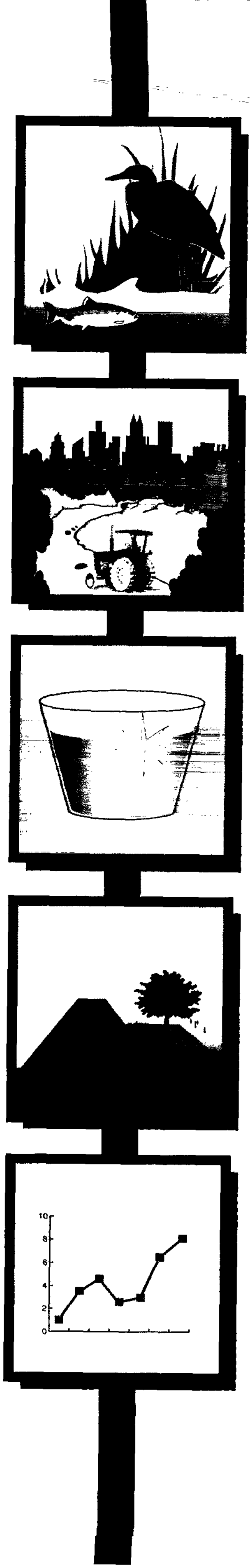

CALFED
BAY-DELTA
PROGRAM

Water Use Efficiency Program Plan

Final Programmatic EIS/EIR Technical Appendix
July 2000

C-026286

C-026286

FOREWORD

The Water Use Efficiency Program, like all components of the CALFED Bay-Delta Program (CALFED or Program), is being developed and evaluated at a programmatic level. The Program is completing Phase II, in which the CALFED agencies have developed a Preferred Program Alternative that has been subject to a comprehensive programmatic environmental review. This report describes both the long-term programmatic actions that are assessed in the Programmatic EIS/EIR, as well as certain more specific actions that may be carried out during implementation of the Program. The programmatic actions in a long-term program of this scope necessarily are described generally and without detailed site-specific information. More detailed information will be analyzed as the Program is refined in its next phase.

Implementation of Phase III is expected to begin in 2000, after the Programmatic EIS/EIR is finalized and adopted. Because of the size and complexity of the alternatives, the Program likely will be implemented over a period of 20-30 years. Program actions will be refined as implementation proceeds, initially focusing on the first 7 years (Stage 1). Subsequent site-specific proposals that involve potentially significant environmental impacts will require site-specific environmental review that tiers off the Programmatic EIS/EIR. Some local actions also may be subject to permit approval from regulatory agencies.

The CALFED Water Use Efficiency Program is based on the recognition that implementation of efficiency measures occurs mostly at the local and regional level. The role of CALFED agencies in water use efficiency will be to offer support and incentives through expanded programs to provide planning, technical, and financial assistance. CALFED agencies also will support institutional arrangements that provide local water suppliers an opportunity to demonstrate that cost-effective efficiency measures are being implemented. Some potential water use efficiency benefits, such as water quality improvements, may be regional or statewide rather than local. These are situations in which CALFED planning and cost-share support may be particularly effective.

The CALFED Water Use Efficiency Program will (1) establish Quantifiable Objectives; (2) offer support and incentives through expanded programs to provide planning, technical, and financial assistance; (3) monitor progress toward objectives; and (4) if these objectives are not met, re-evaluate management options. The Program will periodically evaluate the Quantifiable Objectives in light of new information and make appropriate revisions (up or down) to the objectives.

The program described in this Water Use Efficiency Program Plan is still under development. The actual implementation during Stage 1 and beyond may be revised, including modification, deletion, or addition of individual actions or program components, based upon availability of resources, including funding and personnel; responses to the program proposal from the public, stakeholders, and legislatures; and responses by the program to implementation experience.

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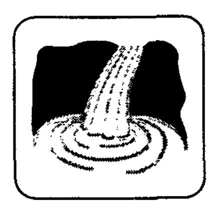

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LIST OF ACRONYMS

AB	Assembly Bill
Agricultural MOU	Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California
AW	applied water
AWMC	Agricultural Water Management Council
BARWRP	Bay Area Regional Water Recycling Program
BMP	best management practice
CALFED	CALFED Bay-Delta Program
CII	commercial, industrial, and institutional
CUWCC	California Urban Water Conservation Council
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
Delta	Sacramento-San Joaquin River Delta
DEP	depletion
DFG	California Department of Fish and Game
DHS	California Department of Health Services
DU	distribution uniformity
DWR	California Department of Water Resources
E	evaporation
EBMUD	East Bay Municipal Utility District
EIS/EIR	environmental impact statement/environmental impact report
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ET	evapotranspiration
ET_o	reference evapotranspiration
ETAW	evapotranspiration of applied water
EWMP	efficient water management practice
gpcd	gallons per capita per day
IRP	Integrated Resource Plan
MAF	million acre-feet
MMWD	Marin Municipal Water District
MWD	Metropolitan Water District of Southern California
NRCS	National Resources Conservation Service
Panel	Independent Review Panel of Agricultural Water Conservation

LIST OF ACRONYMS (CONTINUED)

Program	CALFED Bay-Delta Program
PSA	Planning Subarea
Reclamation	U.S. Bureau of Reclamation
ROD	Record of Decision
SCCWRRS	Southern California Comprehensive Water Reclamation and Reuse Study
SWP	State Water Project
SWRCB	State Water Resources Control Board
T	transpiration
TAF	thousand acre-feet
Urban MOU	Memorandum of Understanding Regarding Efficient Water Management Practices by Urban Water Suppliers in California
USFWS	U.S. Fish and Wildlife Service
WQCP	Water Quality Control Plan

Preface

This document describes the Water Use Efficiency Program of the CALFED Bay-Delta Program (CALFED or Program). It is a revision and expansion of material contained in the following three previous public drafts entitled:

- Water Use Efficiency Component, Programmatic Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) Technical Appendix, March 1998

- Revised Draft Water Use Efficiency Program Plan, February 1999

- Revised Draft Water Use Efficiency Program Plan, June 1999

This document does not contain an impact analysis but instead describes the Water Use Efficiency Program.

This preface **summarizes public comments** received by CALFED on draft documents to illustrate the breadth of comments on the program element. A separate document provides responses to public comments received on the June 1999 Revised Draft Water Use Efficiency Program Plan.

Section numbers in the remainder of this document correspond to sections in the earlier public drafts. This consistent organization of the document will make it easier for readers to compare the old and new drafts. The exception to this parallel organization is the treatment of the CALFED Water Transfer Program element. The first public draft of the Water Use Efficiency Program included a discussion of water transfers. This section has been removed from this document to allow a more complete discussion of water transfers, which is contained in the Water Transfer Program Plan.

C-026297

ISSUE OVERVIEW

As the Water Use Efficiency Program Plan has been developed, eight general issues have been raised by many of the comments on the Draft Programmatic EIS/EIR and by the stakeholders involved in development of the Program Plan. Most of these issues reveal the sharp disagreements among different stakeholder groups and among various public commentors. For example, some believe that the program has gone too far with respect to assurances while others think the program has not gone far enough. This section highlights these eight issues, indicates what progress has been made to resolve conflicts, how the Water Use Efficiency Program Plan addresses the issue, and outlines next steps the Program will take as part of Stage 1. Further detailed information on each of these issues is included in the Program Plan.

ISSUE 1. PARITY

Summary

Should CALFED demand the same level of effort from agricultural, environmental, and urban interests?

Response

CALFED proposes implementing cost-effective efficiency measures in each water use sector: urban, agricultural, and managed wetlands. Because of inherent institutional differences between sectors, approaches are somewhat different for each sector. For example, urban water suppliers are required by the California Water Code to prepare and adopt urban water management plans. They also must consider best management practices (BMPs) and implement those that meet certain criteria. Although agricultural water suppliers do not face the same mandatory planning requirements, CALFED's agricultural water conservation program contains a different, yet equally rigorous approach which will establish Quantifiable Objectives and rely heavily on the stakeholder-driven Agricultural Water Management Council (AWMC). The program's focus on water diverted for environmental purposes has been limited mainly to wildlife refuges and managed wetlands managed by CALFED agencies. Because water is not diverted or applied to other environmental uses as in the urban and agricultural sector, CALFED does not intend to apply efficiency concepts beyond managed wetlands, urban, and agricultural lands. However, CALFED agencies will take direct action to manage water supplies on refuges, rather than an indirect role as in the urban and agricultural sectors.

ISSUE 2. SAVINGS POTENTIAL

Summary

How effective are current efforts to implement water use efficiency measures?

What level of efficiency would occur in the future with and without the implementation of the CALFED program?

What is the potential for future water savings?

Response

Public comments on the savings potential from water use efficiency were numerous and diverse. One clear conclusion is that we still need to refine our estimates of water use and the potential for reduction of water use. In response, CALFED proposes the following actions:

- Stakeholders disagree on the magnitude of forecasted conservation estimates and the feasibility of achieving forecasted levels of conservation. Therefore, the forecasts have been refined and will be further refined during the first few years of Stage 1.
- Develop reference conditions in Stage 1. Reference conditions related to water use and conservation will be established to evaluate future water use efficiency progress.
- Research to improve water use efficiency actions in Stage 1. This program will support research to expand our understanding of the potential of water use efficiency measures.
- Conduct a program of data gathering, monitoring, and focused research (Section 2 of this document). This new program action is intended as a long-term effort that would be implemented as part of the CALFED Preferred Program Alternative.

The purpose of these efforts is to increase confidence in the conservation estimates, while acknowledging that estimates of this nature always retain an element of uncertainty. The need for refinement of the conservation estimates was reinforced by the recommendations of the Agricultural Water Use Efficiency Assurances Stakeholder Focus Group and the Independent Review Panel on Agricultural Water Conservation Potential (Panel). Both of these independent review groups recommended that CALFED refine its conservation estimates (although both felt the initial estimates made by CALFED were a good beginning point).

ISSUE 3. EVAPOTRANSPIRATION AND IRRIGATION EFFICIENCY

Summary

Should CALFED set specific efficiency targets for different water uses?

Response

The Panel recommended that evaporation and transpiration be estimated separately. These factors have been quantified separately as part of the planned refinement of conservation estimates and will be further refined during the first two years of Stage 1. The independent review panel recognized that current methods may prevent confident evaporation estimates. Therefore, CALFED has initiated evaporation research and anticipates additional research during Stage 1.

CALFED will develop a Strategic Plan for Agricultural Water Use Efficiency prior to the during the first year of Stage 1. This strategic planning approach will involve working with local water mangers to establish Quantifiable Objectives that support CALFED's goals (please refer to Attachment C for a description and examples of Quantifiable Objectives). CALFED does not intend to target land use, cropping changes, or arbitrary efficiency standards as part of this planning process. Rather, the Program plans to establish Quantifiable Objectives related to reducing currently irrecoverable losses and improving water quality, timing, and in-stream flows. This approach will rely heavily on local water managers to determine the best actions that will meet these objectives. Financial and technical support for these actions will be provided through the Agricultural Financial Incentive Program which will be implemented during Stage 1. Although this approach does not target land use, cropping changes, or efficiency standards, local water managers are not precluded from those actions.

In regard to concerns that conservation estimates presented in previous documents were incorrect, this draft has attempted to refine the estimates and better present the methodology. The text at the end of this Preface further explains changes in urban conservation estimates.

ISSUE 4. BEST MANAGEMENT PRACTICES AND EFFICIENT WATER MANAGEMENT PRACTICES

Summary

What role should incentive pricing and volumetric water measurement play in the Water Use Efficiency Program?

Response

Measuring and pricing agricultural customer delivery by volume has been a major point of contention between agricultural and environmental interests. Some agricultural interests contend that in certain areas measuring and pricing by volume would place a significant burden on the district without providing compensatory water conservation benefits. Environmental interests contend that water must be measured if it is to be used efficiently and that incentive pricing programs are necessary to provide water users with a signal of the value of the water resource.

Most environmental interests support the Central Valley Project Improvement Act (CVPIA) Criteria for Evaluating Water Management Plans, which require that all customers' deliveries are measured by a device capable of ±6% accuracy and water is at least partially priced by volume. Most agricultural interests support the measurement and pricing approach of the AWMC, which allows districts to analyze measurement and pricing, and potentially exempt themselves from measurement and pricing programs.

As part of the Water Measurement Program planned for Stage 1, CALFED will develop, after consultation with CALFED agencies, the Legislature, and stakeholders, state legislation that requires appropriate measurement of water use for all water users in California. In developing this legislation, important technical and stakeholder issues will be addressed to define "appropriate measurement," which is expected to vary by region. Aspects of this definition include the nature of regional difference, appropriate point of measurement, and feasible level of precision.

The Quantifiable Objectives (developed in the agricultural strategic planning effort approach) will rely heavily on local water managers to determine the best actions that will meet identified objectives (see discussion as part of Issue 3). This approach does not require or preclude the use of incentive pricing practices as a way to meet the identified objectives.

ISSUE 5. ECONOMICS

Summary

How do you determine if an efficiency measure is cost-effective? What factors should be considered?

Response

CALFED will consider local- and state-level cost effectiveness by implementing the agricultural and urban conservation incentive programs during Stage 1. These programs will provide technical assistance and low-interest loans to help facilitate locally cost-effective conservation actions, and grants to facilitate actions that are cost effective at the state-wide level.

The agricultural strategic planning process is expected to encourage additional beneficial uses of water by developing Quantifiable Objectives related to reducing currently irrecoverable losses and improving water quality, timing, and in-stream flows.

One of CALFED's solution principles is to avoid significant redirected impacts. This principle also applies to potential third-party and groundwater impacts associated with water use efficiency actions.

The use of incentive pricing is discussed under the previous issue, "Issue 4. Best Management Practices and Efficient Water Management Practices."

ISSUE 6. ASSURANCES AND PROCESS

Summary

What method should CALFED use to evaluate progress and what should be done to ensure that progress is made?

Response

The Water Use Efficiency Program incorporates valuable assurance mechanisms that make (1) CALFED benefits contingent on individual demonstration of efficiency water use and (2) storage permitting contingent on wide-spread demonstration of efficiency use (see Section 2.2, "Assurances").

The Water Use Efficiency Program will establish a quantitative method for evaluating progress. The agricultural program will establish Quantifiable Objectives through a strategic planning process. The urban program will develop a certification program.

Incentives are a cornerstone of the Water Use Efficiency Program because experience has indicated that incentives are ultimately more effective than command or regulatory approaches at creating change. The incentive-based approaches, however, also include important safeguards. For example, the agricultural approach will rely on mid-course evaluation of the program to determine whether objectives are being met. If the evaluation so indicates, changes will be made in the program approach. These changes could include a regulatory response.

CALFED will use the work of the agricultural and urban conservation councils (formed under their respective Memorandum of Understanding) to contribute to the Water Use Efficiency Program. However, this will not be the extent of the program. The agricultural program will identify and provide grant funding for measures that go beyond those expected from the Agricultural Water Management Council.

ISSUE 7. RECYCLED WATER

Summary

How much water recycling can be realistically achieved and how should this be accomplished?

Response

CALFED will continue to work with stakeholder groups to further develop and refine incentives, assurances, and other programs that will help achieve the 1-1.5 MAF of additional projected recycling potential.

ISSUE 8. THIRD-PARTY IMPACTS AND GROUNDWATER RESOURCES IMPACTS

Summary

How will third party impacts be avoided?

Response

The CALFED solution principles ensure that CALFED will not create significant redirected impacts. As such, the Water Use Efficiency Program will include safeguards against significant third-party impacts. Further, both the AWMC and the U.S. Bureau of Reclamation's (Reclamation's) Conservation Criteria allow for exemptions from implementing some water management practice based on environmental and third-party impact criteria.

CONTINUING WORK EFFORTS

This document describes the development and planned implementation of CALFED's Water Use Efficiency Program. In addition to the actions planned for Phase III, several ongoing efforts are required to complete the planning process as part of Phase II. This subsection describes decisions yet to be made and program development that is expected to occur before a Final Programmatic EIS/EIR is certified and the CALFED Program implementation phase begins.

ASSURING AGRICULTURAL WATER USE EFFICIENCY

There was widespread dissatisfaction with the approach that CALFED proposed for demonstrating and assuring efficient agricultural water use in the March 1998 Program Plan. In response, CALFED staff have been working with stakeholders and technical experts to refine and improve our agricultural approach. These efforts have included the Agricultural Water Use Efficiency focus group, which helped staff design a strategic planning process during late-1998. The resulting strategic planning effort is currently being used to develop Quantifiable Objectives related to reducing irrecoverable losses and improving water quality, timing, and in-stream flows. These Quantifiable Objectives will be met through local water use efficiency actions and facilitated through CALFED-financed incentives. CALFED will provide assurance that the Quantifiable Objectives are met by limiting access to CALFED benefits and through conditions on proposed storage facilities.

DEFINING APPROPRIATE WATER MEASUREMENT

CALFED has included a Stage 1 action to draft legislation that will require appropriate measurement of all water use in California. In developing this legislation, important technical and stakeholder issues will be addressed to define "appropriate measurement," which is expected to vary by region. Aspects of this definition include the nature of regional differences, appropriate point of measurement, and feasible level of precision. A process for addressing these issues will be defined during the remainder of Phase II.

ESTABLISHING A PROCESS FOR DEMONSTRATION OF REFUGE WATER USE EFFICIENCY

Three CALFED agencies and a Resource Conservation District have drafted an Interagency Coordinated Program for optimum water use planning for wetlands of the Central Valley. A task force representing these entities has recommended a program that includes "Effective Water Management Practices" for refuges and wetland areas of the valley. The report, which is currently being reviewed by the sponsoring agencies, is expected to be the cornerstone of CALFED's refuge water management approach.

DEVELOPING ASSURANCES AND INCENTIVES FOR WATER RECYCLING

Analysis conducted by CALFED and others suggests that a significant portion of future water demand could be met through water recycling. However, the mechanism that CALFED has proposed to assure implementation of recycling projects (local agency compliance with the water recycling planning requirements of the Urban Water Management Planning Act) is a less pro-active mechanism than is proposed to ensure that conservation measures are implemented. In fact, this mechanism would ensure only that agencies complete water recycling planning activities but would not ensure that completed plans were implemented. Even though it appears less strict, CALFED believes that this planning-based requirement in existing law is an appropriate assurance mechanism, given the challenges associated with water recycling— high capital cost, complex planning and permitting, and institutional impediments. Some public comments suggested a different sort of assurance mechanism—strong and innovative incentives that would reward agencies that recycle water.

ADDING DETAIL TO MONITORING AND FOCUSED RESEARCH

In response to public comments and recommendations from the Independent Panel on Agricultural Water Conservation Potential, CALFED has included a new action in the Water Use Efficiency Program: a coordinated program to gather and develop better information on water use, identify opportunities to improve water use efficiency, and measure the effectiveness of conservation practices. This effort will include direct activities by CALFED agencies, assistance to the CUWCC and the AWMC, and assistance to cooperating universities and water suppliers to help quantify the savings from water use efficiency measures. Public comments and other stakeholder input will help CALFED add detail to the implementation planning for this action.

DETERMINING WHICH ENTITY WILL CERTIFY URBAN WATER MANAGEMENT PLANS

CALFED recommends that a certification component be added to ensure better water supplier compliance with the Urban Water Management Planning Act. In the March 1998 Draft Water Use Efficiency Technical Appendix, CALFED recommended that DWR provide this certification. DWR has expressed concern over such a role. DWR staff believe that their role as a provider of assistance may be incompatible with a role as a certification entity. Given this concern, another entity, such as a water-user certification board or the State Water Resources Control Board, may need to certify Urban Water Management Plans. CALFED is continuing to work with CALFED agencies to determine an appropriate process for certifying compliance with requirements of the Act.

DEVELOPING DETAILS OF A BEST MANAGEMENT PRACTICES CERTIFICATION PROCESS

In the first public draft of the water use efficiency appendix, CALFED proposed that the requirements of the Memorandum of Understanding Regarding Urban Water Conservation in California (Urban MOU) constituted appropriate demonstration that urban water suppliers had considered urban water conservation measures. CALFED proposed that the organization created by the Urban MOU, the CUWCC, certify water suppliers' compliance with the terms of the MOU.

The California Urban Water Agencies and the Environmental Water Caucus worked to prepare a proposed certification process that the CUWCC might use. Subsequently, a group of other urban water suppliers proposed an alternative certification proposal based in part on the California Urban Water Agencies/Environmental Water Caucus proposal. CALFED has worked to highlight the differences between the two proposals, gathered public input, and developed a proposed certification process that is consistent with CALFED objectives and solution principles and has the highest achievable degree of stakeholder support.

DEVELOPING A PROCESS FOR DISCLOSURE AND COORDINATION OF PROGRAM IMPLEMENTATION

CALFED has identified a critical need for better coordination of agency and stakeholder actions as the CALFED Program is implemented. CALFED proposes many actions that will involve multiple government agencies and stakeholder groups: expanded levels of water conservation assistance and water recycling assistance to be provided by CALFED agencies, more prominent roles for organizations such as the CUWCC and the AWMC, programs to identify and implement water management measures that yield multiple benefits, and increased efforts focused on monitoring and research. To avoid duplication of effort and carry out the most effective programs, it may be highly desirable to create an open agency/stakeholder process for disclosure and coordination of program implementation efforts. This process would help ensure that public funds are spent most effectively and would provide a forum for public input on the future direction of programs to provide water conservation and recycling assistance. During the remainder of Phase II, CALFED will examine options for the creation of such a process or forum.

1. Introduction

Tables

1. Introduction

The CALFED Bay-Delta Program (CALFED or Program) is developing a long-term comprehensive plan to restore the ecological health and improve water management for beneficial uses of the Bay-Delta system.

> The Water Use Efficiency Program will help ensure that California's water supplies are used efficiently and result in multiple benefits. The Program focuses on improvements in local water use management and efficiency in the urban, agricultural, and managed wetlands water use sectors.

The CALFED Bay-Delta Program has made an affirmative commitment to implement a robust, incentive-based Water Use Efficiency Program which will assure that water will be used efficiently in the CALFED Solution Area. The Water Use Efficiency approach integrates State legal requirements and the practical need for local implementation through a combination of technical assistance, incentives, and directed studies for the four WUE program elements: Agricultural, Urban, Water Recycling, and Managed Refuges.

Although details of these elements are currently being refined, implementation is scheduled to begin during 2000. Technical Assistance Programs and directed studies will begin for all four elements in 2000. Partial implementation of the agricultural incentive program will also begin in 2000. The remaining incentive programs will soon follow. Incentive programs will be designed to award CALFED grant funding for projects that demonstrate potential to provide CALFED water supply reliability, water quality, or ecosystem restoration benefits.

The agricultural and urban elements have unique assurance mechanisms. Assurance of high agricultural water use efficiency will be based on a set of agricultural Water Use Efficiency quantifiable objectives. The quantifiable objectives are currently being developed, and will include targeted benefits, measurable indicators, and regional implementation strategies. These quantifiable objectives will be drafted by January 2000 and some of them will be ready for early implementation by the Record of Decision.

Assurance of high urban water use efficiency will be based on a certification process that will provide a rigorous peer review of urban implementation of established Best Management Practices. The certification process is currently being drafted, and will be ready by the Record of Decision.

For the purpose of developing and implementing a Water Use Efficiency Program, CALFED's definition of **efficient water use is the implementation of local water management actions that increase the achievement of CALFED goals and objectives.** This definition encompasses improvements in water timing, quality, and in-stream flows and is therefore broader than traditional definitions of physical efficiency.

This technical document discusses the efforts, estimates, and assumptions of CALFED staff, often working closely with stakeholder interests, in the following areas:

- Development of an implementable water use efficiency component to include:

  —agricultural water use efficiency
  —urban water conservation
  —urban water recycling
  —effective use of managed wetlands water

- Estimation of potential agricultural and urban water savings as a result of implementing the water use efficiency program policies.

- Estimation of potential urban water recycling.

This technical document is organized in sections that correspond to the items outlined above. A summary of potential water savings resulting from urban and agricultural water use efficiency improvements is presented at the end of this section.

1.1 PUBLIC POLICY FOUNDATIONS

California public policy places a strong emphasis on efficient use of developed water supplies. The California Constitution (Article X, Section 2) prohibits "waste or unreasonable use" of water and excludes from water rights any water that is not reasonably required for beneficial use. The constitutional prohibitions of waste and unreasonable use are repeated in Sections 100 and 101 of the California Water Code. The state's process for appropriation of water rights also is based on furtherance of the constitutional policy of reasonable and beneficial use (Cal. Water Code Section 1050). The State Water Resources Control Board (SWRCB) can and does place water conservation conditions on water rights permits that it approves.

California public policy places a strong emphasis on efficient use of developed water supplies and on water recycling. State and federal water projects also are affected by efficiency requirements.

The California Water Code requires all urban water suppliers to prepare and adopt urban water management plans, and requires first consideration be given to demand management measures that offer lower incremental costs than expanded or additional water supplies (Cal. Water Code Section 10610 *et seq.*) The Water Code previously placed planning requirements on agricultural water suppliers, but these provisions have expired as a result of sunset provisions (Cal. Water Code Section 10800 *et seq.*)

State and federal water projects also are affected by efficiency requirements. The Central Valley Project Improvement Act (CVPIA) calls for the development of water conservation criteria "with the purpose of promoting the highest level of water use efficiency reasonably achievable by project contractors." Some State Water Project (SWP) contracts contain conservation requirements, and some water right permits granted to the SWP by the SWRCB contain specific conservation requirements.

Efforts by the SWRCB to place more specific efficiency conditions on water right permits also have led to innovative voluntary efforts. Proposed efficiency requirements in the SWRCB's draft 1988 Water Quality Control Plan (WQCP) for the Bay-Delta prompted efforts that ultimately resulted in the creation of the California Urban Water Conservation Council (CUWCC) and implementation of urban best management practices (BMPs) by many urban agencies. The draft WQCP also prompted the negotiation of the Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California (Agricultural MOU).

California public policy also places a strong emphasis on water recycling. California Water Code Section 461 provides that the public policy of the State requires the maximum re-use of wastewater. California Water Reclamation Law (Cal. Water Code Sections 13500-13556) declares that the people of California have a primary interest in developing water reclamation facilities to meet the State's reliable water needs, and augment existing surface water and groundwater resources. California Water Code Section 13512 declares the intent of the Legislature and the State to undertake steps to encourage development of water reclamation facilities and beneficial reuse of reclaimed water. The Water Recycling Act of 1991 (Cal. Water Code Section 13577) set recycling goals of 700,000 acre-feet (700 TAF) of water annually by 2000 and 1 million acre-feet (MAF) annually by 2010.

Further legislative and regulatory provisions reiterate the general tenets of California Water Reclamation Law, specifically focusing on coastal areas. In coastal zone areas, recycling of treated water that otherwise would have been disposed into the ocean, creates a "new" supply of water for that region. This is recognized legislatively in California Water Code Section 13142.5(e), which urges wastewater treatment agencies located in a coastal zone to reclaim and re-use as much of their treated effluent as is practicable. It is also recognized through regulation by the SWRCB in its 1984 decision "in the matter of the Sierra Club, San Diego Chapter," Order No. WQ 84-7, where the Board held as follows:

In coastal zone areas, recycling of treated water that otherwise would have been disposed into the ocean, creates a "new" supply of water for that region.

In this case and all other cases where an applicant proposes to discharge effluent once-used wastewater into the ocean, the report of the discharge should include an explanation of why the effluent is not being reclaimed for further beneficial uses.

This is consistent with State policy established by the Legislature in California Water Code Section 13142.5(e).

1.2 WATER USE EFFICIENCY IN THE BAY-DELTA SYSTEM TODAY

California's strong public policy emphasis on efficiency and conservation ethic is reflected in many outstanding water use efficiency and conservation efforts throughout the state. California irrigation districts and growers have implemented pioneering methods to manage water supplies and improve efficiency. These methods include automated canal control, flexible water deliveries, new irrigation system technology, drainage reduction techniques, and computerized crop water information. Similarly, urban water suppliers have worked with public interest groups to create the CUWCC, a nationally recognized forum for the successful advancement of understanding and implementation of urban water use efficiency measures.

California irrigation districts and growers have implemented pioneering methods to manage water supplies and improve efficiency.

Two steps can be taken to increase water use efficiency:

1. CALFED agencies must encourage more water users and water suppliers to implement efficient water management practices (EWMPs) that are locally cost effective. Many methods are being used successfully throughout the state to obtain maximum benefits from our water supplies while also providing an economic return for those investing in these technologies.

   However, implementation of locally cost-effective measures have either not been implemented or documented sufficiently. Less than half of California's population is served by urban water retailers that are members of the CUWCC, and slightly more than one-third of the state's agricultural lands are served by irrigation districts that are members of the corresponding AWMC.

2. CALFED will provide funding to tip the local economic scales and foster implementation of practices that are cost effective from a state-wide perspective. Such practices are not cost effective locally (do not provide the water user or district with a return on their efficiency investment) but would provide benefits to the state as a whole that are greater than their cost.

CALFED will provide funding to tip the local economic scales and foster implementation of practices that are cost effective from a state-wide perspective.

CALFED will accomplish these two steps through a series of actions, most notably including agricultural and urban conservation incentive programs that will provide technical assistance and financing to aid adoption of locally cost-effective measures, and grants to foster implementation of measures that are cost effective from a state-wide perspective.

1.3 BASIS FOR A CALFED WATER USE EFFICIENCY PROGRAM

CALFED is addressing problems related to ecosystem health, water quality, water supply reliability, and levee system integrity. The water use efficiency component can contribute to solution of problems in several of these categories. Clearly, water use efficiency can help to achieve the Program's goal for water supply reliability—reduce the mismatch between Bay-Delta water supplies and current and projected beneficial uses dependent on the Bay-Delta system. In addition, changes in local water management, compatible with intended beneficial uses, can help achieve other objectives of the Program, such as improving water quality, reducing diversion effects on fisheries, and benefitting in-stream flows.

During April and May in 1996, a series of public meetings and workshops were held to explain the CALFED Program alternatives under consideration at that time and solicit comments from the public about these alternatives. Citizens from all parts of the state expressed strong support for water use efficiency. There is a strong sentiment that water use efficiency should figure prominently in the CALFED Program and that existing supplies be used efficiently before new storage or improved cross-Delta conveyance are developed. The CALFED Program recognizes and agrees with this view, and believes the Water Use Efficiency Program has been developed to optimize the implementation of feasible and effective efficiency measures.

There is a strong sentiment that water use efficiency should figure prominently in the CALFED Program and that existing supplies be used efficiently before new storage or improved

1.4 SUMMARY OF POTENTIAL WATER CONSERVATION AND RECYCLING

Water use efficiency measures can make additional water supplies available for environmental or consumptive uses and can serve as a useful tool for addressing many of the problems in watershed management. Improvements in water use efficiency are anticipated from a wide range of CALFED programs, not all of which are reflected in this discussion of the Water Use Efficiency Program. As with other program elements, actions and activities undertaken throughout the CALFED Program can result in corollary benefits in other CALFED program areas. For example, CALFED expects to generate water use efficiency incentives through improvements in the water market and through willing-seller water acquisitions for the Ecosystem Restoration Program to augment in-stream flows. In addition, improvements in water quality in the Water Quality Program can assist in meeting water use efficiency goals, by reducing the need for water to meet soil leaching requirements and by enhancing water reclamation opportunities. Similarly, actions taken under the Water Use Efficiency Program are expected to result in ancillary benefits for other CALFED objectives. Reducing unnecessary surface runoff from farms and urban areas can enhance water quality by reducing the discharge of unwanted substances into watercourses. In addition, water use efficiency measures can improve water supply reliability by increasing the number of opportunities available to water managers. Finally, through the planning and implementation of water use efficiency measures, the cost effectiveness of various storage components will become better defined.

Water use efficiency measures can make additional water supplies available for environmental or consumptive uses.

Based on the analyses detailed in Sections 4, 5, and 6 of this document, estimates of potential reduction of water application and losses are summarized in Tables 1-1, 1-2, 1-3, and 1-4. Values provided in the following summary tables represent potential reductions of water application and irrecoverable losses that are most likely to occur for future conditions regardless of the outcome of a CALFED solution (termed the No Action Alternative), as well as the potential incremental savings from a CALFED solution. Representative values shown in this summary table are all midpoints from the ranges detailed in Sections 4, 5, and 6.

The purpose of these tables is to give a perspective of the order of magnitude of the potential effects of water use efficiency improvements both with and without the CALFED solution. **The values presented are not goals or targets**. Rather, they are intended to provide the relative magnitude of potential results of efficiency actions. Actual savings will depend on the magnitude of State, Federal and local investment in water use efficiency measures. Stakeholders disagree on the magnitude and/or the feasibility of achieving these values. Stakeholders do agree, however, that water conservation can provide significant benefits for multiple purposes and therefore is a significant contribution to the CALFED solution. Consistent with a programmatic analysis, specific actions or programs that would need to be implemented to achieve these results have not been specified.

The tables describe three types of potential reductions:

- ***Recovered losses with potential for rerouting flows*** - These losses currently return to the water system, either as groundwater recharge, river accretion, or direct reuse. Reduction in these losses would not increase the overall volume of water but might result in other benefits, such as making water available for irrigation or in-stream flows during dry periods, improving water quality, decreasing diversion impacts, or improving flow between the point of diversion and the point of reentry.
- ***Potential for recovering currently irrecoverable losses*** - These losses currently flow to a salt sink, inaccessible or degraded aquifer, or the atmosphere and are unavailable for reuse. Reduction in these losses would increase the volume of useable water.
- ***Potential reduction of application*** - This is the sum of the previous reductions.

Recovering water that is "lost" to a salt sink, inaccessible or degraded aquifer, or the atmosphere would increase the volume of useable water.

Tables 1-2, 1-3, and 1-4 present more detailed summaries of conservation savings as developed in Sections 4, 5, and 6. Significant local, regional, state, and federal support will be necessary to achieve the expected results.

Table 1-1. Summary of Estimated Conservation and Recycling Potential (TAF)

USE	NO ACTION ALTERNATIVE [1] (IN ABSENCE OF CALFED)			POTENTIAL CALFED INCREMENT			TOTAL CONSERVATION POTENTIAL		
	RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS (A=C-B)	POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES (B)	TOTAL POTENTIAL REDUCTION OF APPLICATION (C)	RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS (A=C-B)	POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES (B)	TOTAL POTENTIAL REDUCTION OF APPLICATION (C)	RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS (A=C-B)	POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES (B)	TOTAL POTENTIAL REDUCTION OF APPLICATION (C)
Urban	397	530	927	355	680	1,035	752	1,210	1,962
Agricultural	2,235	220	2,457	1,676	165	1,841	3,911	385	4,299
Urban recycling	55	455	510	188	567	755	243	1,022	1,265
Total	**2,687**	**1,205**	**3,894**	**2,219**	**1,412**	**3,631**	**4,906**	**2,617**	**7,526**

Note:

Representative values shown are all midpoints in value ranges shown in Tables 1-2, 1-3, and 1-4. See Sections 4, 5, and 6.

[1] No Action Alternative recycling values do not include the existing recycling level of 485 TAF (the March 1998 Water Use Efficiency Technical Appendix inadvertently included the existing values).

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Table 1-2. Summary of Potential Agricultural Water Conservation (TAF)

	NO ACTION ALTERNATIVE (IN ABSENCE OF CALFED)			CALFED INCREMENT (RESULT OF CALFED ACTIONS)			TOTAL CONSERVATION POTENTIAL		
REGION	**RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS**	**POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES**	**TOTAL POTENTIAL REDUCTION OF APPLICATION**	**RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS**	**POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES**	**TOTAL POTENTIAL REDUCTION OF APPLICATION**	**RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS**	**POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES**	**TOTAL POTENTIAL REDUCTION OF APPLICATION**
Sacramento	766-783	0-36	766-819	574-587	0-27	574-614	1,340-1,370	0-63	1,340-1,434
Delta	124-134	0	125-134	93-100	0	93-100	217-234	0	217-234
Westside San Joaquin River	124-128	0-9	124-137	93-96	0-7	93-103	217-224	0-16	217-241
Eastside San Joaquin River	436-463	0-7	436-471	327-347	0-6	327-353	763-810	0-13	764-824
Tulare Lake	685	23-110	708-795	514	17-82	531-596	1,199	40-192	1,239-1,391
San Francisco Bay	4	2-3	7-8	3	2-3	5-6	7	4-6	12-14
Central Coast	3-4	0	3-4	2-3	0	2-3	5-7	0	5-7
South Coast	36	20-31	56-67	27	15-23	42-50	63	35-54	97-117
Colorado River	28	73-126	101-154	21	54-95	75-116	49	127-221	176-270
Total	**2,206-2,265**	**118-322**	**2,326-2,589**	**1,654-1,698**	**88-243**	**1,742-1,941**	**3,860-3,963**	**206-565**	**4,067-4,532**
Mid-Point	**2,235**	**220**	**2,457**	**1,676**	**165**	**1,841**	**3,911**	**385**	**4,299**

Note:

See Section 4 for information on the development of these values.

