made the assumption that the San Joaquin Valley Drainage Program could develop a suitable plan, even though the Bureau knew, as early as September 1985, that the California Legislature had ruled out ocean and estuary disposal and either had restricted or was unlikely to approve other identified disposal options. This opposition left the Bureau with few, if any, practical solutions for disposing of agricultural drainage water from the San Joaquin Valley.

Nonetheless, in April 1987, officials of the San Joaquin Valley Drainage Program issued a draft report that presented the Sacramento-San Joaquin Delta, San Francisco Bay, and the Pacific Ocean as possible disposal sites for agricultural drainage water. This report stirred controversy, and because of strong negative reactions by the Congress, the State of California, and the general public, Program officials stopped studying ways to export agricultural drainage water outside the San Joaquin Valley. Thus within months of the December 1986 settlement, it became clear that the concept of transporting and disposing of drainage water outside the District was questionable and would not, in Bureau planning terms, meet the test of "acceptability."

Consequently, the Bureau submitted a drainage plan to the District in December 1991 that did not provide for the construction of facilities to transport and dispose of drainage water from the District. Instead, the Bureau submitted a Draft Environmental Impact Statement, containing a preferred plan and three alternatives that were designed to reduce the amount of drainage water requiring export from the District. The Bureau's preferred plan consisted of a combination of source

control measures, land retirement, a pilot water marketing program, and the development of new drainage technologies. Under its proposed plan, the Bureau would develop these technologies through further study, testing, and demonstration by the year 2007. Although a Bureau official stated, in court testimony, that this plan was "financially feasible," we found that the Bureau did not have financial analyses documenting that determination. The responsible Bureau official stated that preliminary calculations were prepared but were subsequently discarded.

In reviewing the financial feasibility of the proposed plan, we found that the Bureau apparently had not considered several factors that would increase the District's future annual obligations and significantly reduce its ability to pay for drainage-related costs when its water service contract is renewed in the year 2008. For example, the District's annual capital repayment requirement under its renewed contract would increase from \$8.5 million to \$14.8 million as a result of Public Law 99-546. Under Section 105 of the law, the water rates established under renewed Central Valley Project contracts are required to be sufficient to recover the Government's capital investment by the year 2030. Considering the increased rates resulting from this shortened repayment period and the costs of implementing the Bureau's proposed plan, we estimated that the District's annual obligations in the year 2008 would be approximately \$1 million² more than its ability to pay.³ In addition, we found that the Bureau had not considered (1) the District's own future capital requirements;⁴ (2) Kesterson Reservoir cleanup and San Joaquin Valley Drainage Program costs that may be allocable to the District (see Finding and Recommendations section); (3) any future construction appropriations under the San Luis Unit Act that are allocable to the District; (4) fish and wildlife mitigation costs relating to both the Kesterson cleanup and the Bureau's proposed drainage plan; (5) the District's accumulated operation and maintenance cost deficit; and (6) the updated Central Valley Project cost allocation. These issues collectively could significantly increase the District's annual obligations. The District also questioned

²This amount is expressed in 1991 dollars and could differ depending on comparative price levels in the year 2008.

³Ability to pay, also referred to as "payment capacity," consists of the amount that the District's irrigators can afford to pay for water service. Generally, Reclamation policy requires that project power users assist in repaying reimbursable irrigation costs that are beyond the ability of the irrigators to pay. However, under a 1986 amendment to the San Luis Unit Act, the Bureau is prohibited from using power revenues to assist in repaying the costs of drainage facilities for the San Luis Unit.

⁴In August 1991, the District formed the Westlands Water District Financing Corporation for the purpose of issuing up to \$98 million in debt securities.

the completeness of the Bureau's financial feasibility calculations in its January 17, 1991, letter that rejected the Bureau's proposed drainage plan.

As part of the 1986 settlement, the District agreed to deposit up to \$5 million annually in a trust fund to help finance the future costs to construct the drainage facilities called for under the drainage plan, up to a maximum of \$100 million. However, the court released the District from this funding obligation and refunded the \$17 million in the trust fund when the Bureau failed to develop the agreed-upon drainage plan.

The Bureau's failure to develop an acceptable drainage plan also impacted two lawsuits filed by the District and by affected landowners within and outside the District. These lawsuits had been suspended either by the Barcellos Judgment or by another court action. Upon rejection of the Bureau's proposed drainage plan, new court motions were filed, in part citing the Bureau's failure to develop a drainage plan meeting the requirements of the judgment. In addition, the litigants were on record as being opposed to source control, land retirement, and "unproven technologies," which were measures recommended in the final report of the San Joaquin Valley Drainage Program. These lawsuits could impact the implementation of an interagency agreement and recently enacted legislation. Under a memorandum of understanding executed in December 1991, the Bureau agreed with seven other Federal and state agencies to implement the recommendations included in the final report on the San Joaquin Valley Drainage Program. Also, under Public Law 102-575, enacted in October 1992, the Bureau received authorization to implement or study further at least four of eight measures recommended in the Program's final report. Given the lawsuits and the litigants' expressed opposition to the report's recommended measures, implementation could be obstructed, thereby impeding the Bureau's ability to resolve the area's drainage problems.



IN REPLY REFER TO:

United States Department of the Interior

BUREAU OF RECLAMATION
Washington, D.C. 20240

APPENDIX 5
Page 1 of 3



JUN 18 1993

Memorandum

To: Office of Inspector General
Attention: Assistant Inspector General for Audits (5341-MIB)

From: Assistant Secretary - Water and Science *Elizabeth Ann Ruckel*

Subject: Draft Audit Report on "Department of Interior, Irrigation Drainage Program" (No. W-IN-MOA-002-91) (DIG Audit)

The following comments are offered in response to the recommendations in the subject audit report.