C-026315

Table 1-3. Summary of Potential Urban Water Conservation (TAF)

REGION	NO ACTION ALTERNATIVE (IN ABSENCE OF CALFED)			CALFED INCREMENT (RESULT OF CALFED ACTIONS)			TOTAL CONSERVATION POTENTIAL		
	RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS (A=C-B)	POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES (B)	TOTAL POTENTIAL REDUCTION OF APPLICATION (C)	RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS (A=C-B)	POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES (B)	TOTAL POTENTIAL REDUCTION OF APPLICATION (C)	RECOVERED LOSSES WITH POTENTIAL FOR REROUTING FLOWS (A=C-B)	POTENTIAL FOR RECOVERING CURRENTLY IRRECOVERABLE LOSSES (B)	TOTAL POTENTIAL REDUCTION OF APPLICATION (C)
Sacramento	140-156	5-9	145-165	81-96	4-9	85-105	221-272	9-18	230-270
Eastside San Joaquin River	87-103	3-7	90-110	89-104	6-11	95-115	176-207	9-18	185-225
Tulare Lake	40-45	15-30	55-75	50-55	30-45	80-100	90-100	45-75	135-175
San Francisco Bay	10	65-80	75-90	10	120-140	130-150	20	185-220	205-240
Central Coast	0	20-40	20-40	0	30-50	30-50	0	50-90	50-90
South Coast	70-75	340-385	410-460	75-80	400-445	480-520	150	740-830	890-980
Colorado River	30	20-40	50-70	30	25-45	55-75	60-70	45-85	105-145
Total	**375-420**	**470-590**	**845-1,010**	**335-375**	**615-745**	**955-1,115**	**715-790**	**1,085-1,335**	**1,800-2,125**
Mid-Point	397	530	927	355	680	1,035	752	1,210	1,962

Note:

See Section 5 for information on the development of these values.

C-026315

Table 1-4. Summary of Potential Urban Water Recycling (TAF)

REGION	NO ACTION ALTERNATIVE[1] (IN ABSENCE OF CALFED)		CALFED INCREMENT (RESULT OF CALFED ACTIONS)		TOTAL CONSERVATION POTENTIAL	
	CONSERVATION POTENTIAL	IRRECOVERABLE LOSS SAVINGS	CONSERVATION POTENTIAL	IRRECOVERABLE LOSS SAVINGS	CONSERVATION POTENTIAL	IRRECOVERABLE LOSS SAVINGS
San Francisco Bay	53	48	50-170	40-130	103-223	88-178
Central Coast	35	33	30-70	20-50	65-105	53-83
South Coast	392	349	350-810	260-610	742-1,202	609-959
Total	**510[1]**	**455[1]**	**460-1,050**	**345-790**	**970-1,560[1]**	**800-1,245[1]**
Mid-Point			**755**	**567**	**1,265**	**1,022**

Note:

See Section 6 for information on the development of these values.

These values do not include the existing 485 TAF of water recycling (the March 1998 Water Use Efficiency Technical Appendix inadvertently included the existing values).

[1] The three hydrologic values do not add up to the total because of recycling that is expected to occur in other regions (see Table 6-2)

1.5 VARIATION IN CONSERVATION ESTIMATES

The estimates of conservation potential contained in this document are not the only estimates issued by CALFED agencies. In November 1998, DWR released the California Water Plan, Bulletin 160-98. The public review draft, published in January 1998, received substantial review. The final report reflects comments from reviewers as well as refinements made by DWR. Bulletin 160 presents DWR's estimates of reductions in water demand (depletion reductions) that may occur from the implementation of various demand management measures, including urban and agricultural water conservation and urban water recycling. The estimates prepared by DWR and CALFED will not be identical, because they are prepared for different planning purposes and they examine different scenarios of the future.

The Bulletin 160 series is a framework document designed to assist with water resources decisions. Baseline estimates of future conservation savings are prudently conservative so that the future gap between supply and demand is not underestimated. Additional options for potential future conservation savings, which may be more difficult to achieve, also are presented.

For purposes of comparison to CALFED's conservation estimates, Table 1-5 presents conservation and recycling estimates published in DWR's Bulletin 160-98. **The Bulletin 160-98 options (right-hand set of columns) are comparable to CALFED's No Action Alternative conservation estimates.**

As can be seen in Table 1-5, the Bulletin 160-98 depletion reduction estimates are similar to the CALFED No Action Alternative irrecoverable loss savings (under CALFED's definition, depletion reductions are the same as currently irrecoverable loss reductions). For instance, anticipated agricultural conservation savings estimated by CALFED are between 132 and 324 TAF. Bulletin 160-98's option estimates this savings at 230 TAF.

Table 1-5. Summary of DWR's Bulletin 160-98 Projected Depletion Reductions (TAF)

	DWR ASSUMED BASELINE CONSERVATION SAVINGS[1]		BULLETIN 160-98 IMPLEMENTED OPTIONS[2]	
USE	CONSERVATION POTENTIAL	IRRECOVERABLE LOSS SAVINGS	CONSERVATION POTENTIAL	IRRECOVERABLE LOSS SAVINGS
Urban	1,514	868	n/a	930
Agricultural	797	233	n/a	230
Urban recycling	577[3]	407[3]	835	655
Total	**2,888**	**1,508**	**n/a**	**1,815**

Note: Values are from DWR's November 1998 California Water Plan, Bulletin 160-98.

[1] These savings are anticipated to occur by 2020 as a result of implementing urban best management practices and agricultural EWMPs.

[2] These values represent various urban and agricultural options that could be implemented to improve water use beyond levels expected in the baseline. The values are comparable to the CALFED No Action Alternative estimate but contain savings in regions outside the CALFED geographic scope and overlap with some of the urban conservation actions expected by CALFED to occur as a result of CALFED actions, not only No Action Alternative conditions (this is discussed in more detail in the main text).

[3] The bulletin's "base" is lower than that assumed for CALFED (see Section 6).

The CALFED conservation estimates do vary from those of the bulletin because of three factors:

- The bulletin value includes areas outside the CALFED geographic scope, such as the North Coast and North Lahontan Regions.
- The Bulletin value includes options that overlap with measures assumed by CALFED not to occur under the No Action Alternative (such as greater landscape savings and lower indoor per-capita water use rates).
- CALFED's No Action Alternative recycling values include a portion of the baseline recycling anticipated to occur between now and 2020 as a result of the "build out" of existing recycling facilities. (The Bulletin considers all recycling expected by 2020 in the baseline— this includes 90 TAF of recycling projects that have yet to be brought into full production as existing projects continue to ramp up their recycled water production.)

As an example of overlap conditions, CALFED assumes that CII savings assumed by the bulletin are actually split between being implemented under No Action Alternative conditions and as a result of CALFED actions. Additionally, CALFED assumes indoor residential water use to reach only 60 gallons per capita daily (gpcd) under the No Action Alternative condition, whereas Bulletin 160-98 options assumes that this amount could drop to 55 gpcd. Again, CALFED assumes that this lower use rate occurs only as a result of the CALFED Program. When adjustments are made for the overlaps, the bulletin's estimates of conservation potential more closely match the CALFED No Action Alternative conditions.

When adjusting CALFED's No Action Alternative water recycling estimate for inclusion of the portion of the "base" water recycling yet to occur, the CALFED and Bulletin 160-98 levels compare favorably. (CALFED's estimate is 130 TAF higher than the bulletin's option—approximately the amount included in the bulletin's baseline value that is not existing).

The CALFED Program further anticipates conservation and recycling savings to increase beyond the estimates discussed in Bulletin 160-98 as a result of the CALFED Program. This is illustrated when the **option** values in Table 1-5 are compared to the **totals** in Table 1-1. CALFED has assumed that more than 1.4 MAF of additional reduction in irrecoverable losses, beyond the No Action Alternative conditions, could occur as a result of a successful CALFED Bay-Delta solution.

2. Water Use Efficiency Program Description

2. Water Use Efficiency Program Description

The CALFED Water Use Efficiency Program is one of the cornerstones of CALFED's water management strategy. The CALFED policy toward water use efficiency is a reflection of the State's legal requirements for reasonable and beneficial use of water: existing water supplies must be used efficiently, and any new water supplies that are developed by the Program must be used efficiently as well.

Efficiency has several definitions. A traditional definition of physical efficiency is the ratio of water consumed to water applied. Efficiency also can be defined in economic terms: deriving the greatest economic output from a given input (such as a unit of water). For the purpose of developing and implementing a Water Use Efficiency Program, CALFED has defined efficiency more broadly: **The Water Use Efficiency Program will assure high efficiency through programs that benefit local water users, districts, regions and the state.** This includes all benefits that are cost-effective at the state-wide level.

2.1 PROGRAM OBJECTIVES

The ultimate goal of the CALFED Water Use Efficiency Program is to develop a set of programs and assurances that contributes to CALFED goals and objectives, has broad stakeholder acceptance, fosters efficient water use, and helps support a sustainable economy and ecosystem.

The Water Use Efficiency Program also must adhere to CALFED's solution principles, which include:

- Reduce conflicts in the system
- Be equitable
- Be affordable
- Be durable
- Be implementable
- Pose no significant redirected impacts

To achieve these fundamental goals, the Water Use Efficiency Program has the following objectives:

- ***Reduce existing irrecoverable losses*** - By reducing losses currently unavailable for reuse (because they flow to a salt sink, inaccessible or degraded aquifer, or the atmosphere), CALFED will increase the overall volume of useable water.

- ***Achieve multiple benefits*** - By reducing losses that currently return to the water system (either as groundwater recharge, river accretion, or direct reuse) CALFED can achieve multiple benefits, such as making water available for irrigation or in-stream flows during dry periods, improving water quality, decreasing diversion impacts, and improving flow between the point of diversion and the point of reentry.

- ***Preserve local flexibility*** - Stakeholders have stressed the advantages of maintaining the flexibility of implementing water use management and efficiency improvements at the local level while exploring regional programs to maximize benefits. Past water conservation and water recycling programs have demonstrated that local water users and suppliers can access virtually unlimited creativity and ingenuity in improving water use efficiency. CALFED's approach provides necessary assurances of improved efficiency while maintaining the flexibility to tailor implementation to local conditions.

- ***Use incentive-based actions over regulatory actions*** - CALFED's approach to water use efficiency emphasizes incentives to encourage efficient use. Principal incentives include planning, technical, and financing assistance to local water users and suppliers. Existing regulatory processes provide necessary assurances of efficient use as well as mitigation for third-party impacts that may result from incentive-based approaches.

- ***Build on existing water use efficiency programs*** - Several existing efforts are striving to increase water use efficiency. The California Urban Water Conservation Council and Agricultural Water Management Council are stakeholder organizations devoted to urban and agricultural water management, respectively. Similarly, CALFED agencies, such as DWR, Reclamation, and the National Resource Conservation Service, have ongoing water management programs. SWRCB, DWR, and Reclamation also have ongoing water recycling programs. CALFED will enhance rather than attempt to recreate the positive momentum established by these existing programs.

- ***Provide assurance of high water use efficiency*** - Water Use Efficiency assurances are structured to ensure that urban and agricultural water users and suppliers implement appropriate efficiency measures (please refer to section 2.3.2 for a more complete discussion). These assurances include limiting access to CALFED benefits and conditions on new storage facilities. Additional consequences of inadequate water use efficiency are being considered through the urban certification process (Section 2.2.2) and the Agricultural Strategic Plan (Section 2.2.1).

2.2 PROGRAM APPROACH

The physical scope of Water Use Efficiency Program actions is limited to improvements that can affect Bay-Delta water supplies (surface and subsurface) from points of local diversion for beneficial use to points of local return to the receiving water. This scope focuses on opportunities that can be implemented at the local water supplier and end-user level. For example, changing the timing of diversion, reducing demand through conservation and recycling, or improving the quality of a return flow are actions related to beneficial use of local diversions and can be implemented at the local, regional and end-user levels.

The Water Use Efficiency Program addresses four categories: urban, agricultural, and managed wetlands (for example, wildlife refuges) efficiency and water recycling. The first three elements correspond to traditional water use sectors of urban, agriculture, and the environment. Some differences in the water use efficiency approach for each sector may be appropriate because of differences in water rights, methods of water use, and potential for reuse. Water recycling will be treated separately because water recycling traditionally has been approached separately from water conservation, and often is the responsibility of different agencies.

WATER USE EFFICIENCY:
THINK GLOBALLY, ACT LOCALLY

The Water Use Efficiency Program is based on the recognition that although efficiency measures are implemented locally and regionally, the benefits of water use efficiency accrue at local, regional, and state-wide levels. The role of CALFED agencies in water use efficiency will be to offer support and incentives through expanded programs that will provide planning, technical, and financial assistance. CALFED agencies also will support institutional arrangements that give local water suppliers an opportunity to demonstrate their implementation of cost-effective efficiency measures. Some potential water use efficiency benefits, such as water quality improvements, may be regional or statewide rather than local. In these situations, CALFED planning and cost-share support may be particularly effective.

2.2.1 AGRICULTURAL WATER USE EFFICIENCY APPROACH

In the agricultural sector, the nature and extent of benefits from improvements in local water use management and efficiency differ from the perspective of a field, farm, irrigation district, or basin. As we broaden our perspective to include environmental and water quality benefits, additional measures become feasible. The CALFED agricultural water use efficiency approach is designed to identify diverse opportunities for local water management and efficiency improvements, and increase the benefits that can be derived from a unit of water. The program will look to water management techniques that increase the effectiveness of water use management and efficiency at the field, farm, district, and basin level where these are appropriate.

The 3/16/98 Draft Programmatic EIS/EIR proposed that an existing group, the AWMC that was established pursuant to Assembly Bill (AB) 3616, play a pivotal role in ensuring efficient water use in the agricultural sector. Concerns from environmental representatives about this proposal, and concerns from virtually all other sectors about the general approach to agricultural water use efficiency, led to the formation of (1) a stakeholder-agency advisory focus group to evaluate and propose improvements to the program; (2) a scientific review panel to review the technical basis for the program and proposals included in the Programmatic EIS/EIR; and (3) Agricultural Water Use Efficiency Steering Committee to provide advice through the Strategic Plan. The focus group met several times in late 1998. CALFED has incorporated many of the focus group's recommendations into the Revised Draft Programmatic EIS/EIR (although this document does not necessarily reflect the views of all focus group members). Before the CALFED Revised Draft Programmatic EIS/EIR is finalized, CALFED will incorporate comments received from these three groups, as well as from the public, and will proceed with program refinement in an open public process.

The agricultural component of the Water Use Efficiency Program is structured around four broad elements. These mutually supporting elements are presented below as a package:

1. ***Incentives*** - CALFED is developing, in consultation with the AWMC, a program of technical and financial incentives for the implementation of water use efficiency measures in the agricultural sector.

   CALFED will provide technical assistance and financial incentives in the form of loans for actions or activities that have been identified as cost effective for local water suppliers in water management plans approved by the AWMC. The AWMC was created by the Agricultural MOU, an agreement between signatory agricultural water suppliers and signatory environmental organizations. It was developed by an advisory committee formed pursuant to State legislation in 1990. The AWMC is sometimes referred to as the "AB 3616 committee" as a reference to the original, enabling legislation. The Agricultural MOU is a commitment by signatory water suppliers to prepare and implement water management plans. The AWMC will review and either endorse or withhold endorsement of each water management plan. Signatory water suppliers also agree to submit annual implementation progress reports to the AWMC.

   The MOU calls for water suppliers to implement certain Efficient Water Management Practices (EWMPs), and to evaluate other EWMPs according to a specified analysis method, implementing those found to be feasible and cost-effective from the suppliers perspective.

   In addition to technical assistance, CALFED will provide financial incentives in the form of grants for water use efficiency measures that are cost-effective at the state-wide level, but not cost-effective locally. These additional agricultural water management measures will help CALFED achieve multiple benefits related to water quality, timing, and in-stream flows, as well as reducing irrecoverable losses. The planning process in the Agricultural MOU includes a net benefit analysis which, among other things, will help suppliers identify measures that provide environmental benefits. The ongoing Agricultural Water Use Efficiency strategic planning process is identifying additional opportunities for agricultural water management that will provide environmental benefits.

   Many of these "extra" benefits (beyond those expected through AWMC efforts) will not be locally cost-effective and, as such, will be funded through CALFED grants.

2. ***A locally tailored program that incorporates the work of the AWMC*** - As stated above, the agricultural water use efficiency strategic planning process will incorporate the work of the AWMC to foster locally cost-effective measures and seek to identify additional appropriate water management measures. Locally tailored programs are effective because they build on the experience and creativity of individuals who are most familiar with local conditions.

3. ***Quantifiable objectives*** - Quantifiable objectives are objectives for improvements in water management that can be measured or otherwise tracked to ensure that such improvements occur. Quantifiable objectives will include outcome indicators based on actual water use. Quantifiable objectives must be related to the following four agricultural water use objectives: (1) manage rerouted flows; (2) alter applied water patterns; (3) reduce irrecoverable losses; and (4) reduce shortage impacts. These agricultural water use objectives are linked to CALFED's goals and Solution Principles. Quantifiable objectives are expected to vary by region and will be developed prior to the Record of Decision (ROD).

4. *Assurances* - The assurance mechanisms are structured to ensure that water users implement appropriate efficiency measures. Please refer to Section 2.3.2, "Assurances," later in this section.

Before finalizing the CALFED Program, CALFED will complete the Strategic Plan for Agricultural Water User Efficiency. The purpose of the plan is to articulate a prioritized, strategic, aggressive program for the achievement of efficient water management for all purposes throughout the many different agricultural regions of the state. The plan will focus in detail on specified regions, basins, and districts on a prioritized basis.

The plan is currently being prepared, under staff direction, by a multi-disciplinary technical team which includes water conservation, water quality, aquatic biology, irrigation engineering, local operations expertise, and other regional representatives. This team composition was designed to provide the needed technical expertise and linkage to readily available data and local conditions.

On a region-by-region basis, the technical team will determine the following components which are consistent with the Agricultural Water Use Efficiency Objectives:

- Targeted Benefits: Targeted benefits define qualitatively the intended changes in conditions. These changes recognize potential gains at both the CALFED and local levels.

- Quantifiable Objectives: Quantifiable objectives articulate the specific outcome that must be achieved to produce a targeted benefit. These objectives are to be expressed in a quantifiable form.

- Targeted Flow Path change: A flow path defines or describes the route by which water flows. A targeted flow path change identifies the specific routes which, if redirected, would contribute to the achievement of a quantifiable objective.

- Performance Indicator: An indicator is a parameter that measures progress towards the achievement of quantifiable objectives. Indicators are quantifiable, whenever possible. In some cases, performance indicators may be expressed identically to quantifiable objectives.

- Regional Implementation Strategy: A regional implementation strategy identifies a set of specific actions a regional entity will take to achieve the stated quantifiable objectives. In this case, a regional entity may be an individual actor (associations and groups, irrigation districts, water agencies, RCDs and counties) or a consortium of actors. The regional implementation strategy includes a research and evaluation component.

- Monitoring and Performance Assessment: This action describes the steps that will be taken to monitor and assess its progress towards achieving stated quantifiable objectives through the regional implementation strategy. The results of the performance assessment will be expressed in a concise report made available to CALFED and the region.

- Refinement and Revision: In this action, the results of the Monitoring and Performance Assessment will be considered and used to propose changes to quantifiable objectives, targeted flow path change, indicators and regional implementation strategy. The revision process may also lead to changes in the process of monitoring and performance assessment.

The strategic plan is currently being developed through a facilitated process that includes CALFED agencies, AWMC stakeholders, and the technical team. The strategic plan is scheduled for completion in early 2000.

2.2.2 URBAN WATER USE EFFICIENCY APPROACH

The urban areas of California use over 7 MAF of water each year. Water diverted from the Bay-Delta system currently satisfies much of this demand. Expanding urban populations will create additional needs for reliable water supplies, and will place added pressure on the Bay-Delta system. Through a variety of programs CALFED will help urban areas meet growing water demands while ensuring Bay-Delta ecosystem integrity. Increasing water use efficiency in urban areas will be a fundamental part of this effort.

Urban areas have already made significant advancement towards water use efficiency goals under the 1991 Memorandum of Understanding Regarding Urban Water Conservation in California (Urban MOU). However, the rate and extent of this progress appears to be below its full potential. The CALFED Program will extend the progress already made by (1) providing financial and technical support for urban water use efficiency programs and (2) instituting a process to certify water supplier compliance with the Urban MOU.
In the first public draft of the Water Use Efficiency Program Plan, CALFED proposed that the requirements of the Urban MOU constituted appropriate demonstration that urban water suppliers had considered urban water conservation measures. Water suppliers signing the Urban MOU agree to develop and implement comprehensive conservation Best Management Practices (BMPs) using sound economic criteria. The Urban MOU identifies 14 water conservation Best Management Practices (BMPs) that urban water supplier signatories agree to implement over ten years if locally cost-effective. CALFED proposed that the organization created by the Urban MOU to oversee implementation of the BMPs, the California Urban Water Conservation Council (CUWCC), certify water suppliers' compliance with the terms of the MOU.

CUWCC membership is divided into two voting groups and one non-voting group -- urban water suppliers and environmental interest groups comprise the two voting groups and other interested parties comprise the third, non-voting group. Membership requirements for each group are contained in the CUWCC's bylaws. Since 1991 more than 150 urban water suppliers across California, serving over 75% of the state's population, have signed the Urban MOU. The Department of Water Resources, United States Bureau of Reclamation, State Water Resources Control Board, and California Public Utilities Commission are all signatories to the Urban MOU.

The CUWCC's organizational and decision-making structure is uniquely suited to advance consensus agreements regarding urban water use efficiency between a diverse set of stakeholders. To be adopted, CUWCC decisions require majority approval by each voting group. This requirement has fostered a culture of discussion and compromise within the CUWCC, and has opened important channels of communication between interest groups with competing interests. Indeed, the formal mission of the CUWCC is to increase efficient water use statewide through partnerships among urban water agencies, public interest organizations, and private entities, and to integrate urban water conservation Best Management Practices into the planning and management of California's water resources. Towards this end, the CUWCC has been a highly effective and dynamic organization. The CUWCC is actively preparing for its potential certification role. In the previous year it has increased its staffing and budget levels, adopted a three-year strategic plan anticipating certification, and hired a full-time executive director. CALFED is supporting this effort through financial and staff assistance, pilot projects, and research funding.

Urban MOU certification would formalize the MOU process by requiring suitable demonstration that either BMP implementation is on schedule per the Urban MOU, or the BMP is not locally cost-effective to implement. Access to certain CALFED benefits would be made contingent upon certification of a supplier's compliance with the Urban MOU. The CALFED draft proposal closely follows earlier proposals put forward by stakeholders, as well as input received from public workshops, comments on the draft EIS/EIR, and an informal environmental and urban water supplier workgroup about the participation criteria, administrative structure, and requirements for certification of MOU compliance.

Many urban water suppliers working on the urban water conservation certification frameworks have, from the outset, stated that their support for any urban conservation measures beyond those contained in the urban MOU is conditional on the adoption of a mutually acceptable CALFED solution. Environmental stakeholders, on the other hand, view certification as an important assurance to an overall CALFED solution.

Except where noted, stakeholders working with CALFED on Urban MOU certification generally agree on the following certification proposal features:
Water Supplier Participation. The certification program will apply only to urban water suppliers directly or indirectly deriving supply from the Bay-Delta system. Certification will apply only to urban water suppliers with 3,000 or more connections, or delivering 3,000 or more acre-feet annually. Discussion regarding what constitutes a hydrologic connection to the Bay-Delta system is on-going. This issue will require resolution prior to implementation of any Urban MOU certification proposal.

Certification Reviews. Review of certification status would occur not less than every two years for wholesale water suppliers and retail water suppliers with more than 10,000 connections and not less than every five years for retail water suppliers with between 3,000 and 10,000 connections. Noncompliance review findings could result in more frequent reviews. Conversely, sustained compliance could result in less frequent reviews.

MOU Compliance Standard. Water suppliers implementing all cost-effective BMPs in accordance with Exhibit 1 of the MOU, and substantiating any BMP exemptions in accordance with Exhibit 3 and Sections 4.4 to 4.6 of the MOU will receive certification. CALFED is currently working with the CUWCC and interested stakeholders to put in place formal review processes and administrative structures.

Environmental Costs and Benefits. Per Exhibit 3 of the MOU, compliance would require cost-effectiveness exemptions to address and quantify environmental costs and benefits for the Total and Water Supplier cost-effectiveness tests. However, certification decisions could not be challenged on the basis of these valuations unless the CUWCC or CALFED developed agreed-to methods for quantifying or creating proxy values for environmental benefits and costs. If the CUWCC has not adopted agreed-to methods within the first five years of the program, then the CALFED Commission or its equivalent will develop and adopt such methods and standards for the reasonable consideration and quantification of environmental and other non-market costs and benefits as it deems necessary for the purposes of the Urban MOU by the end of the sixth program year. Through its strategic planning process the CUWCC has assigned a high-priority to developing credible methods and tools for estimating costs and benefits within the next three years.

CVPIA Compliance. Currently, CALFED is proposing that urban CVP contractors with approved CVPIA conservation plan updates would receive MOU certification without undergoing CUWCC review. CALFED, USBR, and the CUWCC would need to work to ensure the consistency of MOU and CVPIA urban water use efficiency standards and review requirements. Some urban and environmental stakeholders have expressed concern that this provision is likely to result in qualitatively different review standards between CVP and non-CVP urban suppliers, and are recommending that CVP contractors should undergo CUWCC review.

BMP Implementation Variances. Compliance would not require all water suppliers to adopt a single implementation method for a BMP. The "At Least As Effective As" provisions of Exhibit 1 to the Urban MOU recognize that "it is likely that as the [MOU] process moves forward, water suppliers will find new implementation methods even more effective than those described [in Exhibit 1]. Any implementation method used should be at least as effective as the methods described [in Exhibit 1]." Water suppliers using methods to implement one or more BMPs different from the methods described in Exhibit 1 would be able to obtain pre-approval of the methods from the CUWCC, though this would not be required. Not obtaining pre-approval, however, would risk a negative "at least as effective as" finding during compliance review. The CUWCC is currently developing a pre-approval procedure.

Certification Decision-Making. The CALFED proposal recommends a nine member peer-review committee supported by CUWCC technical staff to make certification decisions. CUWCC membership is divided into three groups. Group 1 consists of urban water suppliers. Group 2 consists of environmental interest groups. Group 3 includes all other signatories. Only Groups 1 and 2 signatories can vote within the CUWCC. The Compliance Review Committee CALFED is proposing would consist of three Group 1 representatives (and three alternates), three Group 2 representatives (and three alternates), and three members-at-large (and three alternates). The respective memberships of Groups 1 and 2 would elect Group 1 and 2 committee members and alternates. The Group 1 and 2 committee members would then select representatives and alternates for the members-at-large positions. DWR, USBR, and SWRCB would each appoint one ex-officio, non-voting member to the committee. Committee members would serve two-year terms. This proposed structure differs markedly from one of the earlier stakeholder proposals, which recommended a state legislative orgubernatorial appointment process. The merits of both approaches are still under discussion.

Appealing Certification Decisions. CALFED is proposing a *de novo* appeals process that would allow water suppliers and Group 2 MOU signatories to appeal MOU compliance decisions made by the CUWCC. The appeals process would be administered outside of the CUWCC by a designated CALFED agency. Appeals would be required to meet specific criteria demonstrating either that relevant data, required by the MOU, that would have altered the certification outcome were not considered or were incorrectly interpreted, or certification review and decision-making protocols were not followed. Additional conditions to prevent opportunistic or strategic appeals will also be developed. *Water Supplier Compliance Designations.* Water suppliers complying with the MOU will receive a designation of Full Certification. A water supplier's designation will change from Full Certification to Conditional Certification following a first finding of non-compliance. This designation will last for 12 months. To change its designation back to Full Certification a water supplier must either (1) return to compliance or (2) adopt an CUWCC-approved compliance plan within 12 months. Failing to meet one or the other of these conditions will result in a change in designation from Conditional Certification to Suspended Certification. This designation will last for 6 months. To change its designation back to Conditional Certification a water supplier must either (1) return to compliance or (2) adopt an CUWCC-approved compliance plan within 6 months. Periods of suspension will be extended by six months following each review until the supplier returns to compliance or adopts an approved compliance plan.

Compliance Rewards. CALFED will propose rewards for continuous compliance with the MOU. These rewards may include (1) less frequent reviews, (2) preferential State Drought Bank access or terms, and (3) preferential access to or terms for water supply/treatment grants and loans. Discussion of appropriate incentive structures is on-going.

Noncompliance Penalties. CALFED will implement a set of noncompliance penalties to deter persistent noncompliance with the MOU. Water suppliers out of compliance with the MOU for 18 months or longer would be subject to noncompliance penalties. CALFED is proposing three levels of noncompliance penalties. The magnitude of the penalty will increase with each level. The first level, entailing public disclosure and a modest fine, would follow a change in designation from Conditional Certification to Suspended Certification. The second level, entailing public disclosure and a moderate fine, would follow two continuous Suspended Certification designations. The third level, entailing public disclosure, a substantial fine and restricted access to CALFED water supply benefits, would follow three or more continuous Suspended Certification designations. In determining the amount of the monetary penalty imposed for each enforcement level, the designated CALFED agency would consider the nature, circumstances, extent, and gravity of the violation, and, with respect to the violator, any prior history of violations, and the degree of culpability, economic benefits or savings resulting from the violation. Funds collected from monetary penalties for noncompliance would be reinvested in urban conservation financial assistance programs administered by the WUE program. The designated enforcement agency may allow a water supplier to reduce the monetary penalties described by up to 100 percent by undertaking a supplemental water conservation project or investment in accordance with the Urban MOU and any applicable guidance documents. Discussion of the level and structure of monetary penalties and application of water-based sanctions is on-going.

Tier 1 Wholesaler Requirements: CALFED will support state legislation requiring Tier 1 Water Wholesalers to pass through water supply penalties targeted at individual retail agencies facing level three enforcement actions. [Note: Tier 1 wholesalers are wholesale water suppliers that receive water either directly from the Bay-Delta system or directly from the CVP or SWP.] CALFED will structure the certification program to ensure that regional water supply reliability cannot be jeopardized by the actions of individual retail water suppliers within a regional supply system. The CALFED certification document will also formalize current Tier 1 conservation efforts and request comparable efforts in the future.

In addition to an assurance mechanism focused on participation in the Urban MOU, CALFED will work to ensure that more urban suppliers comply with another water planning effort -- the Urban Water Management Planning Act (California Water Code Section 10610 et seq.). The State's Urban Water Management Planning Act requires urban water suppliers to prepare and adopt urban water management plans and update them every 5 years. Although efforts by several urban water suppliers have been adequate to meet general requirements under the Act, many suppliers fail to adequately address local water management issues or even to produce a complete plan. To improve the levels of compliance, CALFED will work with DWR in expanding DWR's plan evaluation efforts to include a certification process.

[DWR has expressed concern about certifying plans. DWR believes that its role as provider of assistance may be incompatible with a role as a certification entity. Given these concerns, another agency, such as the SWRCB, may need to certify urban water management plans.]

Existing DWR efforts to assist urban water suppliers with preparation and implementation of urban water management plans are expected to continue. However, CALFED will help expand DWR's efforts as necessary to ensure that lack of technical support does not impede preparation and implementation of effective plans.

CALFED will also work with the CUWCC, DWR, and USBR to develop effective technical support and financial incentive programs for local urban water suppliers. The intent of these programs will be to foster the highest possible level of conservation practices (above the MOU-specified level) implementation by providing technical and financial support to those programs that promise to provide the greatest CALFED benefits.

2.2.3 MANAGED WETLANDS WATER APPROACH

In addition to the broad categories of urban and agricultural water needs, there are important environmental needs for adequate water supplies. These needs include appropriate in-stream flows, where water is the environment that supports aquatic species and processes, as well as needs for water diverted from the system to support a variety of public and private wetland areas such as national wildlife refuges and state wildlife areas. CALFED is examining both in-stream environmental water use and water diverted for environmental purposes. The in-stream environment is being addressed by the Program's Ecosystem Restoration Program, while policies related to efficient use of environmental diversions on managed wetlands are being examined in the context of the Water Use Efficiency Program.

Three CALFED agencies (the California Department of Fish and Game [DFG], Reclamation, and the U.S. Fish and Wildlife Service [USFWS]) have been working with the Grassland Resource Conservation District to develop an Interagency Coordinated Program for optimum water use planning for wetlands of the Central Valley. A task force representing these entities has recommended a program that includes EWMPs for refuges and wetland areas of the valley. The task force report is now being reviewed by the sponsoring agencies. CALFED's approach to diverted water efficiency will hinge on finalizing and implementing the Interagency Coordinated Program.

2.2.4 WATER RECYCLING APPROACH

Water recycling provides a safe, reliable and locally controlled water supply. Tertiary treated, disinfected recycled water is permitted for all non-potable uses in California through Title 22, Division 4, Chapter 3 of the California Code of Regulations. Moreover, under specific conditions, advanced treated recycled water can be used to augment groundwater or surface drinking water sources. Advanced treated recycled water is presently under consideration for regulation in groundwater applications.

Recycled water supplies are projected to grow. In 1995, DWR conducted a "Survey of Water Recycling Potential" to help identify and quantify recycling plans. The survey identified actual recycling of over 450 TAF annually and projected recycling of 1.49 MAF annually by 2020. The WateReuse Association of California, in its 1993 Survey of Water Recycling Potential, estimated the total wastewater flow to the ocean and other saline water bodies to be 3 MAF.

Despite the potential supply available for recycling, local agency implementation of water recycling projects typically has fallen short of plans. For example, although the WateReuse Association's 1993 survey reported local agency plans to reuse over 650 TAF of recycled water by 1995, the DWR survey reported total reuse of only over 450 TAF. CALFED's approach to water recycling is to identify and resolve barriers that have prevented local entities from implementing recycled water projects. Where appropriate, attention will be focused on overcoming technical and public perception barriers to water recycling.

The approach to water recycling will include water recycling feasibility planning as part of the urban conservation certification effort (see Section 2.2.2, "Urban Water Use Efficiency Approach" above). Presently, all urban water agencies that are required to prepare Urban Water Management Plans under California Water Code Section 10610 *et seq.* also must prepare a water recycling feasibility plan as part of the process (Cal. Water Code Section 10633). CALFED will help urban water suppliers comply with these regulations by assisting local and regional agencies with preparation of water recycling feasibility plans (that meet the requirements of the Urban Water Management Planning Act).

Assistance with feasibility planning will include providing a guidebook and evaluation-decision software to help local and regional agencies more easily and uniformly assess the economic feasibility of water recycling projects and develop a financing plan. In addition, CALFED agencies will make staff available for further feasibility planning assistance and will provide in-kind technical and planning services to regional-scale projects, such as the Bay Area Regional Water Recycling Program and the Southern California Comprehensive Water Reclamation and Reuse Study. (See "6.3.1 Regional Water Recycling Studies.")

CALFED will also work with local and regional agencies and other stakeholders on a best management practice for water recycling that would apply to water suppliers and wastewater utilities. Moreover, CALFED feasibility planning assistance will include identifying and encouraging opportunities for water suppliers and wastewater utilities to partner in regional projects that provide opportunities to: transfer recycled water from areas of excess supply to areas of excess demand, identify regional seasonal storage opportunities, and regional brine line feasibility.