Recommendation 1

Identify all the non-Federal parties considered responsible for repaying the reimbursable costs of drainage studies, the cleanup of Kesterson Reservoir, and the other contaminated sites.

Response

Concur. Since 1991, the Bureau of Reclamation's Mid-Pacific Region has worked to identify all non-Federal parties having obligations to repay the reimbursable costs of Kesterson and the San Joaquin Valley Drainage Program. Likely repayment entities are also being identified as part of the planning activities for other drainage studies conducted under the National Irrigation Water Quality Program (NIWQP).

The target date for identifying and documenting non-Federal participants for Kesterson and the San Joaquin Valley Drainage Program is December 31, 1993. The responsible official is the Regional Director, Mid-Pacific Region.

The target date for identifying all non-Federal parties responsible for repayment of reimbursable costs for all the NIWQP drainage studies cannot be established at this time. Non-Federal participants will be identified for the studies in process; however, identification of all non-Federal participants for future studies may not be possible until well beyond the year 2000. As current and future NIWQP studies move into the planning phase, the participants responsible for repayment of reimbursable costs will be identified in the individual planning documents.

Recommendation 2

Expedite the development of a repayment policy consistent with existing laws for all drainage-related costs, past and future, and submit the policy report stipulated in Conference Report 101-889 to the Congress.

Response

Concur. A repayment policy which takes into account existing laws for all drainage-related costs, past and future, is being developed. The policy will be submitted to the Congress as provided in Conference Report 101-889.

The responsible official is the Secretary of the Interior. The target date for completing the policy and submitting it to the Congress is December 31, 1993.

Recommendation 3

Require a repayment or cost-sharing agreement, as appropriate, for all reimbursable costs before engaging in any further drainage-related programs or studies unless it has been determined that recovery can be effected through existing rate-setting policies in a timely manner without jeopardizing recovery of the Government's future investment or resulting in additional interest costs to the Government.

Response

Nonconcur: DOI irrigation projects heretofore identified by NIWQP with drainage related problems were originally constructed by the Bureau of Reclamation (BOR) or were privately constructed projects that later were managed or enhanced by BOR. Under NIWQP, the participating Department of the Interior (DOI) agencies, including the U.S. Geological Survey (USGS), the Fish and Wildlife Service (FWS), the Bureau of Indian Affairs (BIA), and BOR, provide the funding for problem identification and for determination of the severity of irrigation-induced water quality problems from DOI irrigation projects. The DOI bureau that constructed the project is responsible for the costs of remedial planning and for obtaining repayment for reimbursable remediation costs. The USGS, FWS, and the BIA are not covered by Reclamation law and thus have no mechanisms to require cost recovery under Reclamation's authority. However, these Bureaus should seek voluntary cost sharing for any remediation costs.

For the four NIWQP study areas currently in remedial planning, BOR is the responsible bureau and Reclamation law provides for securing repayment of cost-sharing agreements. In most areas, however, the non-Federal parties considered responsible for repaying reimbursable costs may not agree that a problem exists for which they should be financially responsible. Part of the planning process includes educating non-

Federal parties on the extent, magnitude and causes of the problem, which may make it possible to achieve a repayment or cost-sharing agreement with these parties.

Therefore, we propose that the language in Recommendation 3 should read "Require a repayment or cost-sharing agreement, as appropriate, for all reimbursable costs of remedial planning and remediation prior to implementing remediation, unless it has been determined that recovery can be effected through existing rate-setting policies in a timely manner without jeopardizing recovery of the Government's future investment or resulting in additional interest costs to the Government. If a remediation action is required to mitigate against a life threatening situation, that action would be accomplished in an expedited manner with or without a cost-sharing agreement in place."

Drainage-related programs outside NIWQP will have to identify individual repayment or cost-sharing agreements as defined in the appropriate legislation.

Recommendation 4

Direct that future drainage plans for the San Luis Unit be developed in conformance with the requirements set forth in the Reclamation Planning Instructions and the Federal Principles and Guidelines established for water resources planning.

Response

Concur. The Assistant Secretary - Water and Science will direct the Commissioner, Bureau of Reclamation, to ensure that future planning activities for the San Luis Unit be developed using NIWQP guidelines. These NIWQP guidelines have established decisionmaking processes and strategies that reflect both the Reclamation Planning Instructions and the Federal Principles and Guidelines.

The responsible official is the Assistant Secretary - Water Science. The target date for implementing this recommendation is July 30, 1993.

We welcome the opportunity to further discuss our response with you.

cc: Assistant Secretary - Policy, Management and Budget
Attention: Phillip Haymond
(w/encl)

STATUS OF AUDIT REPORT RECOMMENDATIONS

<u>Finding/Recommendation Reference</u>	<u>Status</u>	<u>Action Required</u>
1	Management concurs; additional information needed.	Provide a response to the recommendation that addresses the costs of the San Luis Unit Drainage Program and the other San Luis Unit studies described in Appendix 3. Also, provide target dates and titles of officials responsible for implementing the recommendation as it relates to the repayment of the San Luis Unit costs and the costs of the National Irrigation Water Quality Program studies in process.
2 and 4	Resolved; not implemented	Recommendations will be referred to the Assistant Secretary for Policy, Management and Budget for tracking of implementation.
3	Unresolved	Reconsider the recommendation, and provide a plan identifying actions to be taken, including target dates and titles of officials responsible for implementation. Also, provide a specific response to the recommendation as it pertains to future drainage-related studies for the San Luis Unit.

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0 16 044034 3 90000

ISBN 0-16-044034-3



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