In addition to feasibility planning assistance, CALFED will provide financial incentives to encourage local and regional recycling projects that reduce demand for diversions from the Bay-Delta system, provide regional supply reliability benefits, and improve the water quality of return flows or enhance wetlands. SWRCB, DWR, and Reclamation have programs that fund recycled water projects. These programs will continue. However, to augment existing programs and help assure California achieves water recycling potential, CALFED will work with a focus group to develop an incentive program that more closely fits the objectives and time line of CALFED Stage 1 actions. CALFED will work with representatives from the WateReuse Association, CUWA, CUWCC, and the Environmental Water Caucus to investigate alternative approaches for providing financial assistance and develop a CALFED water recycling incentive program. A few local water agencies have developed processes for providing financial support for recycled water projects in their service areas, and one or a combination of these processes (setting a standard unit rate of payment based on avoided costs, holding a bidding process similar to that used by electric utilities, or administering targeted grants/loans) may be practicable from a statewide perspective. The focus group will assist CALFED with developing a process CALFED can implement efficiently and effectively. The CALFED water recycling incentive program will then be implemented during the first year of Stage 1.

2.3 IMPLEMENTATION

2.3.1 STAGE 1 ACTIONS

The CALFED water use efficiency element is designed to accelerate the implementation of cost-effective actions to conserve and recycle water throughout the State in order to increase water supplies available for beneficial uses. The major components of the program are: 1) support ongoing urban and agricultural sector processes for certifying and endorsing local agency implementation of cost-effective efficiency measures; 2) provide technical and planning assistance to local agencies and districts developing and implementing water use efficiency measures; and 3) institute a competitive grant/loan incentive program to encourage water use efficiency investments in the urban and agricultural sectors.

- Expand Existing State and Federal Agricultural Water Conservation Programs to Support On Farm and District Efforts - Expand State and Federal programs (DWR, USBR, USFWS, DFG, DHS, NRCS, and SWRCB) to provide technical and planning assistance to local agencies and districts in support of local and regional conservation and recycling programs.

- Expand Existing State and Federal Conservation Programs to Support Urban Water Purveyor Efforts - Expand State and Federal programs (DWR, USBR, USFWS, DFG, DHS, and SWRCB) to provide technical and planning assistance in support of conservation and recycling programs.

- Agricultural Water Management Council (AWMC) Evaluation of Agricultural Water Management Plans - Utilize the AB 3616 AWMC to evaluate and endorse plans to implement cost-effective water management practices by agricultural districts. Identify and secure ongoing funding sources for AWMC and its members seeking to actively participate in the development, review, and implementation of these plans.

- Develop Urban Water Management Plan Certification Process - Select an agency to act as certifying entity, obtain legislative authority, carry out public process to prepare regulations, implement program.

- Implement Urban BMP Certification Process - Implement a process for certification of water suppliers' compliance with terms of the Urban Memorandum of Understanding (MOU) with respect to analysis and implementation of BMP's for urban water conservation. Provide funding support for the California Urban Water Conservation Council to carry out this function.

- Prepare a program implementation plan, including a proposed organizational structure consistent with the overall CALFED governance structure, for an competitive grant/loan incentive program for water use efficiency by December 2000. This will include:

    - Incentives in the agricultural sector that will consider several factors, including: (i) potential for reducing irrecoverable water losses; (ii) potential for attaining environmental and/or water quality benefits from water use efficiency measures which result in reduced diversions; (iii) regional variation in water management options and opportunities; (iv) availability and cost of alternative water supplies; and (v) whether the recipient area experiences recurrent water shortages due to regulatory or hydrological restrictions. Many of these factors are included in the Quantifiable Objectives for Agricultural Water Use Efficiency, and as such, the Quantifiable Objectives will be an important component of the agricultural incentive criteria.

    - Incentives in the urban sector will assist in identifying and implementing urban water conservation measures that are supplemental to BMP's in the Urban MOU process and are cost effective from a statewide perspective.

    - Incentives for water recycling in the urban and agricultural areas.

    - The plan will include annual reporting and evaluation mechanisms to gauge effectiveness of the program.

- Refuge Water Management - Finalize and implement the methodology for refuge water management which was described in the June 1998 "Interagency Coordinated Program for Wetland Water Use Plan, Central Valley, California."

- Research effort to establish appropriate reference conditions for evaluating program progress, and to identify improved methods for water use efficiency.

- Assess the Need for Additional Water Rights Protections - After consultation with CALFED agencies, the Legislature and stakeholders, evaluate the need for additional state regulations or legislation providing protection for water rights holders who have implemented water use efficiency measures and subsequently transferred water to other beneficial uses.

- Water Measurement - Develop, after consultation with CALFED agencies, the Legislature, and stakeholders, state legislation that requires appropriate measurement of water use for all water users in California.

- Create Public Advisory Committee - Create public advisory committee to advise State and Federal agencies on structure and implementation of assistance programs, and to coordinate State, Federal, regional and local efforts for maximum effectiveness of program expenditures.

2.3.2 Assurances

Assurances will play a critical role in the Water Use Efficiency Program. The assurance mechanisms are structured to ensure that urban and agricultural water users and water suppliers implement the appropriate efficiency measures. As a prerequisite to obtaining CALFED Program benefits (for example, participating as a buyer in a water transfer; receiving water from a drought water bank; or receiving water made available solely because of supply enhancements such as new, expanded, or reoperated facilities) water suppliers will need to show that they are in compliance with the applicable urban or agricultural council agreements and applicable state law. This requirement will result in careful analysis and implementation of cost-effective conservation measures identified in those agreements.

A high level of water use efficiency also is expected to be required as a condition for permitting of any new surface water storage projects. Widespread demonstration of efficient use by local water suppliers and irrigation districts will be a prerequisite to CALFED implementation of new storage projects.

Local water suppliers will rely on CALFED agencies to provide a high level of technical and financial assistance to support local conservation and recycling efforts. Adequate funding for assistance programs will be an important assurance for local agencies. CALFED's initial Stage 1 cost estimate for state and federal financial assistance is $700 million, which may be increased as the program is further refined.

Economic analyses are under way that will compare water use efficiency options (including conservation, recycling, and transfers) and new facilities, and identify least-cost ways of meeting CALFED objectives. These analyses are expected to better define the mix of demand management and water supply options and water supplies from new facilities. CALFED will work with stakeholders on technical and implementation issues as these analyses proceed.

In addition, CALFED will develop, after consultation with CALFED agencies, the Legislature, and stakeholders, state legislation that requires appropriate measurement of water use for all water users in California. In developing this legislation, important technical and stakeholder issues will be addressed to define "appropriate measurement," which is expected to vary by region. Aspects of this definition include the nature of regional differences, appropriate point of measurement, and feasible level of precision.

The CALFED Urban Certification process (Section 2.2.2) proposes additional consequences for inadequate adoption of Water Use Efficiency measures, including monetary fines and water-based sanctions. Through the Agricultural Strategic Plan, CALFED staff will consider agency and stakeholder viewpoints in crafting appropriate additional and as yet undetermined consequences for non-compliance of agricultural water use efficiency measures.

2.3.3 DATA GATHERING, MONITORING AND FOCUSED RESEARCH

CALFED agencies will carry out a coordinated program to gather better information on water use, identify opportunities to improve water use efficiency, and measure the effectiveness of conservation and recycling practices. This effort will include direct activities by CALFED agencies, assistance to the CUWCC and the AWMC, and assistance to local water and regional water agencies in their efforts to quantify the savings and new water supply from water use efficiency measures.

Examples of activities that may be carried out by CALFED agencies under this program include developing better information on:

- Basin efficiencies and water balances for the Bay-Delta system and subregions, and the extent of reuse within basins.
- The identification and quantification of water quality and ecosystem improvements related to changes in local water management.
- The areal extent of urban landscaped area.
- The measurement of landscape water use.
- The distribution and useful life of water-using appliances and fixtures.
- The distribution of irrigation technology by type, soil condition, and crop.
- Quantification of evaporation versus transpiration and understanding their relationship.
- Measurement of on-farm efficiency and changes resulting from efficiency improvements.
- Understanding of per-capita water use and how it is affected by implementation of conservation and recycling measures.
- New efficiency technologies and their potential to affect water use.

- Interactions among and program policies or regulations of DHS, SWRCB, the Regional Water Quality Control Boards, and the California Plumbing Standards Commission

- The economics of water recycling

- Existing statewide infrastructure available for the treatment, transport, and storage of recycled water

- Effects of source water quality on the costs of producing recycled water

CALFED agency support for the CUWCC and the AWMC will help these organizations measure the effectiveness of BMPs and EWMPs. DWR support for mobile irrigation laboratories will result in better measurement of on-farm efficiency and better information on trends in irrigation practices and equipment. Technical assistance to local water and regional water agencies will help enable them to measure the results of implementing water use efficiency measures.

2.3.4 PROGRAM LINKAGES

Important linkages exist between water use efficiency and other components of a comprehensive long-term solution to resource problems of the Bay-Delta. Some of these linkages include:

- ***Storage and Delta conveyance*** - The cost of new storage and conveyance projects will help set the marginal cost of new supplies for many water suppliers. This, in turn, will influence the cost effectiveness of efficiency measures. If new supplies are expensive, more efficiency measures will be cost effective.

- ***Delta transfer capacity*** - The increase in physical capacity to transfer water across the Delta that may result from new or improved conveyance will be important in determining the maximum extent of water transfers across the Delta.

- ***Water quality*** - Increases in water use efficiency can reduce the amount of return flow to streams and creeks in the Bay-Delta system. Efficiency actions also may change water quality. This may improve instream water quality by reducing the return flow of salts, sediments, organic carbon, selenium, or metals, or other substances.

- ***Ecosystem quality*** - Increased emphasis on efficiency measures will improve water quality, timing, and instream flows—which will reduce the level of future impacts on aquatic organisms.

- ***Financing*** - How the costs of a Bay-Delta solution are apportioned will significantly affect the cost effectiveness of efficiency measures. To the extent that the costs of actions such as providing water for ecosystem restoration are reflected in the price that agencies and consumers pay for water, efficiency measures will be made more attractive.

- ***Adaptive Management*** - The water use efficiency element will be reevaluated periodically and if necessary adjusted to reflect changes in our understanding of water use efficiency and related Program elements such as water quality, ecosystem restoration, and water supply reliability. This will be consistent with CALFED's adaptive management approach. This allows the CALFED Program to begin investing water use efficiency actions while estimates of future conservation potentials are being refined.

2.3.5 GOVERNANCE

CALFED is currently developing the basis for interim and long-term governance structures for its program implementation. Please refer to the Governance section of the Implementation Plan for a complete description of Water Use Efficiency governance.

3. Determination of Geographic Zones

Figures

3. Determination of Geographic Zones

To facilitate estimation of water use efficiency improvements, zones were created that group together geographic areas with similar characteristics. Specific zones were developed for each of the three water use sectors: urban, agricultural, and managed wetlands.

The CALFED Program's Programmatic EIS/EIR report also is separated into geographic zones to facilitate the presentation of information. Because the Programmatic EIS/EIR includes many more issues than water use efficiency, the water use efficiency zones were developed to fall in the geographic zones defined for the Programmatic EIS/EIR.

The pie-chart shown in Figure 3-1 indicates the relative magnitude of each of the three water use sectors. The following sections of this report attempt to provide estimates of conservation potential for each.

Statewide Distribution of Applied Water

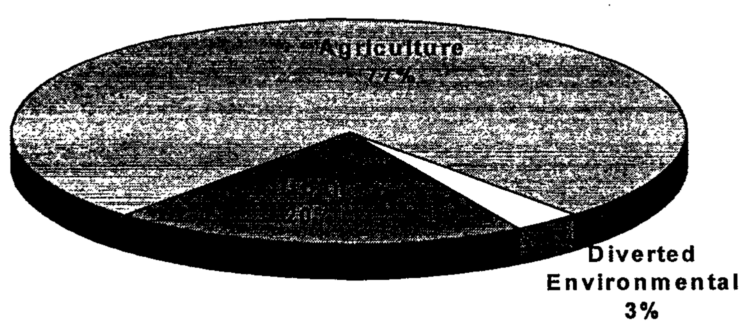

Figure 3-1. State-Wide Distribution of Applied Water Use

Agriculture applies the greatest quantity of water because of the tremendous number of acres producing agricultural crops throughout California. Managed wetlands use is a small percentage of applied water, but overall environmental water use (including in-stream flows) is equivalent to agriculture.

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Many efforts have been undertaken in the past to estimate the potential of water use efficiency improvements. Each effort has developed or presented information using a defined boundary. One of the more common boundary designations is DWR's Planning Subarea (PSA). Forty-four PSAs cover the entire State of California. Information at the PSA level also is readily available for use in this analysis and has been used for other investigative purposes, such as for Reclamation's October 1995 Least-Cost CVP Yield Increase Plan. For water use efficiency estimation purposes, grouping the PSAs into common zones was believed to provide the appropriate level of detail for a programmatic-level analysis. PSAs have been grouped into the zones described below for each of the three water use categories.

3.1 AGRICULTURAL ZONES

The agricultural approach to water use efficiency is focused on identifying and implementing improvements in local water use management and efficiency. This focus includes conservation of losses and changes in local management to gain multiple benefits from existing water supplies. Major differences in the potential resulting from efficiency improvements exist among regions of the state. For instance, conservation of "lost" water typically only can be achieved where water flows to salt sinks or unusable bodies of groundwater, which can occur in areas that export water from the Delta. Conservation potential would then further depend on soil, crop, climate, and other site-specific characteristics. On the other hand, changes in local water use management to possibly achieve a secondary ecosystem benefit are more apt to occur in areas that directly divert water from natural streams and rivers. Because of these differences, it is appropriate to develop estimates that are locally specific. However, although differences exist, existing information limits the understanding of local variations. Therefore, the following grouping of PSAs was established to group areas with regional similarities. PSAs are listed beneath each zone designation. Figure 3-2 represents a graphical view of the agricultural zones.

By inspection, not all PSAs are included in the agricultural zones presented. PSAs not included were considered to have limited agricultural activity or were determined to be outside the CALFED solution area. For instance, the Northern PSA under the Central Coast Region has been included because of SWP agricultural deliveries to the southern Santa Clara Valley. The Southern PSA under the same region is not included because of agricultural water supplies do not originate from the Delta. Areas of the Imperial Valley have been included because potential conservation savings could be used to offset existing or future Delta demands of the South Coast Region.

PSAs included under each zone were assumed to represented the majority of the agricultural production areas. This assumption is believed to provide the necessary level of detail for determination of potential impacts at the programmatic level.

AGRICULTURAL ZONES

Zone AG1
Sacramento River Region
- Northwest Valley
- Northeast Valley
- Central Basin West
- Central Basin East

Zone AG2
Delta Region
- Delta Service Area (Sacramento **HR** ***[[author: what is "HR"?]]***)
- Delta Service Area (San Joaquin ***HR***)

Zone AG3
Westside San Joaquin River Region
- Valley West Side

Zone AG4
Eastside San Joaquin River Region
- Eastern Valley Floor
- Valley East Side

Zone AG5
Tulare Lake Region
- San Luis West Side
- Kings-Kaweah-Tule Rivers
- Kern Valley Floor

Zone AG6
San Francisco Bay Region
- North Bay
- South Bay

Zone AG7
Central Coast Region
- Northern (portion connected to San Luis Reservoir)

Zone AG8
South Coast Region
- Santa Clara
- Santa Ana
- San Diego

Zone AG9
Colorado River Region
- Coachella
- Imperial Valley

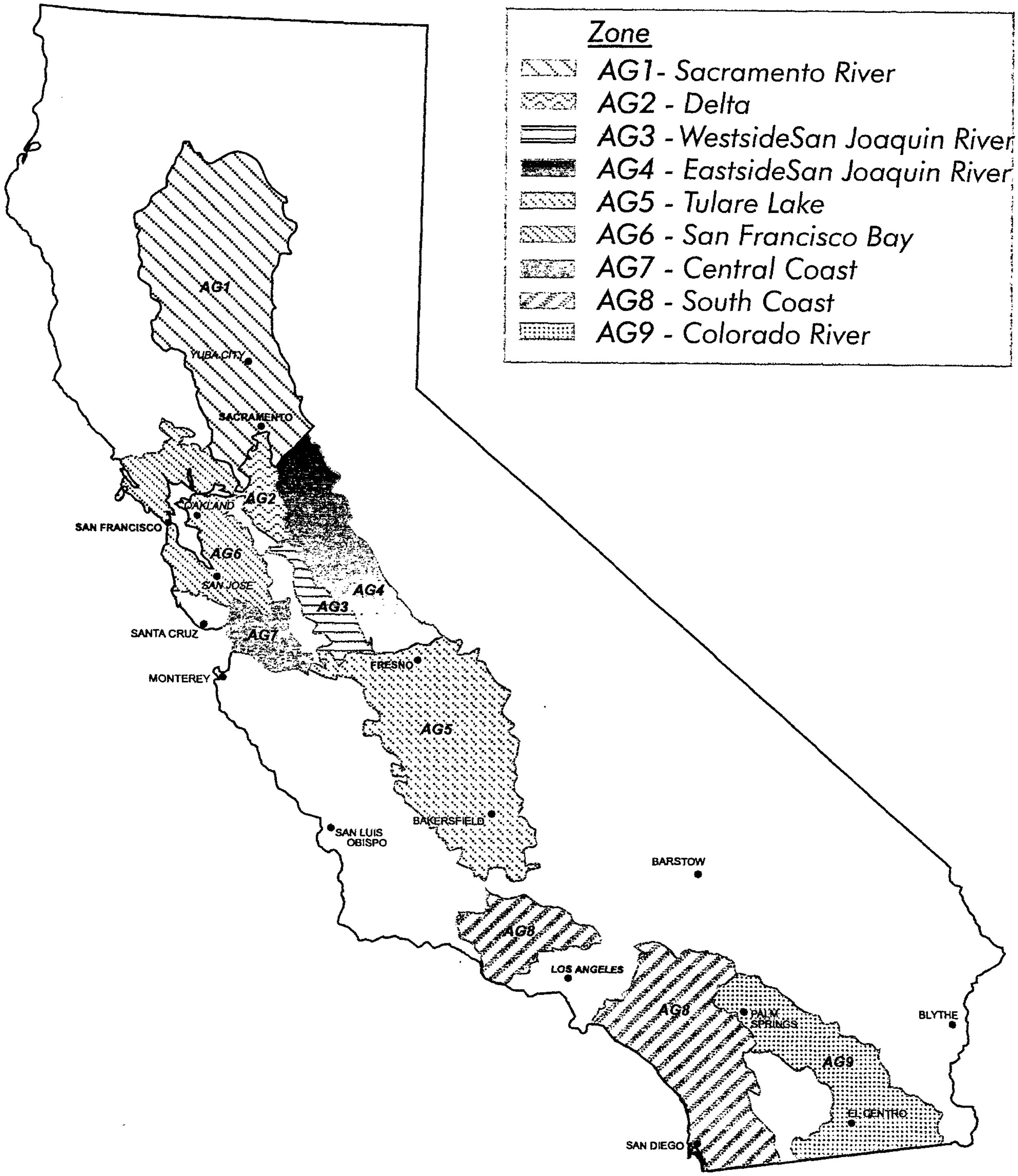

Figure 3-2. Agricultural Regions

3.2 URBAN ZONES

The urban approach to water use efficiency focuses on identifying and implementing conservation and water reuse measures. Conservation measures implemented in some regions will reduce water demands, saving water otherwise lost to saline sinks (for example, the Pacific Ocean). Other regions may not truly save water but can reduce the cost of treatment and distribution, and result in secondary benefits to the environment. Because of the variation in conservation and reuse potential, urban areas were separated into the same regional zones used for agricultural. Although the urban geographic zones may not differ from that used for agriculture, the PSAs in those zones do vary. For instance, conservation or reuse potential in the Sacramento River Region is mainly limited to the Central Basin East PSA. The South Coast Region includes a PSA aptly named "Metropolitan LA," which was excluded from the agricultural zone. The following grouping of PSAs was established to group areas with regional similarities. PSAs are listed beneath each zone designation. Figure 3-3 represents a graphical view of the urban zones.

URBAN ZONES

Zone UR1
Sacramento River Region
- Central Basin East

Zone UR2
Eastside San Joaquin River Region
- Eastern Valley Floor
- Valley East Side

Zone UR3
Tulare Lake Region
- Kings-Kaweah-Tule Rivers
- Kern Valley Floor

Zone UR4
San Francisco Bay Region
- North Bay
- South Bay

Zone UR5
Central Coast Region
- Northern (portion connected to San Luis Reservoir)
- Southern (portion connected to Central Coast project)

Zone UR6
South Coast Region
- Santa Clara
- Metropolitan LA
- Santa Ana
- San Diego

Zone UR7
Colorado River Region
- Coachella
- Imperial Valley

Similar to the agricultural zones, not all PSAs are represented in the above designations. For instance, the Sacramento River Region is limited to the PSA containing the Sacramento metropolitan area. Other urban areas in the Sacramento Valley have much smaller population centers. Areas of the Imperial Valley were included because potential conservation savings could be used to offset existing or future Delta demands of the South Coast Region.

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PSAs included under each zone were assumed to represent the majority of the populated urban areas that derive their water supplies from the Delta or its tributaries. This assumption is believed to provide the necessary level of detail for determination of potential impacts at the programmatic level.

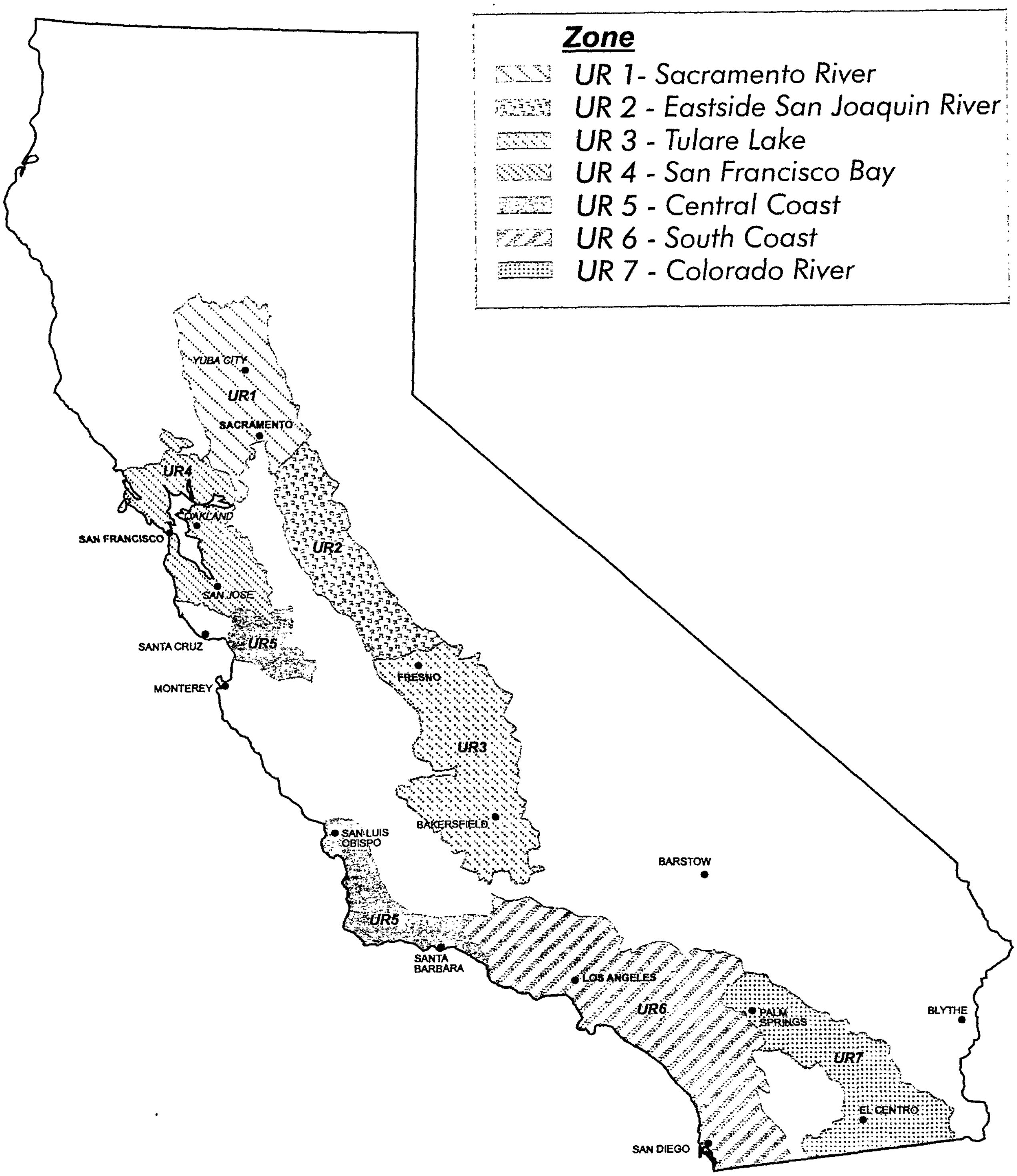


Figure 3-3. Urban Regions

4. Agricultural Water Use Management and Efficiency Improvements

Tables

Figures

4. Agricultural Water Use Management and Efficiency Improvements

This section presents the basis and background for estimating the magnitude of agricultural water conservation potential. These conservation estimates are based on computations of potential reductions of water application and irrecoverable losses. Values presented in this section represent potential reductions that are most likely to occur for future conditions regardless of the outcome of a CALFED solution (termed the No Action Alternative) as well as the incremental savings expected from a CALFED solution.

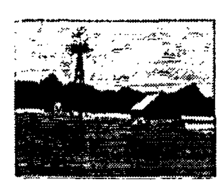
These estimates are intended to provide a perspective of the order of magnitude of the potential effects of water use efficiency improvements both with and without the CALFED solution. The values presented are not goals or targets. Rather, they represent the relative magnitude of potential results of expected efficiency actions.

Stakeholders disagree on the magnitude and the feasibility of achieving these values. In response, CALFED convened an Independent Review Panel of Agricultural Water Conservation (Panel) in December 1998, to provide an unbiased scientific evaluation of this section.

The Panel agreed that the values contained here are acceptable preliminary estimates of conservation potential. They also made several valuable recommendations for refining these estimates and strengthening the methodology. These recommendations included presenting estimates of evaporation reduction potential. The Panel's recommendations will be included in a refinement of these estimates, which will be conducted during the first years of Stage 1.

This section includes the following estimates:

- Potential reductions in agricultural water losses expected for each of the nine geographic regions described in Section 3.
- Expected costs of reducing agricultural water losses



4.1 SUMMARY OF FINDINGS

Improvements in on-farm and district water management can result in the reduction of losses typically associated with the application of irrigation water to fields. Though the majority of loss reduction does not generate a water supply available for reallocation to other beneficial uses, significant benefits to water quality and the ecosystem can be obtained as well as potential in-basin water supply benefits. Conservation estimates are separated into three categories:

- ***Recovered losses with potential for rerouting flows*** - These losses currently return to the water system, either as groundwater recharge, river accretion, or direct reuse. Reduction in these losses would not increase the overall volume of water but might result in other benefits, such as improving water quality, decreasing diversion impacts, improving flow between the point of diversion and the point of return, or potentially making water available for irrigation or in-stream flows during dry periods. (See Section 4.4, "Irrecoverable vs. Recoverable Losses.")

- ***Potential for recovering currently irrecoverable losses*** - These losses currently flow to a salt sink, inaccessible or degraded aquifer, or the atmosphere and are unavailable for reuse. Reduction in these losses would increase the volume of useable water (reducing these losses can make water available for reallocation to other beneficial uses). (See Section 4.4, "Irrecoverable vs. Recoverable Losses.")

- ***Potential reduction of application*** - This is the sum of the previous reductions.

Based on the assumptions and data described later, the conservation estimates are shown in Figures 4-1, 4-2, and 4-3.

Although the total potential loss reduction estimates shown here are sizable, it must be recognized that they assume that **all** agricultural water users in the CALFED solution area will achieve a high level of on-farm irrigation efficiency improvements. This achievement will require increased levels of support and commitment from federal, state, and local agencies.

Costs associated with implementing improvements to achieve these loss reductions will vary by case. Both on-farm and district spending are necessary to obtain the anticipated levels of improvement. Generally, the on-farm cost to reduce losses ranges from \$35 to \$95 per acre-foot annually. District expenses can add an additional \$5 to \$12 per irrigated acre per year to the cost of improved efficiency. In contrast, the range of cost to conserve irrecoverable losses is much greater because in many cases only a small fraction of total loss is irrecoverable (see Figure 4-4). When reductions in irrecoverable losses do occur, the cost is estimated to range from \$80 up to \$850 per acre-foot per year. A detailed discussion of cost is provided toward the end of this section.

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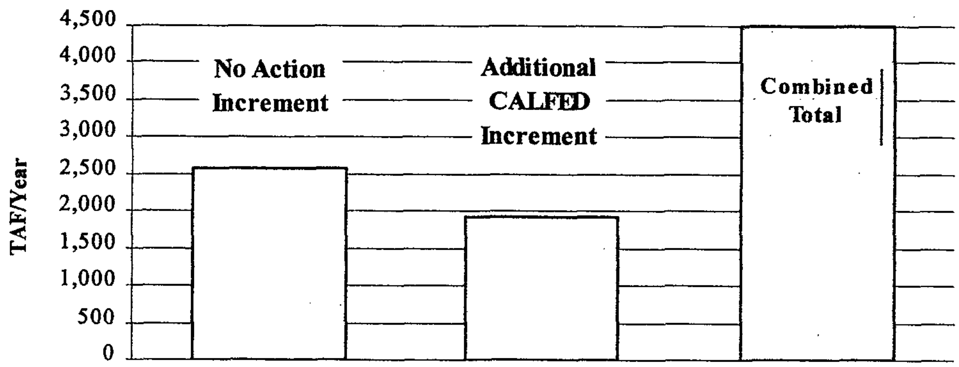

Figure 4-1. Potential Reduction of Application
These reductions are the sum of reductions shown in Figures 4-2 and 4-3.

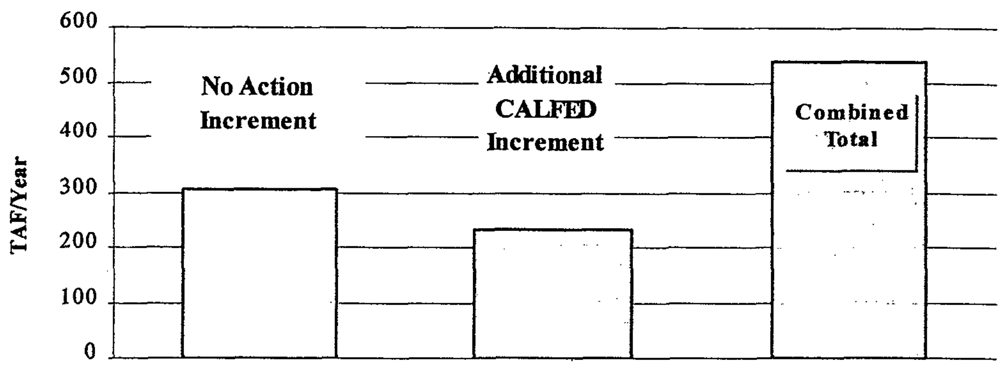

Figure 4-2. Potential for Recovering Currently Irrecoverable Losses
The incremental portion generated by CALFED is less than half of the total projected savings. This savings can be reallocated to other beneficial uses.

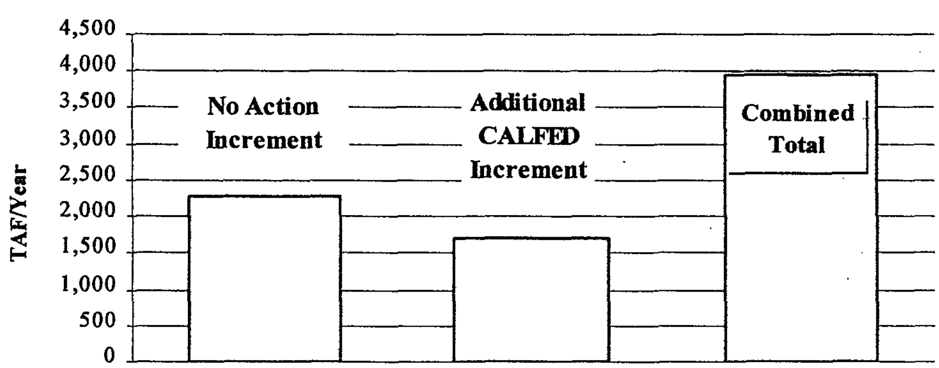

Figure 4-3. Recovered Losses with Potential for Rerouting Flows
These reductions can provide water quality and ecosystem benefits. The reductions do not constitute a reallocable water supply but can reduce projections of future demand.

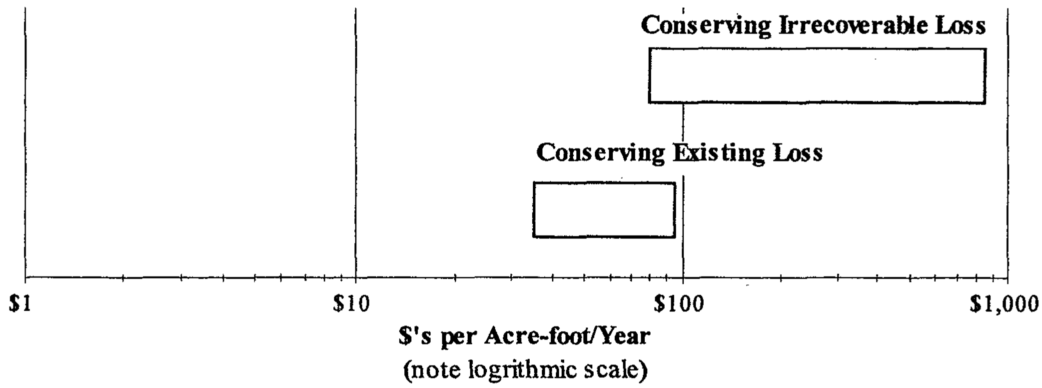

Figure 4-4. Estimated Cost to Conserve Existing Losses
Conserving irrecoverable losses can cost significantly more than reducing recoverable losses.

These costs will occur only when cost-effective conservation measures are implemented. There is no implied assumption that these costs will be incurred regardless of cost-effectiveness determinations. Furthermore, it should be understood that these costs are associated with the implementation and do not designate who is paying. In some cases, state or federal interests may invest in local programs, in an effort to achieve broader water quality, ecosystem, or water supply benefits.

SECTION OVERVIEW

The remainder of this section provides more detail on the assumptions and methods underlying the conservation estimates. The section is subdivided into the following topics:

- General state-wide assumptions.
- Discussion of on-farm irrigation and district delivery efficiency improvements.
- Irrecoverable versus recoverable losses—including differentiation of the two types of losses and the benefits that can be derived from each.
- Methodology for estimating agricultural water conservation potential.
- Regional reduction estimates—including descriptions and assumptions for each defined CALFED agricultural region and the resulting conservation estimates.
- Estimated cost of efficiency improvements—including the cost to implement efficiency improvements for each agricultural region.

4.2 GENERAL STATE-WIDE ASSUMPTIONS

It is important to note that these estimates are presented to help understand the potential role conservation could play in the larger context of state-wide water management, as well as to provide information for purposes of programmatic-level impact analysis. **These estimates are not targets or goals and should not be interpreted as such.** Neither the information nor the analysis is intended to be used for planning recommendations.

The general state-wide assumptions listed below helped guide the overall analysis and development of conservation estimates. Specific assumptions are described later in this section.

- It is assumed that irrigated agricultural acreage will not increase in the future. Statewide, agricultural acreage is expected to decline as a result of Central Valley urbanization, loss of soil productivity, ecosystem restoration activities, land retirement, water transfers, and other factors (DWR Bulletin 160-93). Because such uncertainties are difficult to project, conservation estimates are based on current irrigated acreage using normalized 1995 data on agricultural water use.

- Conservation of water that results in additional water supply available for reallocation to other beneficial water supply uses is limited to the reduction in currently irrecoverable losses. These include losses to evaporation, evapotranspiration of nonagricultural plants, saline sinks, and poor-quality perched groundwater. (This topic is discussed later in this section.) Although other changes in farm management also would reduce consumptive water use by agriculture, only conservation of applied water is discussed. These other measures include changes in crop mix, fallowing, and permanent land retirement and are explicitly not included in the Water Use Efficiency Program. (These measures could occur, though, as a result of actions taken by individual water rights holders through the Water Transfer Program.)

> GENERAL STATE-WIDE ASSUMPTIONS
>
> - Agricultural acreage will not increase in the future.
> - Conservation of water that results in additional water supply available for reallocation to other beneficial water supply uses is limited to the reduction in currently irrecoverable losses.
> - Water conservation actions that reduce currently recovered losses (the portion of loss that is not defined as irrecoverable) potentially can be credited with ecosystem or water quality benefits and could reduce the magnitude of future demand.
> - Conserved water (either by a water district or a water user) will remain in the control of the supplier or water user for their discretionary use or reallocation.

- Water conservation actions that reduce currently recovered losses (the portion of loss that is not defined as irrecoverable) potentially can be credited with ecosystem or water quality benefits and could reduce the magnitude of future demand in a region. However, such savings generally do not result in water that can be reallocated to other uses. Since these losses currently benefit other downstream uses (agricultural, urban, or environmental), the potential exists for adverse impacts to occur when existing irrigation methods are changed. This potential needs to be taken into consideration when implementing efficiency measures. These benefactors can include secondary agricultural users, seasonal wetlands, and riparian habitat in drains, to name a few. For example, a measure to reduce diversions and associated fish entrainment impacts by implementing conservation measures may adversely affect habitat in a drainage course that currently survives off of the "excess" applied water.

- Conserved water (either by a water district or a water user) is assumed to remain in the control of the supplier or water user for their discretionary use or reallocation. This could include applying the "saved" water to additional under-irrigated lands; offsetting groundwater overdraft; or transferring to another benefactor, including the environment. (Transferring water requires additional legal tests to be satisfied.)

When discussing the ability to achieve implementation of conservation measures, not only the technical capacity to improve water management should be considered. From the viewpoint of the landowner, who is a business operator, many factors are considered in addition to the single factor of water conservation. In many instances, a landowner may not see the value of investing in improved levels of efficient use because of insufficient return on the investment. In other instances, landowners justify the expense of improving their irrigation systems through increased yields, better quality, and reduced inputs. In regions where water supplies are less reliable and usually more expensive, improved management and irrigation techniques can be cost effective for the primary reason of the reduced cost of supplying water to the crop. For a grower, the decision to spend capital is generally made when the capital will be returned over a relatively short period of time. Several forms of repayment are possible—from reduced labor, chemical, and water costs, to improved yields per acre.

Social issues also play a role in the decision to implement new measures. For example, some growers use field laborers not trained in irrigation management to irrigate rather than a specially trained irrigator. The operation of a more management-intensive irrigation system may intimidate some irrigators. Although these issues exist and will be a factor in the rate of acceptance and implementation, they are not assumed to limit the values projected here.

4.3 DISCUSSION OF ON-FARM AND DISTRICT EFFICIENCY IMPROVEMENTS

The discussion that follows provides background and justification for assumptions made later in this section regarding levels of conservation expected in the future. On-farm irrigation and district delivery are discussed for the following:

- Existing conditions.
- The No Action Alternative, which includes conditions expected with implementation of some on-farm irrigation and district delivery improvements.
- The CALFED solution alternative, which includes projections of future conditions that could exist as a result of implementing the Water Use Efficiency Program.

4.3.1 IMPROVING ON-FARM IRRIGATION EFFICIENCY

As defined by DWR for the Bulletin 160 series, **irrigation efficiency is defined as the volume of irrigation water beneficially used, divided by the volume of irrigation water applied.** Beneficial uses include crop evapotranspiration (ET), water harvested with the crop, salt removal (leaching), cultural practices, climate control, and other minor activities (Burt et al.). Given these various elements and the difficulty in accurately measuring any one of them, it should be noted that efficiency is a gross measurement. Efficiency values are estimates based on best scientific data and should be viewed as a tool to help make management decisions. The information itself can easily be misinterpreted or may be incomplete, resulting in an estimate of efficiency that is not accurate. For example, not including in the total applied water value a crop's uptake of irrigation water previously stored in the soil can make efficiency appear higher than it actually is.

On-farm irrigation efficiency, in more practical terms, is a complex result of the type of irrigation system, the level of irrigation management, the amount of irrigation system maintenance, the method of delivery to the field, the timely availability of water, the climate, the soil, the crop, the irrigator, and many other factors. Efficiency does not improve simply by changing one of these factors. In fact, some studies have shown that efficiency can worsen when, for example, a system type is changed but the management style is not. High levels of irrigation efficiency that are sometimes referred to by agriculture, by the public, and by policy makers can be misleading since they may reflect regional, miscalculated, or one-time efficiencies and not the average annual efficiency of a particular irrigation practice. In some instances, these high efficiency values mean that the crop actually is being under-irrigated (although it is possible to use 100% of the applied water beneficially and still under-irrigate, it is not possible to use more than 100% of the applied water; thus, efficiency can never be greater than 100%). Under-irrigation can lead to reduced yields and the possibility of salt buildup in the soil.

It is important to distinguish between on-farm irrigation efficiency and regional efficiency. Regional efficiency is derived from a combination of on-farm efficiencies and the level of regional water reuse, including reuse of deep percolation and tailwater runoff. It is erroneous to draw a comparison between regional efficiency and on-farm efficiency without considering regional reuse, a primary reason for higher regional efficiencies. For example, water lost from one field as tailwater runoff or deep percolation, if water quality is not severely degraded, can be reused on another field for additional beneficial uses. The greater the level of reuse, regardless of the on-farm efficiency of any particular field, the higher the regional efficiency will tend to be.

Existing On-Farm Efficiency Levels

Analysis of over 1,000 different field evaluations of on-farm irrigation systems shows that state-wide on-farm irrigation efficiency is averaging nearly 73% (DWR 1992). However, the value can vary significantly from farm to farm, basin to basin, and region to region.

Generally, this value should be viewed as a guide, indicating the approximate conditions that may exist on many farms throughout the state. As discussed later, the amount of total loss derived from applied water and crop consumption data for each region dictate the resulting conservation estimates to a much greater extent than does an existing irrigation efficiency value. This is because the existing efficiency, or baseline, is used simply as a point of reference from which to judge progress toward improved efficiency. We can safely assume that the available efficiency improvement lies somewhere between the existing condition and 100%.

Projected Average On-Farm Efficiency under the No Action Alternative

Average on-farm irrigation efficiency is anticipated to improve as a result of existing trends in growers' irrigation systems and management, coupled with improved district delivery systems (covered in the next subsection). The level of improvement is a matter of judgement. CALFED has assumed, for purposes of estimating incremental conservation improvements, that 40% of the potentially conservable water is saved under the No Action Alternative (more detail is provided later in this section).

Efforts by federal, state, and local agencies over the past decade in research and education are expected to continue to provide new understanding of plant/water/soil relationships that will aid in improving water management. In addition, the renewed focus on conservation and approval of new funding sources, such as Proposition 204, will continue to influence efficiency improvements. Consequently, for the CALFED No Action Alternative, on-farm efficiency is projected to be higher than it is today. Estimates of what may occur are presented here to differentiate between what is projected under the No Action Alternative, absent the CALFED Program, and what additional improvements may result from implementing the Water Use Efficiency element. This difference provided the basis for programmatic-level analysis of the impacts of the Water Use Efficiency Program.

One of the factors that limits projected efficiency improvements is termed "distribution uniformity." Distribution uniformity (DU) is the uniformity with which irrigation water is distributed to different areas in a field (Burt et al.). DU is affected primarily by five factors:

- System manufacturing (nozzle size, material durability, and performance reliability),
- System design (number of emitters per tree, spacing of sprinklers, and size and spacing of furrows),
- System maintenance (nozzle replacement, land grading, and drip system chlorination),
- System management (how well a grower operates the system in comparison to the needs of the crop), and
- Local physical and environmental conditions (soil, terrain, and climate).

Most experts in the field of irrigation maintain that current hardware design and manufacturing technology, as well as typical system maintenance activities, limit the DU to a ratio of 0.8 (80% of the field will be irrigated to the desired depth, while 20% will not). The anticipated efficiency improvements under the No Action Alternative assume that the majority of irrigators will be able to obtain this level of DU with their irrigation systems. This level is necessary to achieve higher average on-farm efficiencies without significant under irrigation. Because of the relationship of DU to efficiency, significant increases in on-farm efficiency is unlikely without accompanying improvements in DU, especially if soil conditions are to be maintained for optimum crop production.

Additional Efficiency Improvements as a Result of the CALFED Program

The CALFED Program's Water Use Efficiency component is expected to gain additional increments of on-farm irrigation efficiency improvements. These gains will be facilitated by increased levels of technical, planning, and financial assistance, along with improved district delivery systems (covered in the next subsection).

To allow average on-farm efficiencies to increase such that more than 40% of the potentially conservable water is saved requires that DU increase to a range of 0.8-0.9. Analysis of data indicates that an increase of DU to this range for example, can result in applied water reduction of 8-12% (for example, about a 3-4 inch reduction in applied water on a crop like tomatoes) without any reduction in crop water requirement or any reduction in beneficial uses (DWR 1990-1996). Such improvements could occur through advances in design and manufacturing of pressurized hardware, along with increase awareness and implementation of irrigation system maintenance. Figure 4-5 shows relationships between applied water, irrigation efficiency, and improved DUs. Note that, as the figure demonstrates, reductions in applied water occur solely as a result of increased DU, without reductions in beneficial use (such as crop consumptive use, leaching, and climate control).

This improvement can occur as a result of combined efforts to improve manufacturing processes and system designs, and from efforts by irrigators in improving maintenance and management practices for irrigation systems. It is reasonable to expect these improvements to occur because of increased awareness and necessity for higher efficiency resulting from the CALFED Program and response by the irrigation industry.

With a higher potential DU, incremental on-farm efficiency improvements above No Action Alternative levels can be assumed for each agricultural region. To estimate conservation potential, CALFED has assumed that the next 30% of available conservable supply (beyond the initial 40% achieved under the No Action Alternative) will be saved as a result of Water Use Efficiency Program actions. However, it must be recognized that this amount is assumed as a maximum level for maintaining optimum crop production. Gains that exceed this level could indicate widespread under-irrigation, salt accumulation in the soil, and lower crop yields per unit of applied water rather than actual improvements in the overall use of the water. In some instances, climate, soil, and cropping conditions on particular fields may allow even greater efficiencies to be achieved, but only to a nominal extent when compared to the average farming condition throughout the state.

For clarification, it is assumed the average on-farm irrigation efficiency will achieve the following gains:

No Action Alternative = First 40% of the potential conservable supply
CALFED alternative = Next 30% of the potential conservable supply

Detailed discussion of the methodology used to calculate conservation potential is presented in Section 4.7, "Estimating Agricultural Water Conservation Potential."

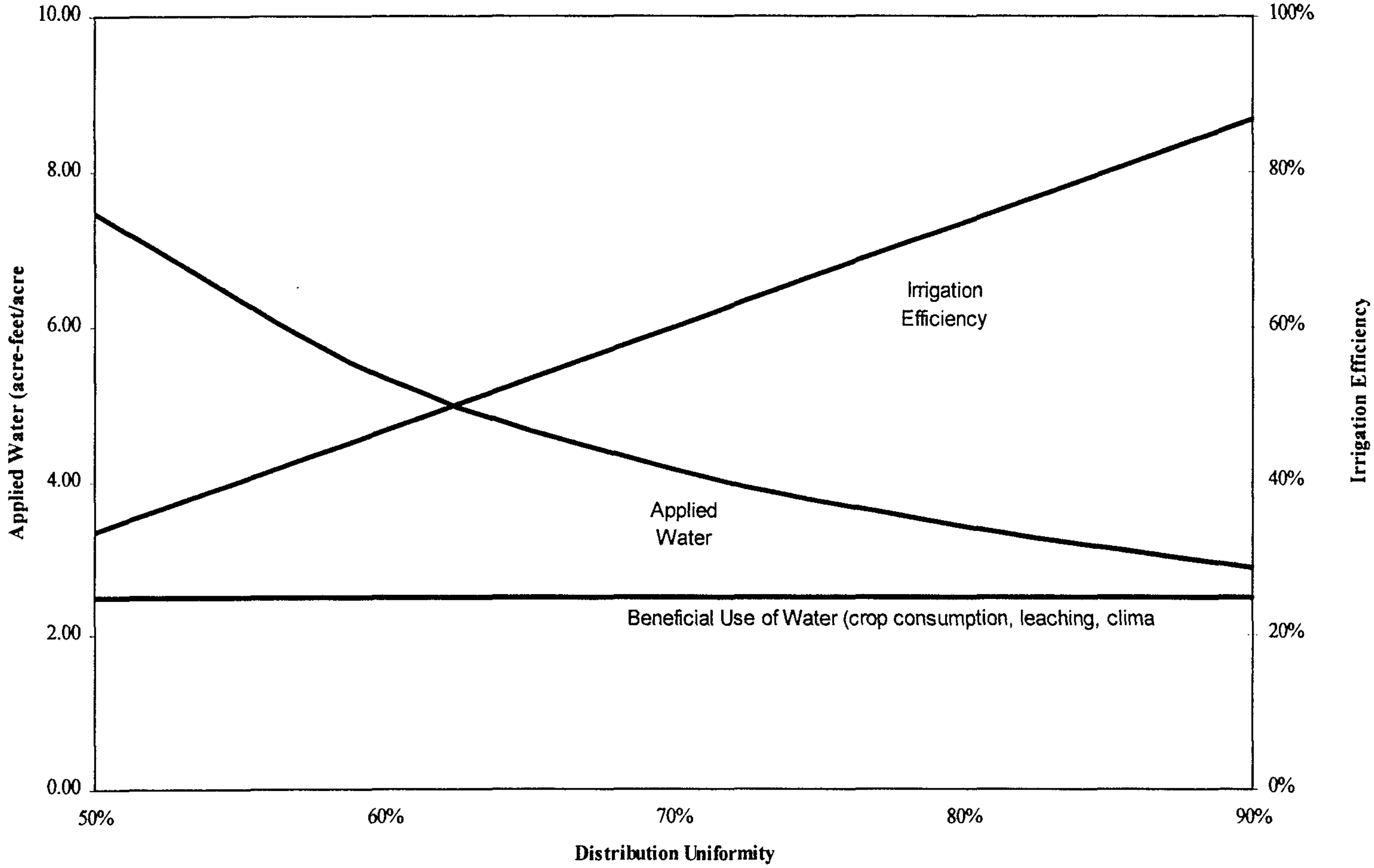

Figure 4-5. Effect of Improved Distribution Uniformity on Potential Seasonal Irrigation Efficiency and Applied Water

Improvements in distribution uniformity can result in increased efficiency and decreased applied water while still meeting beneficial crop needs.

Figure courtesy of DWR

4.3.2 WATER DELIVERY IMPROVEMENTS BY WATER SUPPLIERS

The majority of water applied to fields is obtained from water districts, which obtain most of their water from surface diversions (DWR 1994). Surface water supplies are actively distributed and delivered to fields and farms in a district's service area. Distribution and delivery have been the primary job of the water district for many years. Only recently, has the district begun to assume the role of water supply management It can be noted that districts with typically limited water supplies or high water costs already have taken on the role of water management. Other districts, especially those with ample supplies, still maintain the "delivery only" paradigm. The Water Use Efficiency Program will increase the availability of planning assistance, technical assistance, and funding so that more districts can expand their role to include water supply management, not only delivery.

Distribution of large quantities of surface water is inherently difficult and challenging. In contrast to urban water deliveries, most agricultural water delivery systems are not pressurized or available on demand. (Research to provide on-demand supplies is under way, but such delivery methods typically are cost prohibitive). Instead, large networks of canals rely on gravity to distribute the water. Some water districts in California have new, more manageable systems, including pressurized pipelines, but many districts have gravity systems originally constructed during the early part of this century. Many of these existing water delivery systems need to be upgraded in order to improve the ability of the district to meet more sophisticated needs of their customers, the end user.

Existing Delivery Systems

Like on-farm systems, district delivery inefficiencies are a result of the type of system, availability of water, climatological conditions, management, and maintenance. Losses incurred while delivering water result primarily from four sources:

- Conveyance seepage
- Canal spillage
- Gate leakage
- Conveyance consumption (channel evaporation and bank and riparian ET)

Conveyance seepage originates from water supplier channels and reservoirs where seepage flows directly to groundwater bodies. Canal spillage includes discharges from district end points and drainage courses, and can flow to surface water or groundwater bodies. Gate leakage is water that leaks through the last gate or check structure of a water supply channel. The location of the last gate can vary along the channel with daily demands. Gate leakage is typically small and, as such, usually seeps through channel bottoms into groundwater bodies or evaporates. Conveyance consumption represents consumptive uses of water along supply channels and reservoirs, including evaporation from water surfaces and ET of riparian and bank vegetation (DOI 1995).

Projected Improvement under the No Action Alternative

Recent efforts by agricultural water suppliers, environmental interest groups, and other interested parties have resulted in the development of the Memorandum of Understanding Regarding Efficient Water Management Practices by Agricultural Water Suppliers in California (Agricultural MOU). This MOU is designed to create a constructive working relationship between these groups and to establish a dynamic list of EWMPs for implementation by water suppliers. The goal is to voluntarily achieve more efficient water management by water suppliers and end users than currently exists.

It is anticipated that many agricultural water suppliers will sign the Agricultural MOU and complete the planning requirements. However, implementation levels of EWMPS may occur below the maximum potential. This is based, in part, on resource limitations (both dollars and people) currently experienced by most districts and lack of interest in participating by some water suppliers. The Water Use Efficiency Program includes planning and technical assistance, as well as additional funding and assurance mechanisms, designed to address these shortcomings.

Slightly over 8.5 million acres of irrigated lands are located in the CALFED Program's geographic scope (there are slightly under 9.1 million irrigated acres in the state) (DWR 1998). With the Agricultural MOU being finalized at the start of 1997, 39 water suppliers representing almost 3.3 million acres already have signed. However, current signatories represent about 30% of the potential. Assuming that the number of water suppliers who become signatories may increase only moderately by 2020, total signatories to the MOU may add up to around 4 million acres. Implementation of all cost-effective measures also is anticipated to fall short of the potential under the No Action Alternative (based mostly on limited funding and assistance resources)

In recent action taken by the Agricultural Water Management Council (AWMC), administrator of the Agricultural MOU, additional opportunity for many more acres to sign the MOU has been made available. The AWMC voted to automatically endorse CVP contractors whose plans have been approved by Reclamation on or before November 16, 1998. This action provided an opportunity for many CVP contractors who had not signed the Agricultural MOU, citing concerns of "double jeopardy," to join other water districts as signatories. In total, plans of 51 CVP contractors have been approved by Reclamation (or are currently being approved), representing over 1.6 million acres of additional irrigated lands. If all of these contractors became signatories, the Agricultural MOU would include over 80 water districts representing 4.6 million acres of irrigated agriculture.

Estimated No Action Alternative conservation attributed to district activities is presented in Section 4.7, "Estimating Agricultural Water Conservation Potential."

Additional Improvements as a Result of the CALFED Program

The Water Use Efficiency Program is anticipated to provide the assistance necessary to gain higher levels of EWMP implementation and participation by more agricultural water districts. Incentives, coupled with assurance mechanisms, will encourage more districts to properly examine the benefits of the EWMPs and implement the cost-effective measures. It is assumed that such measures will result in a significant majority of the water suppliers planning, adopting, and implementing feasible, cost-effective efficiency measures.

Estimated No Action Alternative conservation attributed to district activities is presented in Section 4.7, "Estimating Agricultural Water Conservation Potential."

4.4 IRRECOVERABLE VS. RECOVERABLE LOSSES

Except for a negligible amount of water required for plant metabolic processes, agricultural applied water can be accounted for by the various demand elements presented in Figure 4-6. The "consumptive" elements (crop ET, on-farm evaporation, and conveyance consumption) are lost to the atmosphere and generally not recovered.

Tailwater, deep percolation, conveyance seepage, canal spill, and gate leakage flow to surface water or groundwater bodies and may be recoverable. In theory, all these losses are recoverable. In practice, however, losses that flow to very deep aquifers or excessively degraded water bodies may not be recoverable because of prohibitively expensive energy requirements (they become irrecoverable). Determining recoverability varies with location and time, as well as other factors (DOI 1995).

Collectively, losses are composed of irrecoverable and recoverable portions. Distinguishing between irrecoverable and recoverable losses is based largely on water quality considerations. These losses will vary from location to location, with some areas generating minimal or even no irrecoverable portions while other areas may generate irrecoverable losses almost exclusively. Principal water bodies that are regarded as irrecoverable include saline, perched groundwater underlying irrigated land on the west side of the San Joaquin Valley; the Salton Sea, which receives drainage from the Coachella and Imperial Valleys; and the ocean. Therefore, losses that flow to these areas are deemed irrecoverable.

Conserving irrecoverable losses generally is considered to make water available for reallocation to other uses. In some instances, however, reduction of recoverable loss also may provide a water supply benefit in the basin where it was conserved—this benefit may be limited and subject to existing water rights law.

Recoverable losses, on the other hand, often constitute a supply to the downstream user (the loss is recovered and is still available to meet other water supply needs). Downstream uses can include groundwater recharge; agricultural and urban water use; and environmental uses, including wetlands, riparian corridors, and instream flows. Recoverable losses often are used many times over by many downstream beneficiaries. To reduce these losses would deplete such supplies with no net gain in the total water supply, unless the reduction was experienced throughout the basin, when the reduction might constitute an available supply for other uses in the basin.

Reducing recoverable losses primarily provide significant opportunities to contribute to the achievement of other CALFED objectives, such as:

- Improve in-stream and groundwater quality through reduced deep percolation or runoff of water laden with residual agricultural chemicals, sediments, and natural toxicities.
- Reduce temperature impacts resulting from resident time of water on fields prior to runoff returning to surface waters.
- Reduce entrainment impacts on aquatic species as a result of reduced diversions.
- Reduce impacts on aquatic species, especially anadromous fish, through minor modifications in diversion timing, and possibly generate in-basin benefits through subsequent modifications in the timing of reservoir releases.
- Benefit stream reaches that may have previously been bypassed as a result of excessive diversions.

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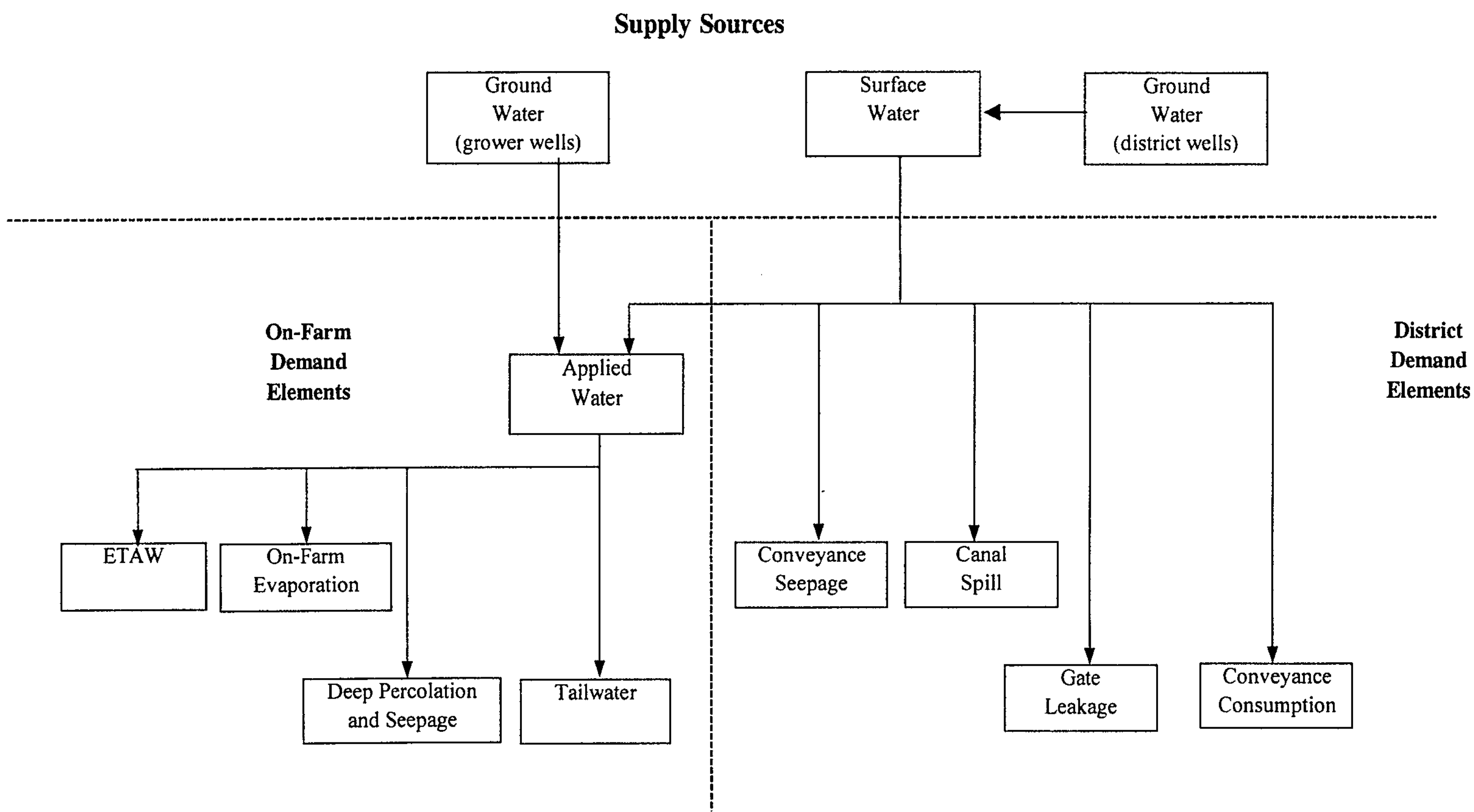

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Figure courtesy of the Bureau of Reclamation - Mid Pacific Region from the *Demand Management Technical Appendix #3* to the *Least-Cost CVP Yield Increase Plan*

Figure 4-6

Example Demand Elements

Water supplied to agricultural fields can result in one of several demand elements. The efficiency of delivery and application systems dictates how much goes to each element.

In general, the same water use efficiency measures available to reduce recoverable losses can be used to reduce irrecoverable losses, although the various measures may be implemented for differing objectives. The primary purpose for separating the two is to distinguish the difference in ability to generate water supplies that can be reallocated. Reallocation of recoverable losses to out-of-basin uses could result in impacts on other diverters or the environment. This is described in more detail later under Section 4.5, "Hydrologic Interconnections."

Although the potential for conserving existing losses can appear significant, the benefit to water quality or the ecosystem is not necessarily one for one. For example, an 8-12% reduction in applied water does not necessarily result in the same percentage of improvement in water quality. Results could be greater or less, depending on local circumstances. For example, applied water reductions may be assumed to be spread throughout an irrigation season. Water quality impacts that accompany the irrigation may be concentrated in particular days or months occur under particular flow conditions, or be associated with particular farm management activities (such as spreading fertilizer or pesticides). Reducing applied water may result in only minimal benefits during certain periods and more significant benefits during other periods. More research into these relationships is necessary and is a prominent part of the Water Use Efficiency Program (see Section 2 for a description of the element's recommended actions).

It is assumed that implementation of conservation measures will not result in redirected impacts on the water user or water supplier. For example, a measure would not be implemented if the water user would experience increased production costs with no subsequent direct benefit. However, the influence of outside interests to offset these impediments for a "win-win" situation is assumed to occur when and where appropriate. Outside participation in planning, funding, and implementation can help make efficiency measures locally cost effective when they otherwise might not be. Benefits also are assumed to be shared when costs are shared, whether gained by the water user, the water supplier, or the environment. As discussed in Section 2 of this document, one of the agricultural water use efficiency actions is management improvements to achieve multiple benefits. This action is intended to help identify and implement such opportunities, expanding on processes contained in the Agricultural MOU.

4.5 HYDROLOGIC INTERCONNECTIONS

The primary reason that reduction of recoverable losses does not generate a water supply for reallocation is because of the complex hydrologic interconnections that occur between surface water, groundwater, stream flows, and losses associated with irrigation. Figure 4-7 illustrates a generic "existing condition" for some areas of the Central Valley. Figures 4-7 and 4-8 are used as the basis for a discussion regarding hydrologic interconnections.

In general, if efficiency is improved, indirect use of "losses" by subsequent users will decline, but direct use of water by those subsequent users will increase. Therefore, the basin's hydrology remains relatively stable. To most simply present this principle on the accompanying figures, the following is assumed:

- Crop ET is assumed not to change (no crop modifications or land fallowing), although potential may exist to reduce nonproductive evaporative losses that are inherently included in ET calculations (see later sidebar discussion on evaporation and transpiration).
- Cumulative target flows downstream remain constant for a given period of time (February through September cumulative demands do not change regardless of upstream activities).
- Long-term groundwater levels remain in balanced conditions.

These assumptions are reasonable, especially for basins such as the Sacramento Valley and agricultural areas along the eastern side of the Central Valley. For example, it is quite likely that growers could improve on-farm efficiency but not change the types of crops grown. In addition, seasonal downstream demands usually remain fairly constant regardless of what occurs upstream since these demands are driven by Delta outflow and export demands. Also, groundwater and surface water interaction is governed by rules of hydrology. **When groundwater elevations are lower than river elevation, a river typically will recharge groundwater, referred to as "river depletion." Conversely, groundwater will add to a river's flow when it is higher than the river elevation ("river accretion").**

The interaction between groundwater and surface water, however, can be slow, depending on the local geologic and hydrologic conditions. Delays of days, weeks, months or even years can erroneously be interpreted as water savings when, in fact, none occurred. If the false savings are redirected out of a basin, overdraft of the groundwater resources and loss of in-stream flows can result. In areas that are not experiencing overdraft, the natural process of depletion and accretion usually can maintain a relative balance.

For illustration purposes, this balance is assumed to occur in the same season, although multi-year benefits could sometimes be gained (through conjunctive use projects) but possibly at the risk of reducing water supplies for other purposes, including high winter flows flowing out to the sea or dropping water levels for local groundwater users. (This is when the concept of "time-value" of water, expressed in the Ecosystem Restoration Program Plan, becomes an important factor to consider.)

As shown on Figure 4-7, releases are made from a reservoir to meet local diversions, in-stream uses, and downstream target demands. The fields in the area obtain water for crop needs by various methods, including delivery via a canal diversion, direct river diversion, direct diversion from drainage, and groundwater pumping. As illustrated with the various flow arrows and accompanying quantities (units are not necessary for this example but could be assumed as TAF), "losses" resulting from over-application of water go to surface runoff or deep percolation. In addition to natural recharge, the deep percolation acts to recharge the aquifer. Surface runoff returns directly to the river, to the river via a drainage course, or to another field. A simple water accounting is shown along the river as diversions remove water and surface runoff returns water. In this example, a balance between deep percolation and groundwater pumping creates a slight surplus of deep percolation. It is assumed that this additional groundwater actually results in river accretion (groundwater naturally flowing back into the river) by the end of this hypothetical stream reach.

By contrast, Figure 4-8 assumes that on-farm efficiency improvements are implemented, resulting in decreased river diversions. Crop demands do not change. The reduced diversions could be interpreted as "real" water savings. However, reduced diversions really are the result of decreased deep percolation and decreased surface runoff—water that was being indirectly used for other existing beneficial uses. To continue to meet crop needs, fields that depended on surface runoff for their supplies now have added new wells. The result is that indirect reuse that was occurring in Figure 4-7 from surface runoff and deep percolation now occurs through increased direct groundwater pumping.

Increased pumping, coupled with decreased deep percolation, results in lower groundwater levels. When this happens, the river naturally will allow more water to recharge into the ground to maintain the balance (river depletion). With natural balancing and the need to maintain downstream target quantities, the seasonal reservoir releases remain the same as under existing conditions. No net decrease in seasonal water use has occurred. Thus, no water is available for reallocation out of basin.

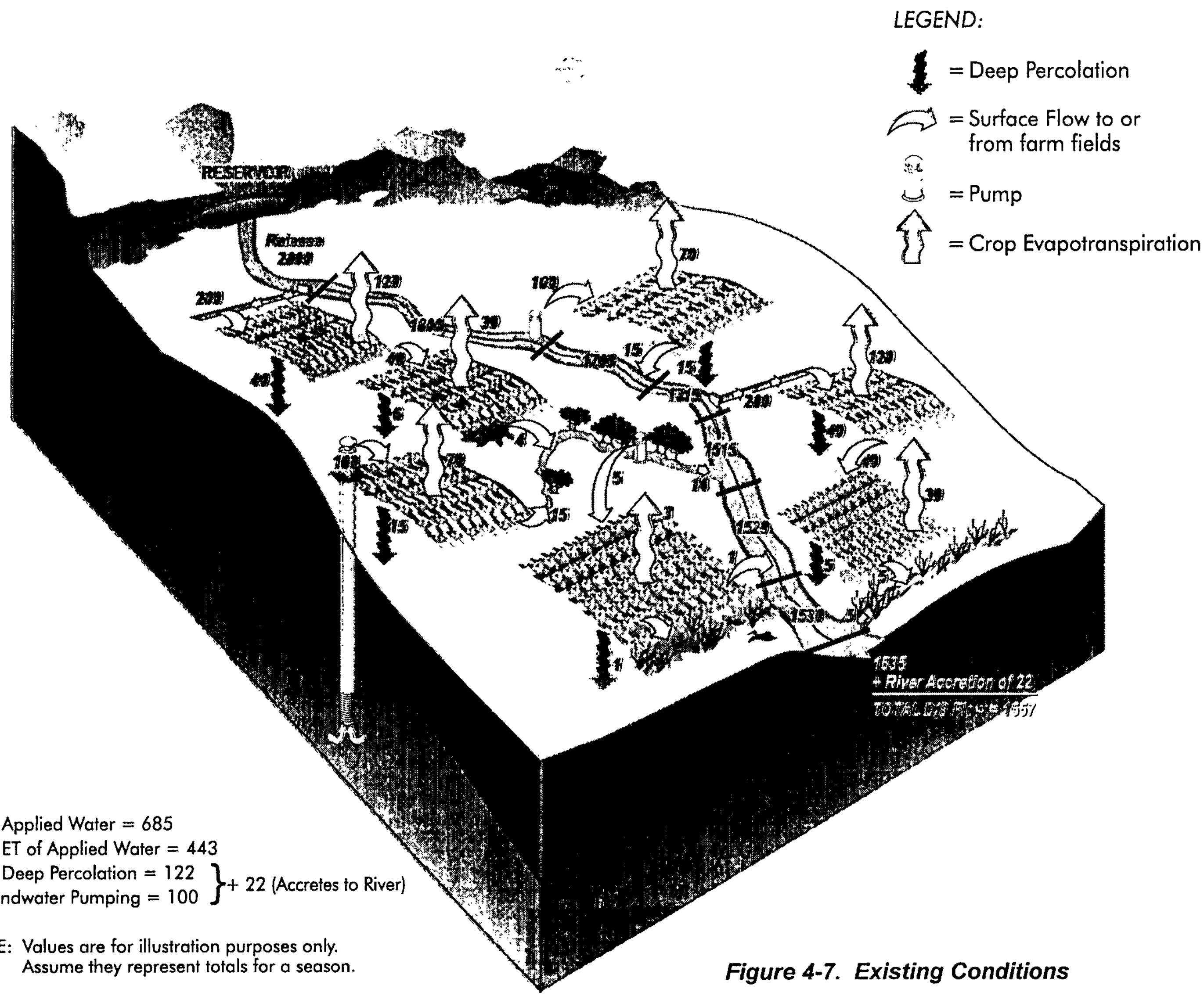
What does change is the seasonal management of water. For example, the seasonal quantity of water instream is higher in Figure 4-8 than under existing conditions, and surface return flows as well as direct stream diversions have been reduced. Indirect use has been changed to manageable, direct use.

The focus should be placed on the benefit from each unit of water, not on the unit of water itself. Changing to more manageable direct use can provide benefits desired by CALFED.

When comparing the two figures, the reduced diversions can reduce entrainment of aquatic species; reduced return flows can result in better in-stream water quality, although reduced return flows also may adversely affect drainage habitat. In addition, the increased in-stream flows can be re-regulated and released from reservoirs to correspond to fishery or other aquatic habitat needs (for example, fish attraction or out-migration flows) rather than for irrigation demands. This is not a water supply that can be reallocated out-of-basin, however.

These important benefits can be gained through efficiency improvements with no adverse impact on local users. However, local users may not be able to justify the cost of implementing efficiency measures when compared to the local benefit they may experience. Thus, outside assistance may be necessary to help realize the more regional or global benefits from improved local water use management and efficiency.

A number of different scenarios other than what is shown on Figure 4-8 could be developed to show how hydrologic elements are interconnected. For example, instead of increased groundwater pumping, a new surface water link could be directly routed to the fields from the river or from an existing canal diversion. This link may help groundwater levels remain high and reduce river recharge but would increase total diversions. Or, a new diversion could be constructed downstream and water pumped back upslope to each of the fields, with existing river diversions abandoned. This may reduce diversion impacts from a particular sensitive reach of the stream but would not change total diversions. Each of these scenarios would create different benefits and impacts. For example, pumping water back upslope would require more energy compared to using a gravity-based system. The array of possibilities underscores the importance to analyze each opportunity individually. What works well in one location may be detrimental in another.



Total Applied Water = 685
Total ET of Applied Water = 443
Total Deep Percolation = 122 } + 22 (Accretes to River)
Groundwater Pumping = 100 }

NOTE: Values are for illustration purposes only. Assume they represent totals for a season.

Figure 4-7. Existing Conditions

Showing Interaction Between Applied Water, Beneficial Uses, Reuse, Groundwater, River Flows, and Downstream Target Flow.

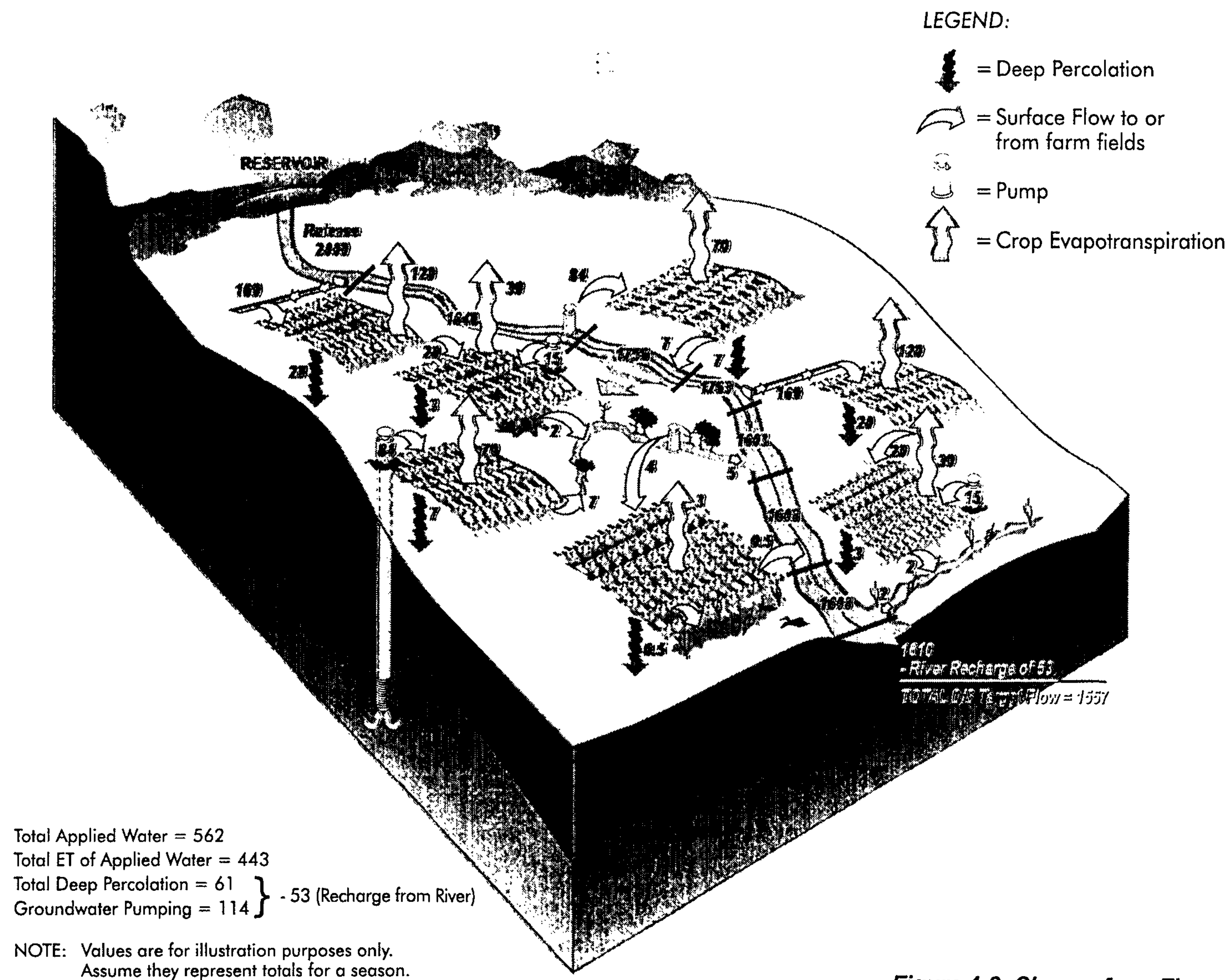


Figure 4-8. Change from Figure 4.7 Resulting from On-Farm Efficiency Improvements

4.6 ASSESSING BENEFITS FROM A BASIN-WIDE VIEW

It is important to note that in some instances water associated with irrecoverable losses provides a benefit and conservation of the losses could be detrimental. For example, agricultural drainage flow in the Imperial Valley currently flows to the Salton Sea. As stated above, these flows are considered irrecoverable losses because of their unavoidable degraded quality—in this case, as a result of leaching salts from the soil profile. However, these flows serve an important role in providing necessary dilution water for toxic drainage inflow from other sources, such as the New River, flowing to the Salton Sea from Mexico. In addition, they provide relatively fresh water to help maintain lake salinity and elevation levels.

Another example of irrecoverable losses providing a benefit is the Salinas Valley, where sea water intrusion into inland areas is an ongoing battle. The result is contamination of groundwater and associated wells with salty ocean water. Deep percolation resulting from inefficiencies helps maintain high groundwater levels that act to hold back the intrusion of sea water.

All aspects of a basin's hydrology should be considered as part of on-farm and district-level improvements. Analysis should be undertaken using basin-wide approaches that look for net benefits. These efforts will be assisted through the CALFED actions outlined in Section 2.

4.7 ESTIMATING AGRICULTURAL WATER CONSERVATION POTENTIAL

The methodology used to estimate agricultural water conservation potential that may result from implementing the Water Use Efficiency Program is described in this subsection. The methodology consists of:

- Input data necessary to develop estimates,
- Assumptions made to interpret and analyze data, and
- Presentation of conservation estimates: No Action Alternative versus a CALFED Program solution and farm-level versus district-level savings.

These estimates were developed to help understand the potential role conservation could play in the larger context of statewide water management, as well as to provide information for the programmatic-level impact analysis. **These estimates are not targets or goals and should not be interpreted as such,** or used for planning purposes.

DEFINING THE DATA

Misuse of terminology can cause significant difficulties with understanding and interpreting the data. To help ensure consistency in using key terms, CALFED adopted the DWR definitions described below.

From DWR's January 1998, public review draft of "The California Water Plan Update: Bulletin 160-98":

Applied Water Demand: The amount of water from any source needed to meet the demand of the user. It is the quantity of water delivered to any of the following locations:

- The intake to a city water system or factory
- The farm headgate or other point of measurement
- A managed wetland, either directly or by drainage flows.

Irrecoverable Losses: The water lost to a salt sink or lost by evaporation or evapotranspiration from a conveyance facility, drainage canal, or fringe areas (for example, surface runoff from a farm field that flows to an evaporation pond).

Recovered Losses: The water returning to a local surface water or groundwater source available for other beneficial uses (for example, surface runoff from a farm field that flows back to a surface stream used by other downstream beneficiaries, including the environment).

Depletion (DEP): The water consumed in a service area and no longer available as a source of supply. For agriculture and wetlands, depletion is evapotranspiration of applied water plus irrecoverable losses. This amount can include conveyance evaporation and evapotranspiration of vegetation lining delivery systems.

Evapotranspiration (ET): The quantity of water transpired (given off), retained in plant tissue, and evaporated from plant tissue and surrounding soil surfaces.

Evapotranspiration of Applied Water (ETAW): The portion of total evapotranspiration that is provided by irrigation. This value is adjusted to account for portions of rainfall that help meet ET.

4.7.1 Input Data Necessary to Develop Estimates

Input data are one of the most important pieces of information when performing a technical analysis because the quality of the data directly bears on the analytical results. Therefore, it is crucial that the data are reliable and widely accepted as credible and applicable for the analysis. With this in mind, the CALFED Program obtained the best available data on regional agricultural water use for its agricultural water conservation analysis.

DWR has collected agricultural water use data for nearly 40 years throughout the state; these records are among the most thorough of their kind. DWR's data regarding historical and "normalized" water use is widely accepted as an accurate picture of existing and historical agricultural water use conditions. To estimate conservation potential, CALFED used normalized 1995 data. These data were adjusted by DWR to reflect "normal" conditions of farmed acres and crop distribution that would have occurred in 1995 had weather patterns and water supply been "normal."

SEPARATING EVAPORATION AND TRANSPIRATION

The terms evaporation, transpiration and evapotranspiration historic-ally have been used in the context of agricultural water use as follows:

Evaporation (E) is the conversion of liquid water to vapor. It generally refers to water evaporated from soil surfaces, flowing water in fields (furrows and sprinkler droplets) and water intercepted on plant leaves.

Transpiration (T) refers to water that passes through the plant and into the atmosphere as vapor. In addition to the climatic conditions that a plant is exposed to (solar radiation and atmospheric conditions), transpiration is affected by evaporation on or near the plant.

Evapotranspiration (ET) is the combination of evaporation and transpiration. The combined ET process is controlled or influenced by soil, crop, irrigation, and atmospheric factors. Evaporation from surrounding areas reduces transpiration, while the absence of evaporation from soil or wet plant surfaces increases transpiration (Burt et al.). However, little research has been completed that quantifies this relationship.

Since E and T are difficult to measure individually, the combined ET generally is used to calculate crop water use. This is not to imply that separating these factors could not provide insight into additional water conservation benefits. The CALFED Program acknowledges the potential for some conservation savings from reducing evaporation, especially evaporation from the soil surface.

For this document, however, CALFED did not attempt to separate these two factors because of limited availability of relational data. The Water Use Efficiency Program does include an action targeted at this information void in an effort to better understand the relationship between E and T so that more accurate conservation estimates can be made. In the interim, the data available to CALFED to estimate conservation potential are believed to still adequately estimate realistic conservation potential.

Actual 1995 conditions of applied water were lower because of wet hydrologic conditions that increased effective rainfall, thus decreasing applied water use. It is important to note that using normalized data instead of actual historical data for 1995 reduced the potential for over- or under-representing average applied water volumes and thus over- or under-representing conservation potential.

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For example, the actual acreage in 1995 may be greater than in other years because of ample water supplies. Using actual data that represent a higher than average use of water would result in over-estimating the average conservation potential.

The 1995 normalized data were used for estimating conservation potential because:

- Data were adjusted for changes in cropping and water management practices that have occurred since the 1987-92 drought and since implementation of portions of the CVPIA (as compared to normalized 1990 data used by CALFED for previous estimates).
- Represent the best information about conditions that provide a useful basis for estimating current conservation potential versus an uncertain projection of future conditions.
- DWR generates agricultural water use data for many small subareas throughout the state based on a multitude of data inputs, including land use and crop water needs. Each subarea is compiled into Planning Subareas (PSAs), which are a subset of the larger hydrologic regions often referred to during water use discussions (such as the Sacramento River and South Coast Regions.) As discussed in Section 3, the CALFED regions used to present information in this document are different from DWR's hydrologic regions, comprised by varying combinations of DWR's PSAs.

To estimate conservation potential for each CALFED region, three PSA data points were obtained from DWR:

- 1995 normalized agricultural applied water (AW)
- 1995 normalized agricultural depletions (DEP)
- 1995 normalized agricultural evapotranspiration of applied water (ETAW)

Table 4-1 summarizes the PSA data obtained from DWR (data have been aggregated for the CALFED regions described in Section 3).

Table 4-1. 1995 Normalized Agricultural Water Use Data Received from DWR (TAF)

REGION[1]	APPLIED WATER[2]	DEPLETION[2]	CROP ETAW[2]
Sacramento River	6,278	4,321	4,096
Delta	1,116	780	758
Westside San Joaquin River	1,361	1,041	973
Eastside San Joaquin River	4,043	2,885	2,781
Tulare Lake	9,209	7,496	6,894
San Francisco Bay	97	86	74
Central Coast	48	39	38
South Coast	755	665	542
Colorado River	2,812	2,742	2,177
Total	**25,719**	**20,055**	**18,333**

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.
[2] Data have been aggregated for the CALFED regions.

4.7.2 ASSUMPTIONS USED TO INTERPRET AND ANALYZE DATA

The assumptions used to interpret and analyze the data are the second most important aspect of a technical analysis, only slightly less important than the input data. It is crucial for the reader to fully understand what assumptions were made to estimate conservation potential. This focuses the reader's attention on the assumptions and their impact on the results, not only on the results.

Estimating conservation potential for California's irrigated agriculture is difficult because of its complexity and variable conditions. The methodology used here was made as simple as possible, while still providing useful results, by using only the three input parameters shown in Table 4-1 and a handful of assumptions.

Assumptions are discussed below in more detail for each of the following:

a. Calculating "existing loss" and "irrecoverable loss" from input data, including:
    a. Defining losses and subtracting input data.

Once these values are determined, it is necessary to perform the next step:

b. Segregating losses into "conservable" and "nonconservable," including determining the amount of water:

    a. Necessary for leaching and
    b. Lost to channel evaporation and consumption by riparian and bank vegetation.

Finally:

(3) The conservable water is split into categories of the:

    a. No Action Alternative increment,
    b. CALFED increment, and
    c. Remaining increment.

The following example table, similar to the specific regional tables provided in Attachment A, was included to illustrate how each assumption and sub-assumption is applied and how calculations were made. Letters (A, B, and C) were used to point the reader to the appropriate location on the example table as each assumption and calculation is discussed. The input data are shown in the example table at area "A."

Figure 4-9 Determination of Potential Agricultural Conservation Savings

Example Region

Input Data from DWR

A

Applied Water	2,500	(1,000 af)
Depletion	2,000	(1,000 af)
ET of Applied Water	1,800	(1,000 af)

Assumptions for Calculations

C

1. Ave. Leaching Fraction = 5%

D

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

I

canal lining:	1	
tailwater:	1	(adjustment factor
flexibility:	1	based on region variation
meas/price:	1	in water districts)
	4	(points for this region's districts of 4 points for average)
	1	**= adjustment factor**
	33%	= district portion
	67%	= on-farm portion

Calculations from Input Data

B **E** **F**

	(1,000 af)	
Total Existing Losses	**700**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	**200**	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**500**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	29%	(Irrecov divided by total existing losses)
Portion lost to leaching	26	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	50	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	624	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	**124**	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	**500**	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

G

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	250	50	200
CALFED Increment =	next 30%	0.30	187	37	150
Remaining =	final 30%	0 30	187	37	150
			624	124	500

Summary of Savings:

Existing Applied Water Use = 2,500

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	167	125	292
District	--	83	62	145
Total	700	250	187	437

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	133	100	233
District	--	67	50	117
Total	500	200	150	350

H

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	33	25	58
District	--	17	12	29
Total	200	50	37	87

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR*Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Calculating Existing Loss and Irrecoverable Loss from Input Data

Three kinds of losses need to be calculated from the input data to estimate conservation potential. These include:

- "Existing loss," which is determined by taking the difference between the AW and the ETAW. (This is equivalent to the total applied water reduction feasible if CALFED assumed 100% irrigation efficiency and no irrecoverable losses during delivery of the water to the plant—and that every drop of applied water is consumed by the plant with no water necessary for leaching or cultural practices.)

- "Irrecoverable loss," a subset of "existing loss," which is determined by taking the difference between the DEP and ETAW. (This is equivalent to the fraction of the total applied water reduction that could be made available to other beneficial uses—again assuming 100% irrigation efficiency.)

- "Recoverable loss," also a subset of "existing loss," is the difference between "irrecoverable loss" and "existing loss."

Calculating existing loss and irrecoverable loss is the basis of the agricultural water conservation estimate because these values are the only water available for conservation. For example, looking at area "B" on the example table, the loss values are determined as follows:

From the input data (area "A"):	AW	=	2,500
	DEP	=	2,000
	ETAW	=	1,800
Then:	Existing loss	=	2,500 - 1,800, or 700
	Irrecoverable loss	=	2,000 - 1,800, or 200
	Recoverable loss	=	700 - 200, or 500

In this example, irrecoverable losses are 29% of the total existing loss. This ratio is an important indicator of the mix of irrecoverable and recoverable losses in a particular region. The ratio will vary with each region because of such factors as varied climate, soil type, geography, and location of each agricultural field. For this document, each region's ratio is considered to be equal across the entire region, except for the Tulare Lake Region (see Tulare Lake information under the regional discussions later in this chapter), which is adjusted to account for differences in water quality as a result of two different primary water supply sources (the Delta and the eastern Sierra Nevada).

The calculated existing loss is a result of on-farm irrigation and district delivery methods. Applying water for too many hours, applying water in a non-uniform pattern across a field, spilling water through the end of a delivery system, and many other activities all are examples of how existing losses are generated. However, some of the existing losses are a necessary or unavoidable part of the on-farm management or water delivery to a field. Necessary or unavoidable existing losses include leaching of salts from the soil profile, evaporation from conveyance channels, and consumption by bank vegetation along open delivery canals. These kinds of losses are described in more detail later.

As should be expected, the accuracy of these calculations is only as good as the input data provided. If the ETAW value is off by 5%, then the calculated loss value may be mis-representative. CALFED did not extensively review the input data received from DWR. However, the methods used by DWR to generate these data have been refined over many years by competent engineers and technicians. For this analysis, CALFED assumed that these data are as accurate as any available and well suited for portraying estimated conservation potential at a programmatic level.

The existing loss and irrecoverable loss values calculated from the input data are presented in Table 4-2. The regional discussion later in this section repeats this information. Again, Attachment A provides the detailed assumptions for each region.

Table 4-2. Losses Calculated from Input Data Received from DWR (TAF)

REGION[1]	EXISTING LOSS	IRRECOVERABLE LOSS[2]	LOSS RATIO (IRRECOVERABLE/ EXISTING)	RECOVERABLE LOSS[3]
Sacramento River	2,182	225	10%	1,957
Delta	358	22	6%	336
Westside San Joaquin River	388	68	18%	270
Eastside San Joaquin River	1,262	104	8%	1,158
Tulare Lake	2,315	602	26%	1,713
San Francisco Bay	23	12	52%	11
Central Coast	10	1	10%	9
South Coast	213	123	58%	90
Colorado River	635	565	89%	70
Total	**7,386**	**1,722**		**5,664**

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

[2] This is a subset of existing loss and represents the total potential if 100% of the applied water was used by the crop. However, since leaching of salts from the soil is necessary, other losses occur that are mostly uncontrollable (canal evaporation and ET of riparian and bank vegetation), and 100% efficiency is nearly impossible to obtain, the total calculated does not equal the total conservable.

[3] This is defined as the difference between existing loss and irrecoverable loss.

Segregating Losses into Conservable and Nonconservable

Conserving water is defined for this section as reducing the amount of water necessary for the continued beneficial uses of agriculture at existing levels. Therefore, conservation does not mean a reduction in the consumptive use by crops (land fallowing, crop shifting, and deficit irrigation are not considered "water conservation" measures). Also, conserving water is independent of whether the water conserved is available for reallocation to other beneficial uses (see previous discussion in Section 4.4, "Irrecoverable vs. Recoverable Losses").

As previously stated, the losses calculated from the input data represent the total of a region's existing loss. However, all of this loss cannot be considered "conservable" because of the following factors:

- The technical limit of reaching very high average on-farm efficiency (see the previous discussion regarding on-farm irrigation efficiency improvements in Section 4.4).

- The need to leach salts from the soil profile to maintain a crop root zone capable of sustained productivity (referred to as the leaching requirement or leaching fraction).

- Evaporative and consumptive losses from district and field-level delivery ditches that are generally open and support riparian and bank vegetation (including trees, shrubs, and grasses). Delivering water in pipes to avoid evaporative losses is often not feasible because of the capital cost to build a high-capacity distribution system and the energy costs to operate it, if it is pressurized.

Although each of these factors contributes to the existing loss, they dictate what portion of the loss should be considered unavailable to conservation efforts. Thus, when these contributors are subtracted from the existing loss value, a more realistic estimate can be made of the conservation potential.

Of these contributors to existing loss, the water evaporated or consumed by riparian or bank vegetation is considered to be an entirely irrecoverable loss since its "use" removes water from the local hydrologic system (see previous discussion in Section 4.4, "Irrecoverable vs. Recoverable Losses"). Also, depending on the characteristics of each region, some or all of the water used for leaching is unavailable to the local water supply. For instance, water used to leach salts from some lands on the west side of the San Joaquin Valley is intercepted by subsurface drains and routed to evaporation ponds. Every acre-foot of this water is lost. On the other hand, some areas of the Sacramento Valley that need to leach salts find that their "leach" water simply flows to groundwater or back into surface water sources, available to others but slightly degraded in quality.

The losses just described are defined as irrecoverable but are not conservable since they are necessary parts of the water management dynamic. These losses are distinguished from losses resulting from poor irrigation methods or spills from district delivery systems that flow to a salt sink. The latter losses also are defined as irrecoverable but are conservable.

As a starting point for determining what water could be conserved, these irrecoverable, non-conservable contributors need to be subtracted from the total existing loss and, since they are defined as irrecoverable losses, they must also be subtracted from the irrecoverable losses shown in Table 4-2.

Since empirical information primarily exists for estimating leaching requirements and channel evaporation and bank consumption, two of the three factors associated with nonconservable losses, only these factors initially can be subtracted from the existing loss values. Estimating water unavailable to conservation as a result of technical limitations is more difficult to calculate and is therefore handled in a different manner (see later discussion regarding "Distributing Conservable Water Across a Range of Efficiency Improvements"). A more complete discussion of how these values are derived follows.

Calculating Nonconservable Water

Water deemed "nonconservable" is water that is necessary for sustainable agricultural productivity but contributes to the total existing loss. This amount includes water used to leach salts, as well as water evaporating from delivery canals, or being consumed by riparian or bank vegetation growing along the delivery system channels and drains throughout the state.

The nonconservable portion must first be subtracted from the calculated losses to estimate conservable water. To do this, CALFED made assumptions to estimate leaching requirements and evaporation and consumption along delivery canals.

Leaching Requirement. The leaching requirement is defined as "the fraction of infiltrated irrigation water that percolates below the root zone necessary to keep soil salinity, chloride, or sodium (the choice being that which is most demanding) from exceeding a tolerance level of the crop in question. It applies to steady-state or long-term average conditions" (Soil Science Society of America web page July 1998).

To estimate the leaching requirement for most fields, an empirical relationship between irrigation water salinity (if this is the parameter of concern) and the desired salinity level in the root zone (based on a crop's threshold) is used. It is calculated using the formula developed by the USDA-Salinity Laboratory and taking the idealized root zone salt accumulation pattern for surface irrigated soil:

YR = ECUS/(5ECe-ECUS)

where ECUS is the salinity of irrigation water and ECe is the soil salinity of soil saturation extract. The threshold salinity level is the maximum soil salinity that does not significantly reduce yield below that obtained under nonsaline conditions. (Maas and Hoffman 1977.) For cotton and tomato, which have a very high tolerance to salinity, the threshold salinity levels are about 7.7 dS/m and 2.5 dS/m, respectively. For a similar soil profile—based solely on the aspect of salinity, assuming no changes in soil salinity throughout an irrigation season and no groundwater contribution to the plant water requirement—the YR ratio is constant within a fixed geographic location. However, the net depth of applied irrigation water for the same crop and similar soil, irrigation quality, and irrigation method might not be the same due to differences in climatic conditions in different parts of the state. This is because irrigation leaching depth is:

[(ETAW - effective precipitation + other cultural practices) * leaching requirement percentage]

Since ETAW for the same crop, precipitation, and cultural practices may vary from one geographic location to another and from one field to another, net irrigation leaching depth also varies accordingly. Another factor affecting the depth of irrigation leaching requirement is irrigation DU (the evenness of irrigation water application over a field, as discussed previously), which may contribute to leaching salt from the root zone. Therefore, excess irrigation water due to non-uniformity may help leach irrigation salt buildup in some parts of a field and, in return, reduce the irrigation leaching requirement depth for portions of a field.

However, all of this information is specific to individual fields, and the formulas are difficult to use for determining average leaching requirements across an entire region. Therefore, to estimate the amount of existing loss generated from leaching for each region, CALFED made assumptions, based on professional judgement, about the average leaching requirement in each region. Spot checking these assumptions with the formula supported this approach.

To account for variation in leaching requirements and the uncertainty of knowing the exact requirement when considering DU and other variables, a range of values was used for each region (see Table 4-3). To calculate the volume of total loss contributed by leaching, the leaching requirement was multiplied by the ETAW and the loss ratio values shown previously in Table 4-2. The resulting values were subtracted from the existing loss and the irrecoverable loss, respectively, to help estimate conservation potential. As illustrated on the example table, the leaching requirement ("C") was multiplied by the ETAW ("A") and the Ratio of Irrecoverable Losses ("B"). This results in an assumed loss derived from the water necessary for leaching ("E"). For each of the CALFED regions, the leaching requirements shown in Table 4-3 were assumed, resulting in the "loss from leaching."

Table 4-3. Range of Leaching Requirement Volumes

REGION	ASSUMED LEACHING REQUIREMENT[1]	RANGE OF POSSIBLE LOSS FROM LEACHING REQUIREMENT[2] (TAF)
Sacramento River	2-4%	8-17
Delta	4-6%	1-2
Westside San Joaquin River	10-14%	17-24
Eastside San Joaquin River	2-4%	5-9
Tulare Lake	8-12%	179-269
San Francisco Bay	4-6%	1-2
Central Coast	4-6%	0-1
South Coast	10-14%	41-57
Colorado River	10-14%	194-271
Total		**446-652**

[1] These percentages represent average leaching requirements for each region. Source water quality dictates higher leaching requirements. For example, water salinity levels in the Sacramento Valley are low but levels in water exported from the Delta to the west side of the San Joaquin Valley and parts of the Tulare Basin are 10 times higher. The Tulare Lake Region has salinity levels that range from high for areas receiving Delta water to low for areas receiving water from the Sierra Nevada. These values are based on professional judgment, following discussion with several irrigation experts.

[2] These values were calculated by multiplying the leaching requirement percentage by the evapotranspiration of applied water and the loss ratio presented in Table 4-2. They are defined as irrecoverable losses but are not conservable. Subtracting them from the total existing loss helps estimate remaining conservation potential. Subtracting them from the total irrecoverable loss helps estimate the conservation potential that is available for reallocation to other purposes.

Channel Evaporation and Consumption by Riparian and Bank Vegetation. Channel evaporation and conveyance consumption also are defined as irrecoverable losses and are considered nonconservable. Therefore, these amounts need to be subtracted from the total existing loss for a more accurate estimate of conservation potential.

Hundreds of miles of irrigation delivery canals, channels, and drainage systems move water from surface and subsurface sources to or away from farm fields throughout the state. Most of these systems are open channels with vegetation on both sides. Enclosing these channels and canals or removing all of the natural vegetation is not practical for most water suppliers, although it may be ideal from a water management standpoint. In many instances, the vegetation systems that have developed along some of these channels provide important riparian habitat in areas where the rest of the land is dedicated to production agriculture. Furthermore, the cost to convert delivery and drainage channels to pipelines in order to reduce evaporation is not cost effective for most water suppliers.

For this document, CALFED assumed that channel evaporation and conveyance consumption are not conservable and therefore need to be subtracted from the total existing loss values presented in Table 4-2.

To estimate how much of the existing loss is attributable to these factors, CALFED assumed:

Channel evaporation and conveyance consumption is equal to 2-4% of applied water.

This assumption is based on investigations made by Reclamation in the "Least-Cost CVP Yield Increase Plan" (DOI 1995) and supporting appendices. The Reclamation report was based on DWR data developed as part of DWR micro-scale water balances. (DWR uses Detailed Analysis Units [DAUs] for their smallest hydrologic scale; for example, there are 33 DAUs for the Sacramento River Region alone). In these water balances, DWR estimated water lost to evaporation and channel consumption. When compared to the conveyance loss values presented in the Reclamation report, the CALFED assumption is supported. The CALFED assumption multiplied by the applied water data in Table 4-1 results in a range of loss that encompasses the values stated by Reclamation). In the example table, this calculation is derived by multiplying the percentage lost to channel evaporation and consumption ("D") by the applied water input data ("A"). The results are presented in area "E."

This relationship provides the best available information since accurately determining the amount of water loss to channel evaporation and consumption is nearly impossible. For CALFED's purposes, using either the Reclamation actual data or the original DWR data did not appear to provide significant improvements in the accuracy of conservation estimates versus using the assumed percentages. Table 4-4 presents the resulting estimate of channel evaporation and conveyance consumption.

Table 4-4. Range of Channel Evaporation and Conveyance Consumption Values (TAF)

REGION	APPLIED WATER[1]	RANGE OF POSSIBLE LOSS FROM CHANNEL EVAPORATION AND BANK CONSUMPTION[2]
Sacramento River	6,278	125-250
Delta	1,116	22-44
Westside San Joaquin River	1,361	27-54
Eastside San Joaquin River	4,043	80-160
Tulare Lake	9,209	185-370 3
San Francisco Bay	97	2-4
Central Coast	48	1-2
South Coast	755	15-30
Colorado River	2,812	56-112
Total	**25,719**	**513-1,026**

[1] See Table 4-1.

[2] These values were calculated by multiplying the applied water value by 2% and 4%, respectively. They are defined as irrecoverable losses but are not conservable. Subtracting them from the total loss helps estimate remaining conservation potential. Subtracting them from the total irrecoverable loss helps estimate the conservation potential that is available for reallocation to other purposes.

[3] The Tulare Lake Region has such a high applied water value that the range of channel evaporation/ET is reduced to only 2-3%.

Calculating Remaining Conservable Water

Before moving on to the next set of assumptions used in estimating conservation potential, the irrecoverable, nonconservable values calculated above need to be subtracted from the existing and irrecoverable loss values calculated previously (see area "B" on the example table). Table 4-5 presents the remaining existing loss and irrecoverable loss eligible for conservation. These values are still subject to technical limits in on-farm irrigation and district delivery systems that will further decrease the final estimated conservation potential. This is discussed in more detail in the next subsection. On the example table, these results are shown in area "F."

Table 4-5. Remaining Conservable Losses (TAF)

REGION	EXISTING LOSS [1]	IRRECOVERABLE LOSS [2]	RANGE OF REMAINING EXISTING LOSS [2]	RANGE OF REMAINING IRRECOVERABLE LOSS [3]
Sacramento River	2,182	225	1,915-2,049	0-92
Delta	358	22	312-355	0
Westside San Joaquin River	388	68	310-344	0-24
Eastside San Joaquin River	1,262	104	1,093-1,177	0-19
Tulare Lake	2,315	602	1,676-1,951	57-238
San Francisco Bay	23	12	17-20	6-9
Central Coast	10	1	7-9	0
South Coast	213	123	126-157	36-67
Colorado River	635	565	252-385	182-315
Total	**7,386**	**1,722**	**5,708-6,447**	**281-764**

[1] See Table 4-2.

[2] Value is calculated by subtracting the leaching requirement (see Table 4-3) and the channel evaporation and consumption (see Table 4-4) from the existing loss. This value is available for conservation resulting from improved on-farm irrigation and district delivery practices.

[3] Value is calculated by subtracting the leaching requirement (see Table 4-3) and the channel evaporation and consumption (see Table 4-4) from the irrecoverable loss. As a subset of the existing loss, this value is available for conservation resulting from improved on-farm irrigation and district delivery practices.

Splitting Conservation Potential among No Action Alternative, CALFED, and Remaining Increments

The conservable water is defined as the remaining existing loss after the nonconservable portions are subtracted (see Table 4-5), with the exception of accounting for the technology limit previously noted. To conserve the entire potential, all farms and delivery systems would need to achieve 100% efficiency in their delivery to the growing plant. Realistically, this is not possible because of technical limits in manufacturing, managing, and maintaining on-farm and district delivery systems. However, saving a portion of this amount is possible.

CALFED has assumed that 40% of the potential can be conserved under the No Action Alternative and an additional 30% can be conserved as a result of CALFED alternative scenarios. Thus, CALFED assumes that 70% of the estimated conservation potential can be achieved. The remaining 30% is considered nonattainable due to technology and management limits.

To estimate the conservation savings for each increment (the No Action Alternative and CALFED solution alternative), the conservable water was split into three pieces based on the 40% and 30% assumed limits, respectively. On the example table, this is shown in area "G." The incremental savings corresponding to the No Action Alternative and CALFED alternative scenarios are identified.

The non-linear distribution assumes that the majority of the water saving potential can be achieved with initial efficiency improvements and that saving water becomes increasingly more difficult as 100% efficiency is approached.

When applied to the conservable water values shown in Table 4-5, these factors allow an estimate of how much of the total conservation potential can be saved as efficiency incrementally improves. Tables provided in Attachment A present the distribution for each region along with all of the other assumptions used to derive potential conservation savings. On the example table, this is shown in area "G."

4.7.3 CONSERVATION ESTIMATES: NO ACTION ALTERNATIVE VS. CALFED SOLUTION AND FARM-LEVEL VS. DISTRICT-LEVEL SAVINGS

As previously discussed, CALFED assumes that 70% of the conservation potential can be achieved as a result of the Water Use Efficiency Program. The No Action Alternative increment comprises the first 40% of this value.

Estimated conservation potential for the No Action Alternative increment and the CALFED increment were distinguished by taking the incremental savings (described in the previous subsection):

No Action Alternative increment	=	**First 40%**
CALFED increment	=	**Next 30%**
Remaining increment	=	**Final 30%**

Regional tables on the following pages present values for each of the nine CALFED regions. The values are displayed in three different tables to distinguish between different benefits of the savings (see area "H" on the example table):

- ***Recovered Losses with Potential for Rerouting Flows*** - These losses currently return to the water system, either as groundwater recharge, river accretion, or direct reuse. Reduction in these losses would not increase the overall volume of water but might result in other benefits, such as improving water quality, decreasing diversion impacts, improving flow between the point of diversion and the point of return, or potentially making water available for irrigation or in-stream flows during dry periods. (See Section 4.4, "Irrecoverable vs. Recoverable Losses.")
- ***Potential for Recovering Currently Irrecoverable Losses*** - These losses currently flow to a salt sink, degraded aquifer, or the atmosphere and are unavailable for reuse. Reduction in these losses would increase the volume of useable water (reducing these losses can make water available for reallocation to other beneficial uses). (See Section 4.4, "Irrecoverable vs. Recoverable Losses.")
- ***Potential Reduction of Application*** - This is the sum of the previous reductions.

In addition to distinguishing between the No Action Alternative increment and the CALFED increment, the estimated conservation savings were separated into on-farm and district improvements. This distinction is provided to illustrate the general relationship between the losses and who may be able to conserve them. To estimate this split, CALFED assumed that, on average, two-thirds of the projected savings were attributable to on-farm improvements. One-third, therefore, was available to conserve through district improvements. This amount is expected to vary by district, however.

To allow for anticipated variation, an adjustment factor was created to account for four typical district-level types of improvements: canal lining, district tailwater recovery systems, delivery flexibility, and measurement and volumetric pricing. Each district has a different philosophy regarding these factors and will focus more on one or another. Furthermore, some districts will stress all factors, while others may not consider any or only one or two. For example, for a district that practices conjunctive management of groundwater and surface water resources, lining irrigation canals can result in negative consequences. Thus, the district may not invest money in this type of conservation measure.

Each factor was given a default value of "1.0," so that all districts are assumed to start with a "4.0." If the districts that comprise a particular CALFED region were considered more or less likely to emphasize a particular factor, the values were adjusted up or down. This was accomplished by adjusting each of the conservation measure's value such that their sum would add to greater, equal to, or less than the assumed starting value of "4.0." For instance, if a region's factors added to five, the percentage of savings attributed to district-level activities was adjusted upward (greater than one-third of the conservation potential was attributed to district-level improvements). If the factors added to less than 4, the adjustment was downward. On the example table, this concept is illustrated at area "I."

The assumptions made for each region are presented in Attachment A (see the "I" area for each). These assumptions were based on professional judgment, considering some of the districts that comprise each region. The adjusted district-level conservation estimates ranged from a low of 17% for the Delta and Eastside San Joaquin River Regions to a high of 42% for the Colorado River Region (the San Francisco Bay and Central Coast Region estimates were only 8% because most of the water is "self-supplied" on farm via groundwater).

These estimates are illustrative and may not fully represent each unique on-farm/district relationship. The remainder of this section documents the results of applying this methodology to each CALFED agricultural region.

4.8 REGIONAL REDUCTION ESTIMATES

Estimates of the results of efficiency improvements are presented here for each of the agricultural regions defined previously in Section 3, "Determination of Geographic Zones." The values presented are to help understand the potential role conservation could play in the larger context of statewide water management, as well as to provide information for purposes of a programmatic-level impact analysis. **These are estimated goals, not required targets, and should not be used for planning purposes.**

Estimates of the potential savings for applied water, irrecoverable losses, and recovered losses are provided for each agricultural region in the tables that follow. This information is included in Tables 4-6a through 4-14c.

4.8.1 AG1 - SACRAMENTO RIVER

The Sacramento River Region is defined by the Sacramento Valley, from the city of Sacramento north to Redding. The area is predominantly in agriculture but many growing communities are within its boundary, including the greater metropolitan areas of Sacramento. All rivers that flow into the valley are carried by the Sacramento River southward to the Sacramento-San Joaquin Delta (Delta). Here, surface flows head west to the Pacific Ocean. With abundant surface water and groundwater resources, agriculture in this region experiences few water shortages. Water users in the Sacramento Valley possess some of the oldest rights to surface water, with some dating back to the Gold Rush Era. Agricultural water use comprises about 58% of the region's total water use.

Typically, losses associated with agricultural water use in this region tend to return to the system of rivers, streams, and aquifers. Reuse of these losses is widely practiced. The region does not have significant irrecoverable losses, although water quality degradation does occur. Much of the region's groundwater resources are recharged by annual over-irrigation and deep percolation of applied water as well as subsurface inflow from the surrounding mountain ranges. This water is pumped by many of the areas agricultural lands that are irrigated solely with groundwater. In addition, tailwater from fields typically returns to streams and becomes part of the in-stream flow diverted for another farm, wetland, or city somewhere downstream.

Agricultural production is anticipated to remain constant into the future, with no significant decreases resulting from the urbanization of areas around Sacramento. New land brought into production is expected to offset any loss of land to urbanization.

AGRICULTURAL INFORMATION
Sacramento River Region

Types of crops grown:	Rice, trees, tomatoes, corn, sugar beets, some truck crops, alfalfa and pasture.
Irrigated land:	Approximately 1,700,000 acres.
Types of irrigation systems in use:	About 70% of the area is under surface irrigation (furrow or border). Drip/micro systems are more prevalent on trees but constitute only a small portion (<10%).
Average applied water:	Approximately 6.3 MAF annually.
Source of water:	Groundwater, about one-quarter of the supply.
	Surface water from the Sacramento, Feather, and American Rivers and various tributaries. Surface water is diverted at multiple points, both by individuals and by water districts. Water is stored in numerous reservoirs and released based mostly on agricultural demands.
	Reuse of losses is an important feature in this area, with deep percolation and tailwater runoff being recovered and reused for other beneficial uses.

Sacramento River Region

Table 4-6a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
On farm	--	511-546	383-410	894-956
District	--	255-273	191-204	446-477
Total	**2,182**	**766-819**	**574-614**	**1,340-1,433**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-6b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-6a)

USE	TOTAL EXISTING LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
On farm	-	0-24	0-18	0-42
District	-	0-12	0-9	0-21
Total	**225**	**0-36**	**0-27**	**0-63**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-6c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-6a)

USE	EXISTING EXISTING LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	-	511-522	383-392	894-914
District	-	255-261	191-195	446-456
Total	**1,957**	**766-783**	**574-587**	**1,340-1,370**

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.2 AG2 - DELTA

The Delta Region is characterized by a maze of tributaries, sloughs, and islands that encompass 738,000 acres. Lying at the confluence of California's two largest rivers, the Sacramento and the San Joaquin, it is a haven for plants and wildlife. Islands, protected from Delta waters by an extensive levee system, are used primarily for irrigated agriculture. The vast majority of the 500,000 acres of irrigated land in the Delta derive their water supply directly by diverting water from the adjacent tributaries, rivers, and sloughs. Agricultural land use is anticipated to decline in the future as a result of other CALFED ecosystem restoration activities.

The Delta Region is bounded on the north by the metropolitan area of Sacramento and on the south by the city of Tracy. The west is bounded by Chipps Island near the true confluence of the Sacramento and San Joaquin Rivers. There is little urban land use in the Delta; however, a few small farming communities are located in the region.

Local Delta water use is protected by a number of measures, such as the Delta Protection Act, the Watershed Protection Law, and water rights. Most water users have the right to divert water for beneficial uses on their land under the riparian water rights doctrine. Water diverted and applied to fields, but not consumed, typically is collected in drains and pumped back into the Delta waterways. Because of this recycling of losses, there is no potential to generate actual water savings available for reallocation to other beneficial uses.

AGRICULTURAL INFORMATION
Delta Region

Types of crops grown:	Tomatoes, corn, sugar beets, some truck crops, alfalfa, and pasture.
Irrigated land:	Approximately 500,000 acres.
Types of irrigation systems in use:	Most of the area is under surface irrigation (furrow or border). Some use of hand-move sprinklers also occurs but primarily for pre-irrigation and germination.
Average applied water:	Approximately 1.1 MAF annually
Source of water:	Groundwater, very limited use. Surface water is pumped directly from the Delta waterways. Reuse of losses is an important feature in this area, with tailwater runoff being pumped off each island back into Delta waterways.

Table 4-7a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	-	104-112	78-83	182-195
District	-	21-22	15-17	36-39
Total	**358**	**125-134**	**93-100**	**218-234**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-7b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-7a)

USE	EXISTING IRRECOVERED LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	-	0	0	0
District	-	0	0	0
Total	**22**	**0**	**0**	**0**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-7c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-7a)

USE	EXISTING RECOVERED LOSS2	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	--	104-112	78-83	182-195
District	-	21-22	15-17	36-39
Total	**336**	**125-134**	**93-100**	**218-234**

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.3 AG3 - WESTSIDE SAN JOAQUIN RIVER

The Westside San Joaquin River Region is bounded by Tracy on the north, the farming town of Mendota on the south, and the San Joaquin River on the east. Agriculture is the predominant feature in this region, with only a handful of small farming communities. Other than the San Joaquin River running along the eastern border, no major rivers provide surface water to the region. Most of the region's agriculture is supported by water exported through the California Aqueduct and the Delta Mendota Canal. These two canals are predominant features that run south through this region. Agricultural acreage is not anticipated to decline much in this area, other than what may result from higher water costs, some urbanization, and limited land retirement.

Toward the southern end of this region, referred to as the Grassland Area, agricultural drainage has become an increasing problem. Combinations of salts, imported by the canals, and naturally occurring trace minerals, such as selenium, have generated concern with drainage from agricultural fields. Some of this drainage results in deep percolation to shallow groundwater. This in turn has degraded the shallow groundwater, limiting potential reuse. Several studies have been completed or are under way to find solutions to the drainage problems, including efforts by the CALFED Program. It is anticipated that these efforts will result in source control measures, increased directed reuse of drain water on salt-tolerant crops (agroforestry), and possibly some land fallowing or land retirement. The source control measures will include improvements in on-farm irrigation efficiency, as well as other measures.

AGRICULTURAL INFORMATION
Westside San Joaquin River Region

Types of crops grown:	Cotton, tomatoes, corn, sugar beets, some truck crops, trees, vines, grain, pasture, and alfalfa.
Irrigated land:	Approximately 430,000 acres.
Types of irrigation systems in use:	Most of the area is under surface irrigation (furrow or border). Hand-move sprinklers are being used in combination with surface systems. Micro/drip systems are increasing in use for some row crops, such as peppers and tomatoes, and on trees.
Average applied water:	Approximately 1.36 MAF annually.
Source of water:	Groundwater is used extensively in the northern part of the region but is limited in the southern portion because of water quality degradation. Surface water is delivered primarily via the California Aqueduct or Delta Mendota Canal. Some surface water is delivered in exchange for San Joaquin River water. Indirect reuse of surface losses occurs regularly. Deep percolation, if not lost to degraded groundwater, also is reused.

Westside San Joaquin River Region

Table 4-8a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
On farm	-	78-86	58-64	136-150
District	-	46-51	35-39	81-90
Total	**388**	**124-137**	**93-103**	**217-240**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-8b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-8a)

USE	TOTAL EXISTING LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
On farm	-	0-6	0-4	0-10
District	-	0-3	0-3	0-6
Total	**68**	**0-9**	**0-7**	**0-16**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-8c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-8a)

USE	EXISTING RECOVERED LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	-	78-80	58-60	136-140
District	-	46-48	35-36	81-84
Total	**320**	**124-128**	**93-96**	**217-224**

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.4 AG4 - EASTSIDE SAN JOAQUIN RIVER

The Eastside San Joaquin River Region encompasses the area from the San Joaquin River near Fresno north to the Cosumnes River, and from the eastern foothills to San Joaquin River as it travels up the valley to the Delta. This area is predominantly agricultural but includes the metropolitan areas of Stockton, Modesto, and Merced along with numerous other communities. Several rivers originating in the Sierra Nevada flow out of the mountains and west into the San Joaquin River (as it travels through the center of the valley). These include the Merced, Tuolumne, Stanislaus, and Mokelumne Rivers, as well as other small tributaries. Natural flows and excellent water quality have provided ample supplies to the agricultural users on the east side of the valley.

Losses associated with applied water typically recharge groundwater or return to surface waterways. Either way, they are available again for other beneficial uses. Irrecoverable losses are almost non-existent. However, some degradation of shallow groundwater does occur as a result of deep percolation of salts and trace elements—primarily in the southern portion of this region and at the bottom of the valley trough.

Many of the local water districts have firm water rights dating back to the turn of the century. Some water is imported into the region via the Madera Canal. This water is diverted from the San Joaquin River at Millerton Lake and routed north to irrigate lands in Madera County. Otherwise, there are no major out-of-basin deliveries of water (as occurs in export regions). Agricultural acreage is anticipated to decline slightly in this region as a result of increased urbanization.

AGRICULTURAL INFORMATION
Eastside San Joaquin River Region

Types of crops grown:	Tomatoes, corn, sugar beets, some truck crops, trees, vines, alfalfa, and pasture.
Irrigated land:	Approximately 1,270,000 acres.
Types of irrigation systems in use:	Most of the area is under surface irrigation (furrow or border). Micro/drip systems are increasing in use for trees and vines.
Average applied water:	Approximately 4.04 MAF annually.
Source of water:	Groundwater, used for less than one-quarter of the water supply needs. An overdraft of approximately 200 TAF occurs annually, primarily in San Joaquin and Madera Counties. Surface water primarily originates in the Sierra Nevada and is of high quality. It is used for the majority of irrigation needs. Reuse of losses is an important feature in this area, with most losses either recharging the groundwater or returning to surface waterways.

Eastside San Joaquin River Region

Table 4-9a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	–	363-393	273-294	636-687
District	–	73-78	54-59	127-137
Total	**1,262**	**436-471**	**327-353**	**763-824**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-9b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-9a)

USE	EXISTING IRRECOVERED LOSS[1]	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	-	0-6	0-5	0-11
District	–	0-1	0-1	0-2
Total	**104**	**0-7**	**0-6**	**0-13**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-9c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-9a)

USE	EXISTING RECOVERED LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	–	363-386	273-289	636-675
District	–	73-77	54-58	127-135
Total	**1,158**	**436-463**	**327-347**	**763-810**

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.5 AG5 - TULARE LAKE

The Tulare Lake Region includes the southern San Joaquin Valley from the southern limit of the San Joaquin River watershed to the base of the Tehachapi Mountains. The area is predominantly agricultural, but many small agricultural communities as well as the rapidly growing cities of Fresno and Bakersfield are located here. The Kings, Kaweah, Tule, and Kern Rivers flow into this region from the east. All of the rivers terminate in the valley floor and do not drain to the ocean except in extremely wet years. This means there is also no outlet for drainage flows originating on farm. This area is considered a closed basin.

Because most of the source water is of very high quality, both surface and subsurface agricultural drainage is extensively reused, except along the western slope of the basin. In fact, **artificial recharge of groundwater basins, known as "groundwater banking,"** occurs in many areas of the Tulare Lake basin. This practice is likely to increase in future years as combined management of surface water and groundwater sources becomes more essential. On the western slope and in the southern end of the basin, significant quantities of water are imported from the Delta via the California Aqueduct. This water supplies areas like Westlands Water District and the member agencies of Kern County Water Agency.

Because of the closed-in nature of the basin (there is no drainage outlet except in very wet periods), salinity does buildup in the soils. As water is reused and natural salts present in the irrigation water are leached from the soil, the drainage water becomes increasingly salty. Several evaporation ponds have been constructed in portions of the basin to collect and evaporate this saltier drainwater. Drainage problems tend to occur only along the western slope of the basin and around the historic Tulare Lake bed. In these areas, the conservation of irrecoverable losses has some potential.

Irrigated agriculture accounts for about 95% of the water use in the region. In the future, increased urbanization and increasing costs for water could reduce the variety and acreage of crops being produced and, thus, the amount of agricultural water use (DWR 1994).

AGRICULTURAL INFORMATION
Tulare Lake Region

Types of crops grown:	Cotton, tomatoes, trees, row crops, truck crops, and vines. Double cropping of some crops also occurs.
Irrigated land:	Approximately 3,200,000 acres.
Types of irrigation systems in use:	About 70% of the area is under surface irrigation (furrow). Drip/micro systems are more prevalent on trees and vines but also are being used more extensively on row and truck crops.
Average applied water:	Approximately 9.2 MAF annually.
Source of water:	Groundwater, including a 500-600 TAF annual overdraft.
	Surface water from Kings, Kaweah, Tule, and Kern Rivers and imported supplies from the Friant-Kern system and the California Aqueduct.
	Reuse of losses is an important feature in this area, with more than 75% of deep percolation being recovered and reused.

Tulare Lake Region

Table 4-10a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS[1]	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	–	443-497	332-373	775-870
District	–	265-298	199-223	464-521
Total	2,315	708-795	531-596	1,239-1,391

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-10b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-10a)

USE	TOTAL IRRECOVERED LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	–	14-69	11-51	25-120
District	–	9-41	6-31	15-72
Total	602	23-110	17-82	40-192

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-10c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-10a)

USE	EXISTING RECOVERED LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	–	429	321	750
District	–	257	193	450
Total	1,713	685	514	1,199

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.6 AG6 - SAN FRANCISCO BAY

The San Francisco Bay Region is primarily urban with very little agricultural acreage. A 1990 land use survey shows only about 60,000 acres of agriculture in the region (DWR 1994). This amount represents a 60% reduction in 40 years. Agriculture only uses about 1% of the entire region's net water demand (80% of net demand is for environmental flows). Agricultural production generally is located on the outskirts of the urban areas and in isolated valleys, such as the Napa, Sonoma, and Livermore Valleys. More than half of the agricultural acreage is for wine grapes. It is anticipated that a small portion of the existing irrigated land will be lost to urbanization. However, the ability to grow vines in areas never before irrigated will add new acreage and result in little or no net change.

Because of the location of most of the agriculture, losses associated with irrigation are recaptured through deep percolation or surface runoff to streams and waterways. The region does not have irrecoverable losses associated with irrigated agriculture (urban use is discussed in a separate section).

AGRICULTURAL INFORMATION
San Francisco Bay Region

Types of crops grown:	Predominantly vineyards, with some truck crops and fruit trees.
Irrigated land:	Approximately 60,000 acres.
Types of irrigation systems in use:	Mostly pressurized systems using drip/micro or sprinklers.
Average applied water:	Approximately 97 TAF.
Source of water:	Groundwater is a key source for agriculture. Surface water is generated locally as well as imported from various areas, including directly from the Sierra Nevada and from the Delta. Reuse is an important feature in this area. Because losses typically recharge groundwater, no irrecoverable water is associated with agricultural use.

Table 4-11a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
On farm	-	6-7	5-6	11-13
District	-	1-1	0	1-1
Total	23	7-8	5-6	12-14

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-11b. Potential for Recovering Currently Irrecoverable Losses (TAF)
(Subset of 4-11a)

USE	TOTAL IRRECOVERED LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
On farm	-	2-4	2-3	4-7
District	-	0	0	0
Total	12	2-4	2-3	4-7

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-11c. Recovered Losses with Potential for Rerouting Flows (TAF)
(Subset of 4-11a)

USE	EXISTING RECOVERED LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	-	4	3	7
District	-	0	0	0
Total	11	4	3	7

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.7 AG7 - CENTRAL COAST

The Central Coast Region encompasses land on the western side of the coastal mountains that is hydraulically connected to the Bay-Delta region. This includes southern portions of the Santa Clara Valley and San Benito County. Most of the agricultural water supplies are generated within the region. However, about 50 TAF of Delta waters are exported annually to this region through the San Felipe Unit of the CVP. Exported water is delivered both to agricultural and urban users in San Benito and Santa Clara Counties. The San Benito River also provides surface water to agriculture in the area. The San Benito River joins with the Pajaro River and flows through the agricultural areas around Watsonville and then on to the ocean.

Some of the coastal area around Watsonville is experiencing sea water intrusion as a result of groundwater overdraft. To combat this, a proposed extension of the San Felipe pipeline may bring additional Delta waters to the Watsonville area.

Agricultural acreage in the upslope portions of the Santa Clara Valley and around Watsonville is anticipated to decline slightly in the future as a result of increased urbanization and increasingly high water costs.

AGRICULTURAL INFORMATION
Central Coast Region

Types of crops grown:	Truck crops, strawberries, artichokes, fruit trees, and vines.
Irrigated land:	Approximately 100,000 acres.
Types of irrigation systems in use:	Mostly pressurized systems using drip/micro or sprinklers. Some furrow irrigation still occurs.
Average applied water:	Approximately 48 TAF annually.
Source of water:	Groundwater is a main source of water for many truck crop fields, except in areas experiencing sea water intrusion. Overdraft conditions exist in some areas of the region. Imported water delivered from the San Felipe Unit. Other surface water originates in the San Benito River. Reuse is an important feature in this area. Losses typically recharge groundwater, but in some coastal areas, deep percolation is "lost" to degraded groundwater.

Central Coast Region

Table 4-12a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	–	3-4	2-3	5-7
District	–	0	0	0
Total	**10**	**3-4**	**2-3**	**5-7**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-12b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-12a)

USE	TOTAL IRRECOVERED LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	–	0	0	0
District	–	0	0	0
Total	**1**	**0**	**0**	**0**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-12c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-12a)

USE	EXISTING RECOVERED LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	-	3-4	2-3	5-7
District	–	0	0	0
Total	**9**	**3-4**	**2-3**	**5-7**

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.8 AG8 - South Coast

The South Coast Region lies south of the Tehachapi Mountains and extends to the California border with Mexico. It is home for more than 50% of the state's population but only 7% of the state's total land area. Rivers and streams that originate in this region flow toward the Pacific Ocean. The climate is Mediterranean-like, with warm and dry summers followed by mild and wet winters. Of the region's 11,000-square-mile area, only around 300,000 acres currently are used for irrigated agriculture. The agricultural net water demand accounts for only about 15% of total net water demand in the region. It is projected that the region will increase from a 1990 population of 16 million to over 25 million by 2020. Urbanization of agricultural land is expected to be most pronounced in this region. It is projected that by 2020 irrigated crop acreage will decline to about 184,000 acres, a 42% reduction (DWR 1994). Some areas in the region may experience even greater reduction with more than two-thirds of the irrigated land going out of production. Reductions in irrigated land, coupled with existing high levels of efficiency, will result in little water savings potential through increased efficiency.

AGRICULTURAL INFORMATION
South Coast Region

Types of crops grown:	Primarily citrus, olives, and avocados (over 50% of the irrigated land). Vineyards, nursery products, and row crops make up another 40%.
Irrigated land:	Approximately 300,000 acres.
Types of irrigation systems in use:	Pressurized systems such as sprinklers, micro-sprays, and drip are widely used for the permanent tree and vine crops. Water delivery systems are mainly pipeline and, in some cases, extensions of municipal systems.
Average applied water:	Approximately 755 TAF annually.
Source of water:	Groundwater, supplying about a third of the total demand.
	Imported water delivered from the Colorado River and from the SWP; limited local surface supplies are also available.
	Reuse; the region is greatly increasing its recycling programs, some of which look to deliver treated urban wastewater to agricultural areas.

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South Coast Region

Table 4-13a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	-	39-47	30-35	69-82
District	-	16-19	12-15	28-34
Total	**213**	**56-67**	**42-50**	**97-117**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-13b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-13a)

USE	TOTAL IRRECOVERED LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	-	14-22	10-16	24-38
District	-	6-9	4-7	10-16
Total	**123**	**20-31**	**15-23**	**34-54**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-13c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-13a)

USE	EXISTING RECOVERED LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	-	26	19	45
District	-	10	8	18
Total	**90**	**36**	**27**	**63**

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.8.9 AG9 - COLORADO RIVER

The Colorado River Region includes a large area of the state's southeastern corner, with about 650,000 acres of irrigated land. The region mainly includes the agriculturally rich Coachella and Imperial Valleys. The Salton Sea, located between the two valleys, is a prominent feature of this area.

AGRICULTURAL INFORMATION
Colorado River Region

Types of crops grown:	Row crops such as cotton, grain, sugar beets, corn, alfalfa, and other truck crops. Alfalfa constitutes about 34% of irrigated acreage. About 7% of irrigated land (50,000 acres) is vineyard and citrus.
Irrigated land:	Approximately 650,000 acres (plus 100,000 acres double cropped).
Types of irrigation systems in use:	The majority of the area is under surface irrigation (furrow). Sprinkler and drip/micro systems are more prevalent on trees and vines but are increasingly used on row and truck crops (such as melons).
Average applied water:	Approximately 2.8 MAF annually.
Source of water:	Groundwater, including an overdraft of approximately 75 TAF annually (although not all attributable to agriculture). The resort areas in the Coachella Valley also use a significant amount of groundwater resources. Surface water is delivered from the Colorado River via the All American Canal. A small amount of SWP water also is delivered to the Coachella Valley via an agreement that exchanges Colorado River water for Delta export water. Reuse of losses is an important feature and is increasing through the adoption of on-farm tailwater recovery systems and district-wide improvements, especially in the Imperial Valley.

The Sea currently is fed by rainfall from the surrounding desert mountains and by agricultural surface drainage from the two valleys. Rainfall in the mountains also recharges the groundwater aquifers that underlie the region. Because of constant evaporation, coupled with the rainfall runoff and agricultural drainage that contain naturally occurring salts, the salinity of the Salton Sea continues to increase. It is now more saline than the Pacific Ocean. However, agricultural drainage also is considered to play a vital role in supplying relatively fresh water supplies to the Sea to maintain water levels and dilute salinity and other toxicities that flow to the Sea from other sources. By 2020, an estimated 10 TAF of water may be needed annually to maintain a stable water level in the Salton Sea. Efforts to reduce the agricultural losses that flow to the Sea must consider this fact. Several plans to conserve water in the area while stabilizing the Sea's salinity and water levels have been developed by the Salton Sea Task Force, chaired by the State Resources Agency. However, these plans would incur substantial cost (DWR 1994).

Because the source of water used in this region originates in the Colorado River and not the Delta, conservation of losses not deemed irrecoverable have little value to the Bay-Delta (if it is not an irrecoverable loss that can be reallocated, there is no water quality or ecosystem benefits that can be transferred to the Bay-Delta).

Colorado River Region

Table 4-14a. Total Potential Reduction of Application (TAF)

USE	TOTAL EXISTING LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	-	59-90	44-67	103-157
District	-	42-64	31-48	73-112
Total	**635**	**101-154**	**75-116**	**176-270**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-14b. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-14a)

USE	TOTAL IRRECOVERED LOSS2	NO ACTION	INCREMENTAL CALFED SAVINGS1	TOTAL POTENTIAL[2]
On farm	-	42-74	32-55	74-129
District	-	30-52	22-39	53-91
Total	**565**	**73-126**	**54-95**	**127-221**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-14c. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-14a)

USE	EXISTING RECOVERED LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
On farm	-	16	12	28
District	-	12	9	21
Total	**70**	**28**	**21**	**49**

[1] See regional table in Attachment A at the end of this document for derivation of values.

Special Conditions

The Imperial Valley and most of the Coachella Valley may play a limited role in a CALFED Bay-Delta solution. Since water used in this area is primarily imported from the Colorado River, reduction in losses will not directly affect the Bay-Delta watershed. However, the potential exists to transfer reductions in irrecoverable losses to offset existing or future demands of southern California, a primary exporter of Bay-Delta waters. To the extent that offsetting can occur, a benefit may be realized in the Bay-Delta watershed. If this conserved water is transferred to southern California, but not in a manner to reduce existing or future Bay-Delta exports, no benefit can be claimed by the CALFED Program. This is the most probable outcome, since California already diverts more than its allocation of Colorado River water entitlement.

Efforts by other states with entitlement to Colorado River water, including Arizona, Colorado, and Utah, may soon force California to reduce its total diversion from the Colorado River. Today, agriculture uses about 3.8 MAF annually of Colorado River water. Urban uses, delivered to southern California via the Colorado Aqueduct, account for an additional 1.3 MAF. California's entitlement is only 4.4 MAF annually, approximately 800 TAF less than existing diversions. The urban demands of southern California met by the Colorado River, delivered via the Colorado Aqueduct, most likely would remain at the levels seen today, or 1.3 MAF. Therefore, reduction probably would occur through reducing agriculture's use of California's entitlement in order to reach the 4.4-MAF limitation.

This process already has begun, with near completion of the MWD's transfer agreement with Imperial Irrigation District. This landmark agreement will result in just over 100 TAF being transferred annually from agricultural uses in the Imperial Valley to urban uses in southern California. The water is generated through conservation and efficiency improvements. The transferred quantity will be conveyed via the existing Colorado Aqueduct, which already runs at capacity. In essence, this is a method of reducing California's overall use of Colorado River water to its required entitlement but maintaining full use of the Colorado Aqueduct to deliver water to urban areas.

Recently, discussions between the Imperial Irrigation District and San Diego have proposed another agricultural-to-urban water transfer. This agreement potentially will transfer another 200 TAF to southern California. The water would be derived from on-farm conservation. If this transfer occurs with no resulting reduction in San Diego's Bay-Delta supplies, there will be no benefit to the Bay-Delta system from the Colorado River Region. Given that the total irrecoverable loss estimate is no greater than the proposed San Diego/Imperial Irrigation District transfer, there probably would be no further opportunities to benefit the Bay-Delta via water conservation in the Colorado River Region after the San Diego transfer is realized.

4.9 SUMMARY OF ESTIMATED AGRICULTURAL CONSERVATION POTENTIAL

Tables 4-15, 4-16, and 4-17 summarize the regional conservation estimates for agricultural conservation potential.

Although the total potential reduction associated with irrecoverable losses could amount to as much as 540 TAF, it must be recognized that this amount would require all farms to be irrigated at very high efficiency and would require regions to substantially improve delivery systems. Achieving this would require significant local, state, and federal support.

It also should be noted that the additional potential irrecoverable loss reduction resulting from the Water Use Efficiency Program is less than half of the total shown (233 of 540 TAF). This demonstrates CALFED's assumption that existing trends will continue to provide improved efficiency regardless of the outcome of the CALFED Program. In addition, a significant portion of the irrecoverable loss reduction is in the Colorado River Region, which may or may not provide any Bay-Delta benefit.

Much of the reduction in existing loss estimated in Table 4-15 is composed of recoverable losses (as shown in Table 4-17) and is not available for reallocation for other water supply purposes. However, this significant conservation potential can provide valuable water quality, water management, and ecosystem benefits that are also key objectives of the CALFED Program. In addition, reducing these losses may provide in-basin water management benefits and help reduce future demand projections.

Table 4-15. Total Potential Reduction of Application (TAF)

REGION	TOTAL EXISTING LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
Sacramento	2,182	766-819	574-614	1,340-1,434
Delta	358	124-134	93-100	217-234
Westside San Joaquin River	388	124-137	93-103	217-241
Eastside San Joaquin River	1,262	436-471	327-353	764-824
Tulare Lake	2,315	708-795	531-596	1,239-1,391
San Francisco Bay	23	7-8	5-6	12-14
Central Coast	10	3-4	2-3	5-7
South Coast	213	56-67	42-50	97-117
Colorado River	635	101-154	75-116	176-270
Total	**7,386**	**2,325-2,589**	**1,742-1,941**	**4,067-4,532**

[1] See Table 4-2. Much of this loss is reused downstream for other beneficial uses, including in-stream flow. Only the portion of these losses that is defined "irrecoverable" is available for reallocation to other beneficial water supply purposes.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-16. Potential for Recovering Currently Irrecoverable Losses (TAF) (Subset of 4-15)

REGION	EXISTING IRRECOVERED LOSS[2]	NO ACTION	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[2]
Sacramento	225	0-36	0-27	0-63
Delta	22	0	0	0
Westside San Joaquin River	68	0-9	0-7	0-16
Eastside San Joaquin River	104	0-7	0-6	0-13
Tulare Lake	602	23-110	17-82	40-192
San Francisco Bay	12	2-3	2-3	4-6
Central Coast	1	0	0	0
South Coast	123	20-31	15-23	35-54
Colorado River	565	73-126	54-95	127-221
Total	**1,722**	**118-322**	**88-243**	**206-565**

[1] See Table 4-2. The difference between these values and the total irrecoverable saving results from water leaching, water lost to channel evaporation and consumption, and limits on irrigation and water delivery technology.

[2] See regional table in Attachment A at the end of this document for derivation of values.

Table 4-17. Recovered Losses with Potential for Rerouting Flows (TAF) (Subset of 4-15)

REGION	EXISTING RECOVERABLE LOSS	NO ACTION[1]	INCREMENTAL CALFED SAVINGS[1]	TOTAL POTENTIAL[1]
Sacramento	1,957	766-783	574-587	1,340-1,370
Delta	336	124-134	93-100	217-234
Westside San Joaquin River	320	124-128	93-96	217-224
Eastside San Joaquin River	1,158	436-463	327-347	763-810
Tulare Lake	1,713	685	514	1,199
San Francisco Bay	11	4	3	7
Central Coast	9	3-4	2-3	5-7
South Coast	90	36	27	63
Colorado River	70	28	21	49
Total	**5,664**	**2,206-2,265**	**1,654-1,698**	**3,860-3,963**

[1] See regional table in Attachment A at the end of this document for derivation of values.

4.10 ESTIMATED COST OF EFFICIENCY IMPROVEMENTS

Reducing recoverable and irrecoverable losses through improved efficiency will result in additional district operation costs as well as on-farm production costs. These increases originate from irrigation system upgrades, changes in management style, and increased operation and maintenance. When cost-effective conservation measures are implemented, costs are incurred regardless of who pays or who benefits. Estimated costs presented in this document do not attempt to allocate the costs or determine whether implementation is cost effective. Determination of the cost effectiveness of various efficiency measures will not be estimated for purposes of the programmatic EIS/EIR, but will occur on a case-by-case basis during implementation phases. This information is provided to give a sense of the funding necessary to achieve higher levels of water use efficiency.

4.10.1 COST OF REDUCING APPLIED WATER VS. COST OF REAL WATER SAVINGS

Implementation of specific water delivery improvements, whether on the farm or district level, will cost relatively the same whether in the Sacramento Valley or around Bakersfield. This is because the cost of irrigation system hardware, skilled irrigation labor, or higher levels of management does not vary significantly throughout the state. What does vary is the associated reduction in losses. The percentage of applied water that results in recoverable and irrecoverable losses depends on the types of crops grown in a region, on-farm irrigation management, district water supply management and operation, hydrologic conditions, soils, and other physical and economic factors.

The cost to reduce losses, regardless of whether recoverable or irrecoverable, can be described in terms of dollars per acre-foot per year. This value would include the capital cost of any system improvements, amortized over the life of the system; and the increased costs of operation, maintenance, and management of the system—divided by the potential water savings (in acre-feet annually) that are anticipated to result from implementing the improvements. This value represents the cost to reduce total losses (irrecoverable and recoverable). **The cost associated with reductions in irrecoverable losses will be at least as great as that for overall loss reduction and in many cases, much greater, for reasons explained below.**

In areas where irrecoverable losses have been identified, each acre-foot of loss includes both recoverable and irrecoverable loss. The irrecoverable portion is generally a small percentage of the total, but in some cases it can approach 100%. The percentage will depend on the specific local conditions. Irrecoverable loss can be the result of either on-farm or district inefficiencies.

To illustrate this relationship, suppose a field is being irrigated at 75% **efficiency, defined as the ET of applied water and water needed to maintain salt balance and other cultural practices, divided by applied water**. In this case, 25% of applied water goes to losses. If losses (for example, surface runoff and percolation to degraded groundwater) are split evenly between recoverable and irrecoverable and if efficiency improvements equally reduce recoverable and irrecoverable losses, then a reduction by 1 acre-foot of applied water reduces irrecoverable loss by half that amount. Therefore, efficiency improvements that may cost $50 per acre-foot of overall loss reduction actually cost $100 per acre-foot of reduced irrecoverable loss.

Similarly, if irrecoverable loss accounts for only 20% of applied water savings, the actual (real) cost per acre-foot of conserving it would be five times greater, or $250 per acre-foot. The same example also could be made to describe this concept as it applies to district inefficiencies. However, in such an example, the field may be replaced with a set of delivery canals. Either way, some fraction of each acre-foot of loss is irrecoverable but not necessarily the entire acre-foot.

The analysis below uses a range of irrecoverable loss from 10 to 50% of total loss, based on estimates of existing on-farm conditions developed by Reclamation (DOI 1995). This translates to cost increases between 2 and 10 times the cost for applied water reduction.

4.10.2 ESTIMATED ON-FARM EFFICIENCY IMPROVEMENT COSTS

Cost estimates to increase on-farm efficiency are based on a study prepared for Reclamation "On-Farm Irrigation System Management" (CH2M HILL 1994). This study estimates the costs and performance characteristics of many different irrigation systems for eight crop categories common in the Central Valley. Costs are based on different combinations of hardware, operational regimes, and management and are expressed as dollars per acre per season. For a given crop, each irrigation system option is summarized by two main characteristics: the irrigation efficiency and the cost per acre per season.

For each crop, a nonlinear curve was fitted using each cost versus efficiency combination as a data point. The fitted curves describe the trade-offs between cost and irrigation efficiency. These curves have been incorporated into a regional agricultural production model called the Central Valley Production Model (CVPM). CVPM also incorporates data on cropping patterns, water use, and costs by region.

Using CVPM, estimates were made of the cost to improve average on-farm efficiency from current, or baseline, levels to 80%, then again to 85%. The model increases efficiency by 1% increments until the desired level is reached. The cost shown represents the cumulative cost to move from a baseline efficiency to an 85% level.

The values are presented on a per-acre-foot, per-year basis for regions in the Central Valley. Values for areas outside the Central Valley were extrapolated from the Central Valley data since the model is limited to the Central Valley. The cost shown in Table 4-18 represents the cost incurred for implementing and maintaining improved efficiency measures. In some cases, however, as a benefit of improved efficiency, a small discount may be subtracted from the values as a result of less water applied to the field (less water is purchased or pumped).

Table 4-18. Range of Annual Costs to Achieve On-Farm Efficiency of 85%

REGION	COST PER ACRE-FOOT OF APPLIED WATER REDUCED ($/af/yr)	IRRECOVERABLE LOSS IDENTIFIED (SEE TABLE 4-1)	COST PER ACRE-FOOT OF IRRECOVERABLE LOSS SAVED[1] ($/af/yr)
Sacramento	50-60	Yes	100-600
Delta	40-50	None identified	-
Westside San Joaquin River	35-45	Minimal	70-450
Eastside San Joaquin River	55-70	Minimal	110-700
Tulare Lake	75-95	Yes	150-950
San Francisco Bay	75-95[2]	Minimal	150-950[2]
Central Coast	75-95[2]	None identified	-
South Coast	75-95[2]	Yes	150-950[2]
Colorado River	-[3]	Yes	150-950[2]

[1] Costs shown for reducing irrecoverable losses are based on assuming from 10 to 50% of each acre-foot of applied water reduction is irrecoverable (i.e., costs are multiplied between 2 and 10 times the cost of applied water savings).

[2] These values have been extrapolated from the Tulare Lake Region results.

[3] The Colorado River Region has no water quality or ecosystem benefits that can be translated to the Bay-Delta as a result of applied water reductions. The only benefit is derived by reducing irrecoverable losses and transferring the water supply benefit to another entity dependent on Bay-Delta supplies.

This is only one of several economic benefits that may offset the cost of implementing improved irrigation. As discussed in the following two paragraphs, the cost can decrease or increase, depending on the situation.

Because water supply costs vary for each region, a beneficial savings that may be experienced from reducing applied water also will vary. Cost reductions also will depend on which supply of water is reduced, surface water or groundwater. If surface supplies are reduced, which are generally considered less expensive than groundwater, the savings benefit is lower. If groundwater pumping is reduced, the cost savings are usually greater. In general, reduced surface supply costs can offset the efficiency costs shown above by $2-$10 per acre-foot per year. Assuming a mix of reduced groundwater and surface supplies, this offset can be up to $10-$30, with the higher dollar savings occurring in areas with already higher per-acre-foot costs (for example, the Tulare Lake Region). These estimates assume that water supplies' fixed costs are held constant.

Although most water users will gain a minor savings from reduced water supply costs, some will see a minor increase. Increases will most likely be experienced by water users who currently depend on the losses of others to supply their needs. As these losses are reduced, so is their indirect water supply. To offset this reduction, these users will need to obtain water directly, either through groundwater pumping or direct delivery from a water supplier. In either case, the cost to obtain direct delivery of water is usually greater than the cost of indirect use.

4.10.3 ESTIMATED DISTRICT EFFICIENCY IMPROVEMENT COSTS

In addition to on-farm efficiency improvement costs to the growers as depicted in Table 4-18, districts or other local agencies may incur costs for on-farm improvements associated with necessary district or agency-level improvements. Without support by the water suppliers and other water agencies such as DWR and Reclamation, high on-farm efficiency, if not impossible, can be much more difficult to achieve. In addition, districts will incur significant costs for such district-level improvements as lining canals, flexible water delivery systems, regulatory reservoirs, and tailwater and spillwater recovery systems.

Estimates and projections of these costs for such improvements for different regions were made using information from local agencies, DWR, and Reclamation. Because of the unique situation at each water district, it is difficult to generalize about the costs. However, the estimates presented in Table 4-19 are intended to aid in the programmatic impact analysis. Costs shown for each region may vary for each specific project.

Table 4-19. Estimated District Efficiency Improvement Costs ($/yr)

REGION	COST TO SUPPORT ON-FARM EFFICIENCY IMPROVEMENTS[1]	COST FOR IMPROVEMENTS IN DISTRICT WATER DELIVERY[2]	TOTAL COST TO THE DISTRICTS	AVERAGE COST PER ACRE ($/af/yr)[4]
Sacramento	9,000,000	4,250,000	13,250,000	7.80
Delta	1,000,000	1,250,000	2,250,000	4.50
Westside San Joaquin River	4,000,000	1,080,000	5,080,000	11.80
Eastside San Joaquin River	6,000,000	3,180,000	9,180,000	7.25
Tulare Lake	13,000,000	8,000,000	21,000,000	6.60
San Francisco Bay	300,000	150,000	450,000	7.50
Central Coast	1,000,000	250,000	1,250,000	12.50
South Coast	1,000,000	none 3	1,000,000	3.30
Colorado River	3,000,000	1,630,000	4,630,000	7.10

[1] Improvements may include more district personnel, increased operation and maintenance costs, use of CIMIS stations, and hiring irrigation advisers. The cost will vary regionally because of the different crops and irrigation system mixes that are inherent in each region.

[2] Estimates are based on a $2.50 per-acre-foot, per-year cost for district-level activities such as improved delivery system monitoring and measurement, canal lining, system automation, and regional tailwater recovery systems. This cost is assumed to occur every year but may be higher in some years.

[3] No value is provided for the South Coast Region because most agriculture in this area is already served by pressurized municipal-type delivery systems. Additional improvement potential is limited.

[4] Average cost per acre is the total district cost divided by the average irrigated acreage in each region.

5. Urban Water Conservation

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Tables

Figures

5. Urban Water Conservation

This section presents the basis and background for estimating potential water savings that may occur as a result of the No Action Alternative and savings that are anticipated to result from implementation of the Water Use Efficiency Program., or CALFED alternative. As described in Section 2, the proposed CALFED approach to urban conservation focuses on identifying and implementing new measures, as well as expanding existing measures, to improve the efficiency of local urban water use.

The values derived by CALFED and presented in this section are for a few primary purposes:

- To provide information for programmatic-level impact assessments;
- To gain a better understanding of the order-of-magnitude role urban conservation can have in statewide water management; and,
- To aid CALFED in designing the appropriate types and levels of incentive programs and assurance mechanisms.

The values are not targets, objectives, or goals. CALFED is not mandating that these or any other levels of water savings be achieved. CALFED is, however, requiring that many actions be undertaken by water suppliers and water users that will result in the implementation of more conservation and more reuse projects, but the actual savings that will result cannot be accurately estimated. Please refer to Section 2 for further description of CALFED's intended Water Use Efficiency Program.

This section presents the following information:

- Potential reductions in existing losses resulting from efficiency improvements identified as either total loss reduction or irrecoverable losses reduction (a subset of total loss available for reallocation).

- The approximate cost associated with implementing cost-effective agricultural efficiency improvements. (No determination of "who pays" is included, only an identification of the cost incurred when a cost-effective measure is implemented.)

5.1 SUMMARY OF FINDINGS

Improvements in urban water use efficiency can result in reduction of urban per-capita use and reduction of existing or projected losses associated with that use. A large percentage of these reductions can result in a water savings that can be reallocated to meet other water in per-capita water use can result in benefits to water quality and the ecosystem, and reduced energy needed for water treatment (both potable processes and wastewater) and home water heating. Potential conservation estimates developed by CALFED are separated into two categories:

- Estimated reduction in total loss (other than the "irrecoverable loss" portion; most of this reduction is available only to provide water quality and ecosystem benefits, and potentially reduce future demand projections of a particular basin).

- Estimated reduction in irrecoverable losses (available to reallocate to other beneficial water supply uses)

Based on the detailed assumptions and data described in this section, the following estimates of cumulative savings from conservation measures are shown in Figures 5-1 and 5-2.

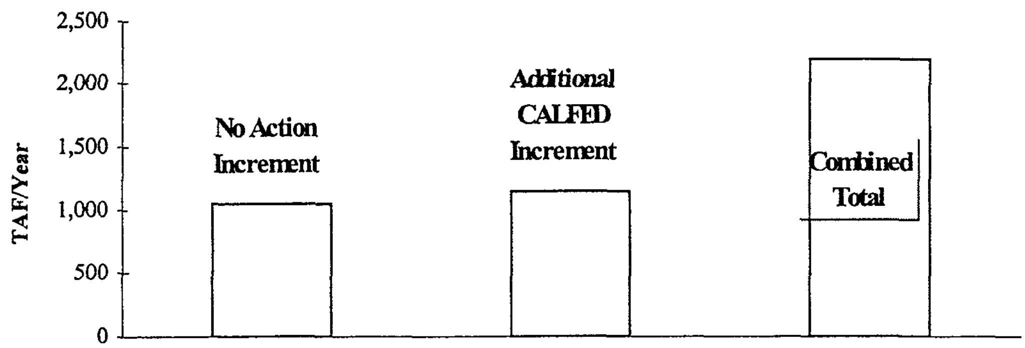


Figure 5-1. Estimated Conservation Potential of Existing Losses

These reductions can provide water quality and ecosystem benefits. The reductions do not constitute a reallocable water supply but can reduce projections of future demand.

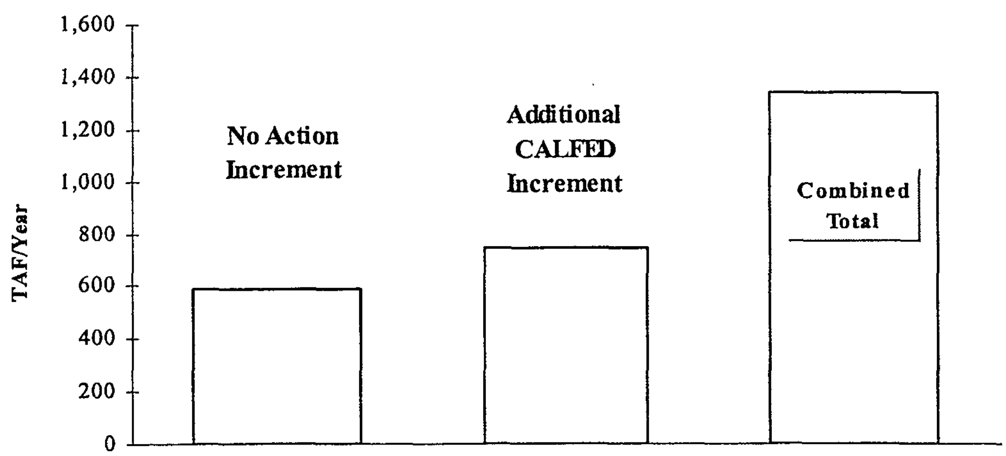


Figure 5-2. Estimated Conservation Potential of Irrecoverable

The incremental portion generated by CALFED is about half of the total projected saving
water can be reallocated to other beneficial uses.

Although the conservation savings shown in these figures are sizable, it must be recognized that such savings require full implementation of conservation measures by all urban water use sectors. This effort will require increased levels of support and commitment from federal, state, and local agencies.

Costs associated with implementing conservation measures to achieve these loss reductions will vary by case. Both customer-level and water-supplier spending is necessary to obtain the anticipated levels of improvement. Water supplier expenses represent conservation support programs, including completing plans, developing customer programs, and education. A detailed discussion of conservation cost is provided toward the end of this section.

SECTION OVERVIEW

The remainder of this section provides a more detailed discussion on CALFED's assumptions used to estimate the potential reduction in per-capita water use. The section is subdivided into the following topics:

- General state-wide assumptions.
- Specific state-wide assumptions, including the basis for projecting indoor residential; urban landscape; commercial, industrial, and institutional; and system distribution loss savings for the No Action Alternative as well as those anticipated for the CALFED solution alternative.
- Irrecoverable losses vs. recoverable losses , including differentiation of the two types of loss and the benefits that can be derived from each.
- Regional reduction estimates, including descriptions and assumptions for each urban region (see Section 3) and the resulting estimates of conservation from reduced indoor water use; landscape water savings; reduced commercial, industrial, and institutional use; and distribution system loss reductions.
- Estimated cost of conservation measures, including cost information for each urban zone associated with implementing conservation measures.

5.2 GENERAL STATE-WIDE ASSUMPTIONS

It is important to note that the estimates presented in this section were developed to help understand the potential role urban conservation could play in the larger context of state-wide water management, as well as to provide information for purposes of programmatic-level impact analysis. **These estimates are not targets or goals and should not be interpreted as such.** Neither the information nor the analysis is intended for use as planning recommendations.

The general state-wide assumptions listed below helped guide the overall analysis and development of conservation estimates. Specific assumptions are described later in this section.

- It is assumed that any decrease from existing levels of water use will be first used to offset portions of future demands resulting from increasing urban populations. Increased water conservation in the urban sector is assumed to improve the reliability of water supplies for the local entities implementing the measures. Urban water conservation is not anticipated to result in dramatic decreases in existing levels of gross demand. However, it is assumed to result in future demands being less than otherwise may have occurred.

- Urban populations are expected to increase from approximately 32.7 million to 47.5 million by 2020 (see Figure 5-4 presented later). This estimate is based on the California Department of Finance projections and is used by DWR for water demand projections. State policy requires that all state agencies use Department of Finance population data for planning, funding, and policy-making activities.

- Conservation of water that results in additional water supply is limited to the reduction of urban consumptive use and irrecoverable losses. These include reductions in landscape consumption and CII consumption, as well as reduction of losses to evaporation, saline sinks, including ocean discharge, and poor-quality perched groundwater. More detailed discussion is included later in this section.

- Conservation of water in areas where water returns to the hydrologic system in a usable form can potentially be credited with ecosystem, water quality, or energy savings benefits. Such conservation could reduce the magnitude of future demand in a region or reduce the need to develop additional water supplies. However, such savings do not result in water that can be reallocated to other uses without potential impacts on existing beneficiaries. This assumption primarily relates to daily per-capita demand that generates wastewater which, after treatment, is returned to a useable body of water. Implementation of conservation measures needs to consider existing beneficiaries that may be adversely affected by change. Such considerations include wastewater discharges that contribute to historical in-stream flows or groundwater recharge, and downstream users of treated wastewater. For example, indoor residential conservation measures to reduce diversions may adversely affect historical wastewater discharges that benefit in-stream flows in a specific waterway.

- Water that is conserved is assumed to remain in the control of the supplier for its discretionary use or reallocation. The conserved water could be used to meet growing local urban demands; offset groundwater overdraft or saline intrusion; or transfer to another benefactor, including the environment It cannot be assumed that conserved water is automatically available for environmental uses.

- Water savings experienced by export areas importing water sources in addition to water from the Bay-Delta system will not necessarily result in the reduction of Bay-Delta exports. The reallocation of conservation savings is a local decision based on local economic and water supply conditions. For example, assume that a water agency could save 100 TAF of water annually by Conservation Measure X. This savings could reduce demands for Bay-Delta water (future or existing); reduce demands from another source, such as the Colorado River; or offset the need for other new sources. As a result of this unknown, conservation savings in regions with multiple imported supplies should **not** be assumed to result in a direct reduction of Delta exports.

5.3 SPECIFIC STATE-WIDE ASSUMPTIONS

The assumptions listed here provide the specific basis for estimating conservation potential from implementation of efficiency measures. Estimates are based on determinations of:

- Existing conditions.

- No Action Alternative conditions, which include implementation of urban BMPs to levels targeted in the existing Urban MOU, as well as some additional urban conservation measures that are similar to those projected in DWR's Bulletin 160-98 (DWR 1998).

- The CALFED solution alternative, which includes projections of future conditions that could exist as a result of implementing the Water Use Efficiency Program.

Technical assumptions are presented below for the following categories:

- Urban per-capita water use

- Residential indoor conservation
  - Existing residential indoor use
  - Projected conservation under the No Action Alternative
  - Additional conservation as a result of the CALFED Program

- Urban landscape conservation
  - Existing use
  - Projected conservation under the No Action Alternative
  - Additional conservation as a result of the CALFED Program

- Commercial, industrial, and institutional conservation
  - Existing use
  - Projected conservation under the No Action Alternative
  - Additional conservation as a result of the CALFED Program

- Water delivery system loss and leakage reduction
  - Existing system losses
  - Projected reduction in losses under the No Action Alternative
  - Additional reduction in losses as a result of the CALFED Program

5.3.1 URBAN PER-CAPITA WATER USE

Since the 1976-77 drought, a combination of mandatory requirements and voluntary agreements have directed municipal government and urban water suppliers to implement water conservation practices. Current urban water conservation programs reflect state and federal legislation that mandated changes designed to improve the efficiency of plumbing fixtures, and a voluntary MOU that set the industry standard for conservation programs.

The Urban Memorandum of Understanding

One of the primary forces behind increased urban conservation in the recent past has been the adoption of the Memorandum of Understanding Regarding Urban Water Conservation in California (Urban MOU) by many urban agencies. The Urban MOU, originally drafted in 1991, has over 200 signatories, including over 150 urban water suppliers. The Urban MOU contains 14 BMPs that are to be implemented by each urban water agency, if deemed locally cost effective and technically feasible. These BMPs are listed in Table 5-1. Implementation rates of BMPs by the urban agencies have been behind those scheduled in the Urban MOU. Continuing efforts and a recent renewed focus on BMPs, however, are anticipated to result in increased levels of implementation by the signatory agencies.

Table 5-1. Revised Best Management Practices in the Urban MOU (Revised September 1997)

BMP NO.	BEST MANAGEMENT PRACTICE
1	Water survey programs for single-family residential and multi-family residential customers
2	Residential plumbing retrofit
3	System water audits, leak detection, and repair
4	Metering with commodity rates for all new connections and retrofit of existing connections
5	Large landscape conservation programs and incentives
6	High-efficiency washing machine rebate program (new)
7	Public information programs
8	School education programs
9	Conservation programs for commercial, industrial, and institutional accounts
10	Wholesale agency assistance programs (new)
11	Conservation pricing
12	Conservation coordinator (formerly BMP 14)
13	Water waste prohibition
14	Residential ultra low-flush toilet replacement program (formerly BMP 16)

Note: During 1997, the CUWCC reviewed the original BMPs. Based on input from MOU signatories, the BMPs were revised to incorporate technology and experience gained since the original BMPs were drafted.

The California Urban Water Conservation Council (CUWCC), formally established under the Urban MOU, is composed of water suppliers and public interests. The CUWCC updates the list of BMPs and revises implementation requirements. The CUWCC also disseminates information on BMPs among member agencies and reports to the SWRCB on the implementation by signatory agencies of BMPs listed in the Urban MOU. CALFED has proposed that the CUWCC certify water supplier compliance with terms of the Urban MOU.

Per-Capita Water Use

Urban water demand often is described in terms of per-capita water use. Most often, this term represents average daily water use in gallons per person per day. However, the daily use is an aggregate figure and actually represents the combination of several water-using sectors, divided by the population of the region. These sectors include:

- Residential
- Commercial, industrial, institutional
- Other, including fire flows, median landscapes, and other miscellaneous uses

For example, a per-capita demand of 200 gallons per-capita per day (gpcd) may represent a community's total residential, CII, and other uses (including fire fighting and distribution losses), divided by the area's population. Yet, the residential portion may constitute only 60% of the total (or 120 gpcd), with the remainder used by local commercial and industrial businesses, and others. Gross per-capita rates in some regions of the state reflect large industrial or commercial enterprises combined with low resident populations. For example, as shown in Table 5-2, the Colorado River Region has high per-capita water use rates because of tourist populations and a predominance of golf courses, coupled with the hot desert climate. The combination of the various water-use sectors will vary from community to community and region to region, and also can vary diurnally, weekly, monthly, and seasonally.

Table 5-2. DWR's Base and Projected Regional Urban Per-Capita Water Use (gpcd)

REGION[1]	1995 BASE URBAN DEMAND[2]	2020 PROJECTED URBAN DEMAND (WITH EXPECTED CONSERVATION)[2]	2020 PROJECTED URBAN DEMAND (WITHOUT CONSERVATION)[2,3]
Sacramento River	274	257	292
Eastside San Joaquin River	301	269	306
Tulare Lake	311	274	304
San Francisco Bay	177	169	199
Central Coast	180	164	192
South Coast	208	191	222
Colorado River	578	522	594
State-wide average	**224**	**203**	**237**

Notes:

This information is primarily for illustrative purposes and does not form the basis for all of CALFED's urban conservation estimates. CII and system distribution loss conservation do use these values.

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

[2] Values are from DWR's Bulletin 160-98 Public Review Draft, January 1998. The BMPs in the Urban MOU are the expected conservation measures implemented to project 2020 demands with conservation.

[3] Per-capita use generally increases when a region's population has more money to spend. This level of demand is projected to occur if no additional conservation measures beyond those already existing in the 1995 Base occur and the regions experience a positive change in socio\economic conditions.

Generally, the per-capita water use is used to characterize and understand the overall water demands for an area, to help plan for additional demands, and to look for opportunities to reduce demand. DWR has estimated per-capita demand through use of census data, models, local information, and an array of other investigations. DWR has noted that, in the long-term, permanent water conservation programs and other factors have begun to reduce overall per-capita water use in some areas. However, other factors tend to raise per-capita rates, thus making an analysis of trends difficult. Future per-capita use rates are estimated from current rates but are further influenced by on-going conservation efforts and anticipated increases in regional economics. The latter factor can increase residential water use and landscaping demand because of inherent lifestyle changes that accompany increases in income.

DWR projects that conservation measures will reduce current per-capita use rates, although economic effects will tend to offset some conservation gains. Table 5-2 shows DWR's estimates of future per-capita water use. The DWR per-capita projections primarily illustrate urban conditions expected to occur around the state by 2020. Only a portion of the CALFED methods used to estimate potential urban conservation is based on these projections (see the more detailed discussion of methodologies later in this section).Specifically, only the estimated conservation potentials for the CII sector and distribution system losses rely on these estimates.

The values shown for 2020 have been estimated by DWR independent of the CALFED Program and are based on DWR's estimate of full implementation of the BMPs currently included in the Urban MOU. Although the actual implementation of urban BMPs is behind schedule, DWR assumes that they will be fully implemented by 2020 (originally. implementation was to occur by 2001). This level of BMP implementation is anticipated by DWR to generate an estimated 870 TAF of depletion reduction (reduction in irrecoverable losses) annually statewide by 2020 (DWR 1998). This depletion reduction is an aggregate of the conservation occurring in residential, urban landscape, CII, and "other" water use sectors and is based on assumed reductions factors only for quantifiable BMPS.

Prior to reading the next subsection, it must be understood that "Full implementation" of BMPs, as defined used in this Section is the amount of savings determined by the DWR. It is based on a limited level of implementation of quantifiable BMPs included in the Urban MOU. Not all of the BMPs are quantifiable. As such, CALFED's No Action condition and its with-project condition are premised on the assumption that greater levels of implementation will occur (i.e., more users/water suppliers are implementing measures) than assumed in DWR's estimate.

CALFED believes that the current list of BMPs in the Urban MOU is extensive and incorporates most, if not all, types of conservation measures. The key, however, is in the assumption of how extensive the implementation of BMPs is under given conditions. Actions undertaken by water suppliers and users under the CALFED with-project condition are the same as under No Action and under baseline conditions. It is not the action that changes, but the increased levels of implementation that result in greater savings at each increment. CALFED's estimates assume more users and water suppliers implement more of the BMPs, at greater levels than assumed by DWR and as included as the baseline, as is described in the next subsection.

Finally, implementation of the BMPs included in the Urban MOU are based on a cost-effectiveness test. CALFED assumes this same cost-effectiveness test will result in more measures implemented because of No Action assumptions that will likely change current cost-effectiveness calculations (see Attachment A to the Programmatic EIS/EIR for a description of No Action features). As such, there would likely be more BMPS implemented by more water suppliers by 2020 without a CALFED Bay-Delta Program than are currently anticipated by urban water suppliers today.

5.4 ESTIMATING URBAN WATER CONSERVATION POTENTIAL

The methodology used to estimate urban water conservation potential that may result from the implementation of the Water Use Efficiency Program is described here. A different methodology is applied for each of the following conservation sectors:

- Residential indoor use
- Urban landscape use
- Commercial, industrial, and institutional use
- Water distribution system loss and leakage

These estimates are developed to help understand the potential role urban conservation could play in the larger context of state-wide water management, as well as to provide information for the programmatic-level impact analysis. These estimates are **not targets** or goals and should not be interpreted as such.

CALFED acknowledges that there exists limited empirical data from which to draw to make these estimates. In this context, the water savings cannot be assumed to predict the exact outcome of future conservation efforts, either with or without the CALFED Bay-Delta Program. However, it should be noted that the Water Use Efficiency Program itself is not predicated on the actual conservation estimates. Rather these values helped CALFED design the appropriate types and levels of incentives and assurance mechanisms that are fully described in Section 2.

Furthermore, to improve upon the shortcomings of data, for the benefit of future planning exercises, the CALFED Water Use Efficiency Program includes an actions aimed at data gathering, monitoring, and focused research. This will help bring needed resources to an important part of future conservation planning and implementation. Please refer to Section 2.3.3 for more information on this CALFED action.

5.4.1 RESIDENTIAL INDOOR CONSERVATION

Residential water use includes both indoor and outdoor demands and is influenced by many factors, including climate, type and density of housing, income level, cost of water, plumbing fixtures, and the kinds of water-using appliances. Family size, metering, and water costs also influence household and per-capita water use (Pacific Institute 1995). The methodology used by CALFED to estimate indoor residential conservation potential was based on assumed average indoor water use quantities, **not** on the total per-capita use of a region.

Existing Residential Indoor Water Use

Current average indoor residential water use is estimated to vary from 65 to 85 gpcd and is estimated statewide to average 75 gpcd (DWR 1998). The range results from the dynamic factors mentioned previously but is relatively similar in any part of the state. This is primarily because typical residential indoor habits, such as showering, laundry, and toilet use, are not influenced greatly by climate or location. Rather, indoor water use is influenced by family income, family size, housing type, and other nongeographical factors. The similarity of residential indoor water use is in contrast to the wide fluctuation in urban landscape water use, as discussed later.

In addition to DWR's "minimum month" method, used to estimate existing indoor water use, a 1998 study by WaterWiser shows that a typical family home without conservation uses 74 gpcd (WaterWiser 1998).

Assumed 2020 Baseline Residential Indoor Water Use

With current indoor use around 75 gpcd, conservation experts tend to agree that indoor use will continue to drop, especially as more of the urban BMPs are implemented (see Table 5.1). DWR, in their Bulletin 160-98, estimated 2020 indoor water use to reach 65 gpcd as a result of continued implementation of BMPs by many urban water suppliers.

CALFED has chosen to use this same 2020 baseline value to be consistent with DWR's projections contained in Bulletin 160-98. Therefore, for purposes of estimating additional conservation potential, CALFED assumes that a base level of indoor conservation of 65 gpcd has occurred. This savings is not reflected in any of the CALFED conservation estimates. Rather, the CALFED conservation projections estimate the **additional** potential to conserve water, both under No Action conditions and as a result of CALFED Water Use Efficiency Program actions.

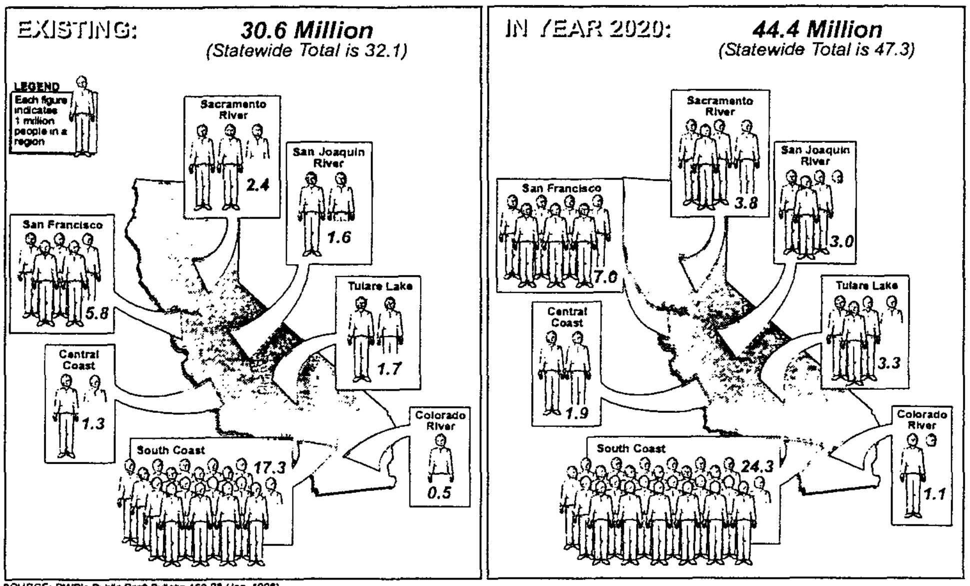
CALFED assumes that under the No Action condition additional conservation savings will still occur, beyond the 65 gpcd assumed in the baseline. This assumes that the level of indoor water use BMPs implemented to achieve 65 gpcd is limited and that additional measures are 1) still cost-effective but have not been implemented, 2) implemented for reasons other than water savings (i.e., toilet replacement associated with remodeling or with home resale), or 3) implemented through other incentive programs, such as conservation funding in California's 1997 Proposition 204, which are or will be available even without a successful CALFED Bay-Delta Program.

Projected Conservation Under the No Action Alternative

Under the No Action Alternative, indoor residential water use is expected to decrease to 60 gpcd, based on installation of new water-efficient appliances and plumbing fixtures. Such reduced levels are already being achieved in a few California communities and are assumed to be achievable statewide.

The highest percentage of indoor use is from toilets, showers, and faucets. Plumbing code changes made in the 1970s and again in the early 1990s have required installation of only low-water-using fixtures for toilets, showers, and, in some areas, for other plumbing fixtures. Although these changes are implemented slowly in existing structures as fixtures are replaced, change-out of many plumbing fixtures is anticipated by 2020 regardless of a CALFED solution. Because low-water-use fixtures are installed in new housing, further upgrades would not be necessary. Furthermore, replacement of existing high-water-using appliances (such as dishwashers and washing machines) with new, more efficient appliances also will help reduce the per-capita water use to achieve the anticipated levels.

For purposes of estimating the No Action Alternative conservation potential, CALFED assumed a value of 60 gpcd. The difference between this value and the 2020 baseline value of 65 gpcd (65 minus 60 equals 5) is multiplied by the 2020 projected population and converted to acre-feet per year. Population projections are shown in Figure 5-4.



SOURCE: DWR's Public Draft Bulletin 160-98 (Jan. 1998)

Figure 5-3. Regional Population Distribution
Note the continued population density in the South Coast Region.

Additional Conservation as a Result of the CALFED Program

Opportunities exist to further reduce indoor use below the 60 gpcd assumed under the No Action condition to levels as low as 55 gpcd or even 50.

This amount is still ample for continuation of existing lifestyle habits, such as daily showers, dishwashers, laundry, and use of water softeners, and will result in reductions in future demand statewide. This additional reduction can be obtained through measures such as more aggressive interior water audits; use of incentive programs to retrofit residences with low-water-use fixtures; conversion to low-water-use shower heads; and gradual conversion to very efficient appliances in the majority of households, such as horizontal-axis washing machines. (This technology is new to the United States but widely used in other parts of the world, such as Europe and the Middle East.) Estimates also assume the development of additional technologies and incentive programs that go beyond BMPs currently suggested in the Urban MOU. Lifestyle habits do not need to change to allow these gains to occur. To achieve these levels, however, will require strong incentive programs and public outreach to gain widespread acceptance and implementation.

For purposes of the Water Use Efficiency Program, indoor residential water use rates are assumed to reach 55 gpcd statewide. Again, this value is supported by information developed by WaterWiser in its 1998 end-use study. In graphs published on their web page, WaterWiser indicates that the typical family home could reduce its indoor use rates to 52 gpcd with full implementation of available conservation measures (WaterWiser 1998). CALFED believes that this reduction can be achieved by large sectors of the population by 2020 and feels confident that using 55 gpcd represents a realistically achievable level of indoor residential water conservation.

Estimated savings resulting from this indoor use reduction were calculated in the same manner as the No Action Alternative savings. The incremental difference between the No Action Alternative condition of 60 gpcd and CALFED's assumed level of 55 gpcd is multiplied by the projected 2020 population for each region (see Figure 5-4). The estimated savings are shown under each regional description provided later in this section.

5.4.2 URBAN LANDSCAPE CONSERVATION

Outdoor water use for landscape irrigation varies widely across California. In fact, this portion of urban water use is probably the most varied of all urban water use factors. In hot inland areas, average outdoor water use, primarily from landscaping evapotranspiration, can be as high as 60% of the total residential use. Conversely, in cooler coastal areas, outdoor use can be as low as 30% of total residential use. Effective precipitation occurring in coastal areas, either as rain or dew from fog, also acts to reduce coastal area outdoor use.

There is little empirical data that currently exists which provides sufficient information on statewide landscape acres and water use. Current estimates of state-wide urban acreage have been developed by DWR and indicate about 1 million acres of urban areas are part of an irrigated landscape. A large majority occurs in the South Coast Region, which includes the area from greater Los Angeles to San Diego. It is anticipated that as the state's population increases, so will the residential landscape acreage. However, data regarding current acreage amounts and relationships to potential increases are not readily available. For purposes of the CALFED Program, the 1 million acre estimate has been distributed, statewide based iitially on population. Values were adjusted to account for assumed regional differences, such as coastal areas generally characterized by smaller yards and more people per household than inland areas (for example, San Francisco versus Sacramento) and thus less total acreage per person. Estimated current and projected acreage values are shown in Table 5-3. Values for 2020 were projected by increasing current estimates by the ratio of a region's forecasted population to its existing population (population information is presented for each urban zone later in this section). Regional population estimates are displayed in Figure 5-4.

Table 5-3. Urban Landscaped Area (acres)

REGION[1]	1995 ESTIMATED	2020 FORECAST
Sacramento River	100,000	145,000
Eastside San Joaquin River	65,000	120,000
Tulare Lake	70,000	130,000
San Francisco Bay	155,000	180,000
Central Coast	35,000	50,000
South Coast	480,000	650,000
Colorado River	35,000	75,000
Total	**940,000[2]**	**1,350,000**

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

[2] Values shown in the table do not add to 1 million acres because some areas of the state, like the north coast and eastern side of the Sierra Mountains, are outside the CALFED Program geographic scope but are included in the estimated statewide value of 1 million.

Irrigation Needs of Urban Landscapes

Each acre of urban irrigated landscape represents a demand for water. The primary element in the determination of this demand is the evapotranspiration rate (ET). ET is the amount of water evaporated by the soil (evaporation) and used by the plants (transpiration) over a given period of time. Reference evapotranspiration (ET_0) is a measurement of a standard crop (well watered, cool-season grass, 4-6 inches tall) under standard conditions.

ET_0 usually is determined daily for a specific area, using climatological instruments at specific locations. Daily values are cumulated to form average monthly or annual values. Although the specific ET_0 for every location is not available, average ET_0 values for most regions of the state are fairly well accepted and used for planning and analysis. The values in Table 5-4, obtained from DWR, were assumed by CALFED to aid in conservation calculations.

Table 5-4. Reference ET_0 Values Assumed for Urban Regions

REGION[1]	REFERENCE ET_0
Sacramento River	4.2 (feet/year)
Eastside San Joaquin River	4.3
Tulare Lake	4.3
San Francisco Bay	3.3
Central Coast	2.8
South Coast	4.0
Colorado River	6.0

Note:

These values were provided by DWR staff at the Division of Planning and Local Assistance. They are similar to values used by DWR in the Bulletin 160-98 Public Draft (DWR 1998).

[1]Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

Once the ET_0 is determined for an area, three other factors must be considered:

- The size of the area to be irrigated
- The plants within the area
- The efficiency of the irrigation system

The amount of water a plant needs in relation to the standard measurement of ET_0 varies, depending on the physiology of the plant. In general, cool-season grasses like Kentucky Bluegrass and Fescue, require 80% of ET_0 while warm-season grasses like Bermuda grass require 60% of ET_0 Trees, shrubs, and groundcovers in the moderate water-using category (close to 80% of the commonly grown plants in California) require 40-60% of ET_0. Low water-using plants range from 0 to 30% of ET_0.

The typical California residential landscape (also the majority of the urban landscape acreage), consists of a lawn, some shrubs or other smaller plants, and a few trees. This tends to be the case whether in the Bay Area or Palm Springs, Bakersfield, or Sacramento. Recent landscaping trends in some areas of the state include planting water-efficient landscapes, or xeriscape, a term given to the use of more low-water-using plants in combination with more efficient landscape designs and irrigation systems. These landscapes can use far less water than the more lawn-intensive landscapes but are slow to be adopted in some areas of the state.

The last factor in determining landscape water needs is the efficiency of the irrigation system and operation. Data developed by DWR's mobile irrigation laboratories show that the state-wide average landscape irrigation system has a distribution uniformity (one measure of irrigation efficiency: how evenly water is distributed over a given area) of about 50%. While distribution uniformity is more important for lawns than most other landscape plants, it is an indication that improvements could be made in this area. Surface runoff, because of poor percolation, high application rates, and sloping surfaces, contributes greatly to poor efficiency. Improvements in how water is applied can result in water savings without affecting the landscape water needs.

Thus, to determine landscape water needs, the following formula can be used:

$$\textbf{Landscape water needs} = (ET_o * \text{area} * \text{plant factor}) / \text{irrigation efficiency}$$

This formula can be converted to a percentage of ET_o, or an ET_o factor. These factors are used to estimate landscape water use by multiplying the factor times the ET_o for the region (for example, if an ET_o is 4 acre-feet per acre, but irrigation efficiency is poor, the water applied to the landscaping may be as much as 1.2 times ET_o)

Estimating Landscape Conservation Potential

DWR estimates that on average, state-wide residential landscaping is currently irrigated at 1.2 times ET_o. However, limited data are available to support this estimate.

To better address this unknown, the CALFED Program has assumed a distribution of landscape acreage over a range of ET_o factors. Since many residential customers have adopted landscape conservation measures, including changes in irrigation systems and operations as well as changes in landscape type, this distribution should more realistically reflect current conditions. Each region's landscaped area has been distributed for:

- A baseline condition
- The No Action Alternative condition
- The CALFED alternative condition

These are shown in detail in Attachment B and summarized in the regional discussions later in this document. To the extent possible, local climate, combined with assumed traditional attitudes toward landscaping, were considered for each region's acreage distribution.

Existing landscaped acreage was distributed differently than the increment of new landscape acreage assumed to be planted by 2020. For example, it is less likely that existing landscapes will be dramatically changed from their current configurations (what is primarily lawn now probably will remain lawn). However, new acreage could be planted with lower ET in mind, such as planting less lawn area, planting more Mediterranean-style landscape, or using xeriscape. As shown in Attachment B, the resulting distributions vary for each urban region.

Separating Aspects of Landscape Conservation Potential

CALFED has assumed a distinction between reduction of losses through irrigation improvements and reduction in landscape ET, using the following criteria:

- Any reduction in ET_0 factor that is above or inclusive of 0.8 assumes reduction in losses that were attributable to irrigation (such as reducing surface runoff to gutters). ET_0 values of 0.8 and above do not assume any change in the type of traditional lawn-oriented landscapes, whether existing or to be planted by 2020. Some fraction of this savings could include reduced evaporative losses associated with landscape irrigation.

- Any reduction below 0.8 is assumed to represent a change to or new planting of Mediterranean, xeriscape, or other landscaping with lower ET than traditional lawn landscaping. These savings are not attributed to irrigation system improvements.

For example, a change from a factor of 1.2 to an ET_0 factor of 0.6 would assume that the increment of reduction from 1.2 to 0.8 is associated with reducing the losses from inefficient irrigation. The additional change from 0.8 to 0.6 would reflect a reduction in the ET of the landscape. Depending on the region, some or all of the initial reduction (that associated with irrigation system improvements) would be considered irrecoverable (see discussion of real water savings versus applied water reduction in Section 5.5 below). For example, if the runoff to the street from inefficient irrigation flowed directly to the Pacific Ocean, it would represent an irrecoverable loss reduction. If, however, the runoff flowed back to a river that was a source to downstream users, the reduction would constitute a reduction in applied water. In either case, the reduction in ET in this example would constitute a reduction in irrecoverable losses.

Baseline Urban Landscape Water Use

For each region, the landscape acreage is distributed among a range of ET_0 factors, accounting for local considerations such as climate, historical landscaping trends, and public perception regarding landscaping. For example, for the South Coast Region, it is assumed that existing acreage is spread between ET_0 factors of 1.2 down to and including 0.6. This amount assumes that some landscapes in this region are already planted in a Mediterranean or xeriscape style. All of the acreage for Sacramento, on the other hand, is assumed to have an ET_0 of 1.2 under existing conditions. **The acreage distribution for each region is presented under the regional descriptions later in this section.** Attachment B contains tables that detail the assumptions and calculations.

To allow a comparison between the No Action Alternative and CALFED conditions, the same distribution of existing acreage was assumed for the future 2020 acreage. This created a baseline condition with which to compare savings from the No Action Alternative and CALFED conditions. For example, the Tulare Lake Region is assumed to currently include approximately 7,000 acres of urban landscaping. This amount is projected to increase to 130,000 acres by 2020. The distribution for the current acreage assumes that 15% is at a factor of 1.2 ET_0, 60% is at 1.0, and 25% is at 0.8. The future baseline condition assumes the same distribution for the 130,000 acres. This assumption allows for savings potential to be estimated as the projected 130,000 is redistributed as a result of expected efficiency improvements.

Projected Conservation under the No Action Alternative

The existing and future acreage were kept separate to allow different distributions to be made. No Action Alternative conditions assume that some improvements to irrigation are made for the assumed existing landscaped acreage. In addition, a small percentage of the existing landscaped area is assumed to be modified to lower-water-using landscapes. For example, using the Tulare Lake Region's 70,000 acres of existing landscape, increasing to 130,000 by 2020, the 70,000 acres is redistributed from the baseline assumption of 15%, 60%, 25% to a new pattern of 10%, 60%, 30% (see Attachment B). The acreage expected in the future (130,000 acres minus 70,000 existing; or 60,000 acres) is distributed as 10%, 30%, 60%. These two distributions are combined for a regional No Action Alternative distribution of 10%, 46%, 44% for ET_0 factors 1.2, 1.0, and 0.8, respectively.

Estimates for new acreage, land that will be developed as population grows and new houses are built, assume that more efficient irrigation systems will be installed and greater amounts of lower-water-using landscape will be planted, when compared to expected changes to existing landscapes. For example, local landscape ordinances could be adopted that would result in more Mediterranean, or other landscapes conducive to the local climate, to be installed for all new housing instead of typical lawn-intensive landscapes. However, existing acreage would be slow to transition to these new landscape configurations. The distribution of acreage across the various ET_0 factors is shown for each region below under the regional discussions and in Attachment B.

Additional Conservation as a Result of the CALFED Program

The Water Use Efficiency Program is assumed to result in even greater changes to landscape irrigation and plant types than envisioned under the No Action Alternative condition. These changes would occur through technical, planning, and financial support along with a more concerted effort, through urban agency certification, to implement cost-effective conservation measures.

For purposes of estimating potential incremental savings above the No Action Alternative condition, a third distribution of acreage among ET_0 factors was made, both for existing acreage amounts and additional acreage expected to be planted. These distributions simply shifted more acreage lower on the range of ET_0 factors compared to the No Action Alternative condition. Most of the distributions at this level were based on professional judgement. The incremental difference between the No Action Alternative distribution and the CALFED distribution is used to drive the conservation calculations.

5.4.3 Interior Commercial, Industrial, and Institutional Conservation

Statewide, the commercial, industrial, and institutional sectors, collectively referred to as CII, represent about 30% of the total per-capita daily use, on average. The actual amount of use, can vary significantly for each local water supplier, depending on the quantity of commercial and industrial use, and demand compared with other sector demands. For example, industry may be the predominant user for a particular water supplier, with little or no residential connections in the area. On the other hand, residential use may comprise the majority of a supplier's demands, with very little commercial or industrial uses. To estimate potential CII conservation, CALFED has assumed that the regional CII percentages shown in Table 5-5 represent the portion of this sector's urban demand. These values can be used only to represent a region and do not necessarily represent the variation that can occur when comparing water suppliers.

Table 5-5. Assumed Baseline Commercial, Industrial, and Institutional Percentage of Urban Per-Capita Use

REGION[1]	1995 CII PERCENTAGE	2020 ASSUMED CII BASELINE PERCENTAGE
Sacramento River	35	36
Eastside San Joaquin River	24	25
Tulare Lake	24	25
San Francisco Bay	38	38
Central Coast	30	30
South Coast	32	32
Colorado River	27	28

Note:

Values were obtained from DWR 1997.

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

Commercial customers generally are defined as water users that provide or distribute a product or service, such as hotels, restaurants, office buildings, commercial business, and other places of commerce. Industrial users can vary from low-water-using industries, such as clothing manufacturing, to high-water-use industries, such as food processing or the semi-conductor industry. Institutional users include establishments dedicated to public service, such as schools, courts, churches, hospitals, and government facilities.

The demand for water from CII customers includes many of the same needs as residential users—toilets, sinks, laundry facilities, and kitchens—but the use is often much greater. CII demand also can come from process water, cooling towers, and large restaurant kitchens, as well as outdoor decorative landscaping. Landscape water use, however, is accounted for under the previous subsection, "Urban Landscape Conservation" and is not included here. The CII conservation estimates discussed in this section primarily focus on improving the efficiency of internal CII water use.

As noted in a recent study, the potential indoor water conservation opportunities for commercial water users ranges from a 20-25.6% reduction from existing use levels, with an average of 22.2 % (EPA 1997). DWR also has stated that the BMPs in the Urban MOU (see discussion earlier in this section) are projected to reduce CII water use by 12-15% by 2020 (DWR 1998). Given this information, it would appear that of the 22% reduction potential noted in the EPA study, approximately one-half to two-thirds of the potential would occur by 2020 under current efforts.

Baseline Commercial, Industrial, and Institutional Water Use

An estimate of projected baseline CII water use that could occur in 2020 is necessary to estimate potential conservation savings under the No Action and CALFED Program Alternatives, respectively. Per-capita water use values assumed to occur in 2020 as a result of population increases and economic influences, coupled with expected urban BMP implementation, were used (see Table 5-2 in the column "2020 Urban Demand with Expected Conservation").

As previously shown in Table 5-5, a portion of each region's projected per-capita water use value is attributable to CII demand. However, the percentage is not necessarily the same as occurs under 1995 assumed conditions. For example, the Sacramento Region has a 1995 CII demand of 35% of the total per-capita use value. In 20 years, the value may increase as a result of a shift in the make-up of the types of CII users in the region.

In general, **industrial** use is anticipated to continue to decline or stabilize as a result of:

- Increasing environmental constraints regarding wastewater discharge and recycling practices
- More energy- and water-efficient industrial processes and equipment
- A national shift away from a manufacturing economy to a service-oriented economy
- A shift of some industry to out-of-state areas

However, as the state's population and economy increase, **commercial** water use is expected to increase, although the extent is unknown. To estimate conservation potential, CALFED has assumed that the percentage of per-capita use resulting from commercial activities will increase to a greater extent than industrial use declines. The assumed baseline CII percentages are shown in Table 5-5.

Projected Conservation under the No Action Alternative

Since some CII water saving is inherent in the 2020 per-capita projections, an assumption is necessary to determine what additional savings could occur absent a CALFED Bay-Delta solution. CALFED has assumed that the 2020 per-capita projection with urban BMP implementation achieved half of the conservation potential (one-half of 22%, or 11%). It is assumed that additional CII conservation also could occur beyond the urban BMPs under the No Action Alternative conditions. This additional conservation is assumed to result in another 4% reduction in CII use, bringing the total CII savings under the No Action Alternative to an assumed 15% of existing conditions.

Several other factors besides the CII-related BMPs are believed to result in more efficient water use by this sector by 2020. Some of these factors include:

- The existing trends discussed under baseline conditions.
- Water and wastewater costs probably will increase faster than the rate of inflation to account for infrastructure replacement and population growth, creating an incentive to be more efficient.
- California's industrial and commercial sector will become more efficient with their processes, including water use, to gain or maintain a competitive edge.
- Existing and new businesses will use more efficient equipment as it becomes available.
- Continued state-wide demand for water will continue to bring greater attention to efficient water use practices and present "pressure" to implement conservation measures.

Since the 2020 per-capita values in Table 5-2 are assumed to include much of the 15% assumed conservation potential, additional potential is calculated by reducing the projected 2020 CII demand by only 4%.

To illustrate this, consider:

For the Sacramento Region (using 2020 per-capita with conservation as baseline):

Assume:	2020 per-capita use	=	257 gpcd (see Table 5-2)
	2020 population	=	3,900,000
	2020 CII portion of total	=	36% (see Table 5-5)
	No Action savings	=	4%
Calculations:	Projected CII use	=	404,130 acre-feet
	Projected savings	=	16,160 acre-feet [404,130 * 4%]
	2020 remaining CII use	=	388,000 acre-feet

Another possible method to calculate savings potential would use projected 2020 per-capita values absent conservation as a baseline (Table 5-2). If these values were used, they would need to be reduced by the full 15% to account for both the expected BMP-related savings and additional No Action Alternative reductions.

To compare the results of this methodology, consider:

For the Sacramento Region (using 2020 per-capita without conservation as baseline):

Assume:	2020 per-capita use	=	292 gpcd (see Table 5-2)
	2020 population =		3,900,000
	2020 CII portion of total	=	36% (see Table 5-5)
	No Action savings	=	15%
Calculations:	Projected CII use	=	459,165 acre-feet
	Projected savings	=	68,875 acre-feet [459,000 * 15%]
	2020 remaining CII use	=	390,000 acre-feet

When the remaining CII use projected for 2020 is compared for each method, the answers are very similar. Thus, whether or not the expected BMP implementation is included in the calculation, the CII demand expected under 2020 conditions is the same.

CALFED has proceeded with its calculations using the 2020 projected per-capita values that already account for BMP savings. This assumption is consistent with the other urban conservation estimates that assume a baseline with conservation has been reached by 2020.

Additional Conservation as a Result of the CALFED Program

As with other components of urban conservation, the CALFED alternative is assumed to result in CII water use savings that reach beyond those estimated under No Action Alternative conditions. Since the No Action Alternative condition was assumed to result in 15% of the 22% goal, the CALFED alternative is expected to achieve another 7% reduction from the 2020 baseline.

It is assumed that these gains can be achieved through implementation of several measures, such as:

- Enlarging the scope of CII water audits to include warehouses, correctional facilities, military bases, utility systems, and passenger terminals (largely ignored under current audit programs).
- Developing incentive programs to obtain consistent, effective data at the water supplier level so they better understand the water needs of their CII customers.
- Developing local programs that offer financial incentives, public recognition, technical information, or water rate adjustments.
- Developing and enforcing local CII water use efficiency ordinances.
- Implementing state and federal programs that offer financial and technical assistance directly to the CII users.

The calculation to determine the potential water conservation as a result of the CALFED Program is similar to that used to determine the No Action Alternative savings. Since the CALFED increment is additive to the No Action Alternative projection, the same baseline must be used.

To illustrate this, consider:

For the Sacramento Region (using 2020 per-capita with conservation as baseline):

Assume: 2020 per-capita use = 257 gpcd (see Table 5-2)
2020 population = 3,900,000
2020 CII portion of total = 36% (see Table 5-5)
CALFED savings = 7%

Calculations: Projected CII use = 404,130 acre-feet
Projected CALFED savings = 28,290 acre-feet [404,130 * 7%]

Previously calculated: No Action savings = 16,160 acre-feet
Combined total savings = 44,450 acre-feet (28,290 + 16,160)
2020 remaining CII use = 359,680 acre-feet [404,130-44,450]

Thus, CALFED's incremental savings are assumed to reduce CII use from the same base as the No Action Alternative (i.e., they both calculate savings from the same 2020 per-capita use value). This assumption considers the reality that actions taken by CII users as a result of CALFED will not be independent of actions taken under the No Action Alternative

Depending on each region, a portion of this savings does constitute a reduction in irrecoverable losses and is available for reallocation to other purposes. See the regional discussions later in this section for the specific values.

5.4.4 WATER DELIVERY SYSTEM LOSS AND LEAKAGE REDUCTION

Throughout the state, urban retailers deliver water via pressurized pipelines to numerous residential and CII users. These pipelines are made of ductile iron, metal, concrete, plastic, or a combination of materials and are of various sizes and in a variety of working conditions. For the most part, urban water supplier maintenance and replacement programs tend to correct the worst conditions, but with many systems placed underground more than 50 years ago, and often during the 1930s and 1940s, many leaks still exist. In some instances, this can result in the loss of significant amounts of potable water, water otherwise available for meeting urban demands.

Leaks, the most common form of system losses, may be caused by several factors, including:

- Corrosion of pipe materials
- Faulty installation
- Natural events, such as earthquakes and land subsidence
- Aging water control structures

Current estimates place average unaccounted water in the various regions of the state between 6 and 15% of system deliveries. However, the amount varies significantly among urban suppliers, with some experiencing losses as high as 30% and others with less than 5%. Two percent is attributed to unmetered water use (including water used for construction, fire fighting, and flushing drains and hydrants) and meter errors; therefore, distribution system losses range between 4 and 13% (DWR 1998). CALFED has assumed for purposes of this estimate that reduction below 5% of system deliveries is cost prohibitive and technically difficult and therefore becomes the limit of conservation potential. With several hundred miles of pressurized pipeline for each utility, maintenance activities are continuous and new leaks arise as old ones are repaired, resulting in a loss constantly occurring somewhere in the system.

Current Funding Programs

For the past two decades, DWR has administered several programs to provide loans to local urban water suppliers for replacement of old, leaky systems. The programs include:

- ***Proposition 25—The Clean Water Bond Law of 1984*** - This program authorized the sale and issuance of $325 million in state bonds. Water conservation loans administered by DWR comprised $10 million of the total. This money was used to provide low-interest loans to aid in the conduct of voluntary, cost-effective capital outlay water conservation programs, including system leak reduction.

- ***Proposition 44—The Water Conservation and Water Quality Bond Law of 1986*** - This program authorized the sale and issuance of $150 million in state bonds. DWR was responsible for administering low-interest loans using about half of this funding. These loans were available for cost-effective capital outlay water conservation programs, including system leak reduction.

- ***Proposition 82—The Water Conservation Bond Law of 1988*** - This program authorized the sale and issuance of $60 million dollars that was available for cost-effective capital outlay water conservation programs, including system leak reduction.

These programs have resulted in substantial improvements in local urban distribution systems and have generated water savings of about 60 TAF annually.

Projected Conservation under the No Action Alternative

Minor reductions in distribution system losses will continue to occur regardless of the outcome of the CALFED Program. Through continuation of loan programs, mostly administered by DWR, and increasing focus by local agencies on the destination of their water, CALFED has assumed that system loss reductions potentially decreases a percent on average throughout many of the water districts in the state. However, several regions are believed to already have reduced system losses to 7%, leaving only slight reductions feasible before reaching CALFED's assumed practical limit. For these regions, reductions under the No Action Alternative condition are assumed to result in average regional system losses of 6%. Table 5-6 presents CALFED's assumed levels of reduction.

Estimates of potential savings were calculated based on an estimate of baseline distribution system conditions and future water delivery quantities. Because conservation estimates are regional, estimates of regional system loss conditions, not per-district conditions, were needed. Data from DWR regarding existing urban "unaccounted" delivered water was obtained and adjusted downward by 2% to account for unmetered water and meter errors (DWR1997) (see Table 5-6). The results for each region are shown under the regional discussion later in this section.

Reduction estimates were calculated by taking the difference in the baseline percentage and the assumed No Action Alternative savings, multiplied by the projected urban use for each particular region (2020 per-capita use multiplied by the projected population; see Table 5-2 and Figure 5-4).

To illustrate this method, consider:

For Region X:

Assume:	Baseline loss	=	9%
	No Action Alternative condition	=	7%
	2020 per-capita use	=	200 gpcd
	2020 population	=	TAF
Calculations:	Projected urban use	=	224,000 acre-feet [gpcd * population]
	Projected loss	=	20,000 acre-feet[224,000 * 9%]
	Saving potential	=	224,000 acre-feet * (9%-7%)
		=	4,480 acre-feet

Additional Conservation as a Result of the CALFED Program

Additional reduction in system losses are anticipated to occur as a result of the CALFED Program's additional assistance and funding programs, as well as assurance mechanisms designed to ensure that high levels of water use efficiency are being achieved. As previously stated, CALFED assumed that distribution system losses could be lowered to 5% of system deliveries. Table 5-6 shows how the 5% value relates to each region's assumed No Action Alternative condition.

Limiting the reduction potential to 5% assumes continuation of pipeline wear and breakage that will occur regardless of the time and effort spent trying to prevent it or to immediately correct it. Obtaining system losses of less than 5% is also technically limited by reduced ability to detect leaks in plastic pipes, the latest pipeline material to be used for urban water distribution systems. Although this material is less likely to corrode, cracks or breaks, which inevitably will occur, are difficult to detect when compared to iron or clay.

The same method used to calculate potential No Action Alternative savings was used to calculate incremental CALFED reductions. The difference between the assumed No Action Alternative system loss percentage and that assumed for CALFED formed the basis. Results are presented under the regional discussions.

Table 5-6. Assumed Levels of System Distribution Losses (Percent of Total Demand)

REGION[1]	BASELINE CONDITIONS[2]	2020 NO ACTION ALTERNATIVE CONDITIONS	2020 WITH *CALFED CONDITIONS*
Sacramento River	7	6	5
Eastside San Joaquin River	7	5	5
Tulare Lake	7	6	5
San Francisco Bay	6	6	5
Central Coast	8	7	5
South Coast	7	6	5
Colorado River[3]	12	8	5

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

[2] Existing percentage values are compiled from data submitted to DWR by many water agencies throughout the state. Values do not include unmetered water or meter errors, both of which are not considered distribution system losses (DWR 1997).

[3] This region is assumed to have a high existing condition and is expected to make greater progress in reducing system losses under the No Action Alternative than is assumed for the other regions (4% versus 1%).

5.5 IRRECOVERABLE LOSSES VS. RECOVERABLE LOSSES

Similar to characteristics of water losses in agriculture, losses associated with urban water use can be characterized as resulting in irrecoverable or recoverable losses. Refer to the discussion in Section 4.4, "Irrecoverable vs. Recoverable Losses," for a more detailed explanation of this issue.

All urban water losses from landscaping, CII, and residential uses either directly or via a wastewater treatment plant return to surface water or groundwater bodies and may be recoverable. In theory, all losses are recoverable. In practice, however, losses that flow to very deep aquifers or excessively degraded water bodies may not be recoverable because of prohibitively expensive energy requirements (that is, they become irrecoverable). Determining recoverability varies with location and time, as well as other factors (DOI 1995).

Distinguishing irrecoverable and recoverable losses typically depends solely on water quality considerations. This assumes that all losses to usable water bodies can be economically recovered. Principal water bodies that are regarded as irrecoverable include saline, perched groundwater underlying irrigated land on the west side of the San Joaquin Valley; the Salton Sea, which receives urban wastewater from the Coachella and Imperial Valleys; the San Francisco Bay; and the ocean.

Real water savings can be achieved only by reducing irrecoverable losses because that water is truly lost from the system. Water is considered "saved" when these losses are reduced. However, while the reduction of urban nonconsumptive use does not generate a new supply of water, the conserved water could be available to meet projected increases in local demand.

Recoverable losses, on the other hand, often constitute a supply to the downstream user. Downstream uses can include groundwater recharge; agricultural and urban water use; and environmental uses, including wetlands, riparian corridors, and in-stream flows. Often, recoverable losses are used many times over by many downstream beneficiaries. To reduce these losses would deplete such supplies with no net gain in the total water supply. Their reduction, however, provide significant opportunities to contribute to the achievement of other CALFED objectives, such as:

- Improving instream water quality through reduced runoff of water laden with residual landscape chemicals and other urban toxins that can flow into storm drains.
- Reducing temperature impacts resulting from resident time of wastewater during treatment process.
- Reducing entrainment impacts on aquatic species as a result of reduced diversions, and
- Reducing impacts on aquatic species, especially anadromous fish, through minor modifications in diversion timing and possibly providing in-basin benefits through subsequent modifications in the timing of reservoir releases.

5.6 REGIONAL CONSERVATION ESTIMATES

Estimates of the results of efficiency improvements are presented here for each of the agricultural regions defined previously in Section 3, "Determination of Geographical Zones." The values presented are to help understand the potential role conservation could play in the larger context of state-wide water management, as well as to provide information for purposes of a programmatic level impact analysis. **These estimates provide our best estimate of the potential for urban conservation but are not goals and targets and are not intended to be used for planning purposes.** Estimates of potential reduction in urban demand are presented under one of two categories:

- Estimated reduction in total loss (other than the "irrecoverable loss" portion, only available to provide water quality and ecosystem benefits, and potentially reduce future demand projections of a particular basin).
- Estimated reduction in irrecoverable losses (available to reallocate to other beneficial water supply uses).

For each urban region, the following tables are presented: assumed distribution of landscaped acreage among ET_o factors, potential conservation of existing losses (including irrecoverable loss), and potential conservation of irrecoverable losses (available for reallocation). This information is included in Tables 5-7a through 5-14c.

Estimated reduced irrecoverable losses can be viewed as a source of water for reallocation to other purposes, such as improved local supply reliability; offsetting local groundwater overdraft; or a transfer to other beneficial water supply uses, including the environment. Reduction of loss that is not defined as irrecoverable is not available for reallocation to out-of-basin water supply purposes but can provide significant benefits to water quality and ecosystem health as well as improving local water supply reliability.

It is important to note that potential loss reductions in the Colorado River Region would not directly translate to water quality or ecosystem benefits in the Bay-Delta watershed. Similarly, reduction of losses in regions that import water from the Bay-Delta but are not tributary to the Delta (South Coast, Central Coast, and San Francisco Bay Regions) can only provide an ecosystem benefit through reductions in diversions or modified diversion timing. Their ability to provide water quality benefits is limited because wastewater treatment plant return flows, a primary source of degradation, from these regions do not re-enter the Delta watershed. Therefore, reduced urban use that reduces wastewater flows does not provide a Bay-Delta benefit. Other export areas whose return flows do re-enter the Bay-Delta watershed can provide water quality as well as ecosystem benefits.

5.6.1 UR1 - SACRAMENTO RIVER

The Sacramento River Region is defined by the Sacramento Valley, from Sacramento north to Redding. The area is predominantly in agriculture, but many growing communities are within its boundary, including the greater metropolitan areas of Sacramento. All rivers that flow into the valley are carried by the Sacramento River southward to the Delta. Here, surface flows head west to the Pacific Ocean. With abundant surface and groundwater resources, urban users in this region experiences few water shortages. Sacramento Valley water users possess some of the oldest rights to surface water, with some rights dating back to the Gold Rush era. Urban water use comprises only about 6% of the region's total water use. The more populated urban areas are located on the valley floor, where summer temperatures over 100 degrees are not uncommon.

The region is characterized by largely single-family dwellings with relatively large landscapes, numerous processing and packing facilities for agricultural products, and limited manufacturing industry. For its size, the Sacramento River Region is sparsely populated, with an average density of fewer than 90 people per square mile. Most of these people live in the southern end of the region in and around Sacramento.

Typically, nonconsumptive urban water use, such as indoor residential use and losses associated with landscape irrigation, tend to return to the system of rivers, streams, and aquifers. Water applied to the landscape in excess of landscape water requirements usually flows to the storm channels via paved gutters and back to the surface waters. Likewise, after treatment, industrial and municipal indoor water use also ends up in the surface waters and is available for subsequent reuse. The region does not experience significant irrecoverable losses, although water quality degradation does occur.

The potential for reduction of irrecoverable losses exists through the reduction in landscape water use and any potential reduction in consumption associated with commercial or industrial uses. Otherwise, conservation measures can primarily provide water quality, ecosystem, and timing and energy savings benefits, as well as potentially reducing future need for more water supply development.

Urban populations are expected to grow significantly in the next 20 years, primarily around the greater Sacramento metropolitan area.

In this region, 21 urban agencies have signed the Urban MOU.

URBAN INFORMATION
Sacramento River Region

	Population	*Baseline per-capita water use*
1995:	2.4 million	274 gpcd
2020:	3.9 million	257 gpcd (292 if no conservation occurs)

Approximate CII use in 1995:	35% of per-capita use
Estimated CII use in 2020:	36% of per-capita use
Assumed CII reduction as a result of conservation measures:	
No Action Alternative:	4% (of 2020 projected per-capita water use)
CALFED:	7%
Assumed residential indoor use (average):	
2020 baseline	65 gpcd
2020 No Action Alternative	60 gpcd
2020 CALFED	55 gpcd
Assumed distribution system losses (as a percent of 1995 total urban use):	
Existing:	7%
No Action Alternative:	6%
CALFED:	5%
Assumed ratio of irrecoverable losses to total existing loss:	0.05 (5%)
Assumed existing urban landscape acreage:	100,000 acres
Assumed urban landscaped acreage in 2020:	145,000 acres
Assumed ET_o Value:	4.2 feet of water annually

Estimated Reduction in Irrecoverable Losses for Reallocation to Other Water Supply Uses

As discussed above, the Sacramento River Region is characterized as having significant amounts of incidental reuse, especially of indoor residential water. Most indoor use returns to local surface streams and rivers after treatment and is relied on as part of downstream flows. In addition, changes in the type of outdoor landscaping are assumed to result in only negligible savings. The region has little potential water savings that can be reallocated to other beneficial uses. It is true, however, that potential exists to implement urban conservation measures for other purposes, namely improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development. These benefits primarily relate to the savings shown in Table 5-7b.

Table 5-7a. Assumed Distribution of Landscaped Acreage among ET_0 Factors for the Sacramento River Region (%)

			2020 NO ACTION		2020 CALFED	
ET_0 FACTOR	1995 ACRES (%)	BASE ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)
1.2	100	100	50	30	40	10
1.0			25	30	30	10
0.8			25	40	30	75
0.6						5
0.4						

Table 5-7b. Potential Conservation of Existing Losses (Including Irrecoverable Loss) for the Sacramento River Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	20-25	20-25	40-50
Urban landscaping[1]	100-105	30-35	130-140
Commercial, industrial, institutional[1]	15-20	25-30	40-50
Distribution system[1]	10-15	10-15	20-30
Total	**145-165**	**85-105**	**230-270**

[1] For this region, it is assumed that 95% of all losses are recovered and available to the local water supply.

Table 5-7c. Potential Conservation of Irrecoverable Losses (Available for Reallocation) for the Sacramento River Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	1-2	1-2	2-4
Urban landscaping[1,2]	4-5	2-4	6-9
Commercial, industrial, institutional[1]	0-1	1-2	1-3
Distribution system[1]	0-1	0-1	0-2
Total	**5-9**	**4-9**	**9-18**

[1] For this region, it is assumed that only 5% of all loss reduction is available for reallocation.

[2] Urban landscaping values include both reduction in losses and changes to landscaping types. See Attachment B for more details on landscape conservation estimates.

5.6.2 UR2 - EASTSIDE SAN JOAQUIN RIVER

The Eastside San Joaquin River Region encompasses the area from the San Joaquin River near Fresno north to the Cosumnes River, and from the eastern foothills to the San Joaquin River as it travels up the valley to the Delta. This area is predominantly agricultural but includes the metropolitan areas of Stockton, Modesto, and Merced along with numerous other communities. Several rivers originating in the Sierra Nevada flow out of the mountains and west into the San Joaquin River (as it travels through the center of the valley). These include the Merced, Tuolumne, Stanislaus, and Mokelumne Rivers as well as other small tributaries. Urban water use comprises only about 5% of the region's total water use. The more populated urban areas are located on the valley floor, where summer temperatures over 100 degrees are not uncommon.

With abundant surface water and groundwater resources, urban users in this region experience few water shortages. However, most of the urban communities in the region rely heavily on groundwater for municipal supplies. Recently, some agricultural irrigation districts in the region are developing agreements that would allow them to provide surface water to these communities as a supplemental source to the current groundwater supplies.

The region is characterized by largely single-family dwellings with relatively large landscapes, numerous processing and packing facilities for agricultural products, and limited manufacturing industry. The region has an average population density of just under 200 people per square mile. Most of these people are concentrated in the urban towns and cities.

Typically, non-consumptive urban water use, such as indoor residential use and losses associated with landscape irrigation, tend to return to the system of rivers, streams, and aquifers. Water applied to the landscape in excess of landscape water requirements usually flows to the storm channels via paved gutters and back to the surface waters. Likewise, after treatment, industrial and municipal indoor water use also ends up in the surface waters and is available for subsequent reuse. The region does not experience significant irrecoverable losses, although water quality degradation does occur.

The potential for reduction of irrecoverable losses exists through the reduction in landscape water use and any potential reduction in consumption associated with commercial or industrial uses. Otherwise, conservation measures can primarily provide water quality, ecosystem, and timing and energy savings benefits, as well as potentially reducing future need for more water supplies.

Urban populations are expected to grow significantly in the next 20 years, primarily around the cities of Stockton, Modesto, and Merced. These areas increasingly serve as "bedroom communities" for the Bay Area.

In this region, six urban agencies have signed the Urban MOU.

URBAN INFORMATION
Eastside San Joaquin River Region

	Population	*Baseline Per-capita water use*
1995:	1.6 million	301 gpcd
2020:	3.1 million	269 gpcd (306 if no conservation occurs)

Approximate CII use in 1995:	24% of per-capita use
Estimated CII use in 2020:	25% of per-capita use
Assumed CII reduction as a result of conservation measures:	
No Action Alternative:	4% (of 2020 projected per-capita water use)
CALFED:	07%
Assumed residential indoor use (average):	
2020 baseline	65 gpcd
2020 No Action Alternative	60 gpcd
2020 CALFED	55 gpcd
Assumed distribution system losses (as a percent of total urban use):	
Existing:	7%
No Action Alternative:	6%
CALFED:	5%
Assumed ratio of irrecoverable losses to total existing loss:	0.05 (5%)
Assumed existing urban landscape acreage:	65,000 acres
Assumed urban landscaped acreage in 2020:	120,000 acres
Assumed ET_o Value:	4.3 feet of water annually

Estimated Reduction in Irrecoverable Losses for Reallocation to Other Water Supply Uses

As discussed above, the Eastside San Joaquin River Region is characterized by significant amounts of incidental reuse, especially of indoor residential water. Most indoor use returns to local surface streams and rivers after treatment and is relied on as part of downstream flows. Changes in the type of outdoor landscaping are assumed to result in only negligible savings. The region has little potential water savings that can be reallocated to other beneficial uses. The potential exists, however, to implement urban conservation measures for other purposes, namely improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development. These benefits primarily relate to the savings shown in Table 5-8b.

Table 5-8a. Assumed Distribution of Landscaped Acreage among ET_o Factors for the Eastside San Joaquin River Region (%)

			2020 NO ACTION		2020 CALFED	
ET_O FACTOR	1995 ACRES (%)	BASE ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)
1.2	85	85	50	30	20	5
1.0	10	10	25	30	40	5
0.8	5	5	25	40	40	80
0.6						10
0.4						

Table 5-8b. Potential Conservation of Existing Losses (Including Irrecoverable Loss) for the Eastside San Joaquin River Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	15-20	15-20	30-40
Urban landscaping[1]	65-70	60-65	125-135
Commercial, industrial, institutional[1]	5-10	15-20	20-30
Distribution system[1]	5-10	5-10	10-20
Total	**90-110**	**95-115**	**185-225**

[1] For this region, it is assumed that 95% of all losses are recovered and available to the local water supply.

Table 5-8c. Potential Conservation of Irrecoverable Losses (Available for Reallocation) for the Eastside San Joaquin River Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	0-1	0-1	0-2
Urban landscaping[1,2]	3-4	6-8	9-12
Commercial, industrial, institutional[1]	0-1	0-1	0-2
Distribution system[1]	0-1	0-1	0-2
Total	**3-7**	**6-11**	**9-18**

[1] For this region, it is assumed that only 5% of all loss reduction is available for reallocation.

[2] Urban landscaping values include both reduction in losses and changes to landscaping types. See Attachment B for more details on landscape conservation estimates.

5.6.3 UR3 - TULARE LAKE

The Tulare Lake Region includes the southern San Joaquin Valley from the southern limit of the San Joaquin River watershed to the base of the Tehachapi Mountains. The area is predominantly agricultural, but many small agricultural communities as well as the rapidly growing cities of Fresno and Bakersfield are located here. The Kings, Kaweah, Tule, and Kern Rivers flow into this region from the east. All of the rivers terminate in the valley floor and do not drain to the ocean except in extremely wet years. Urban water use comprises only about 3% of the region's total water use. The more populated urban areas are located on the valley floor, where summer temperatures over 100 degrees are not uncommon.

The region is characterized by mainly single-family dwellings with large rural landscapes. The region has a substantial amount of dairy operations and processing and packing industries for agricultural products, but very little or no industrial manufacturing activities, beyond the extraction of oil from subterranean reserves. This activity primarily occurs south and west of Bakersfield and does not constitute a large municipal water demand. The region has an average population density of just over 100 people per square mile. Most of these people are concentrated in the urban towns and cities.

Like other Central Valley regions, municipal and residential water reuse is common. Landscape water runoff often percolates to the groundwater since the region is a closed basin. However, after being treated in wastewater treatment plants, the majority of the treated water is evaporated in large evaporation ponds. Some of this water also percolates downward and provides recharge to local groundwater sources. In many parts, shallow groundwater has become salty and, in some cases, contaminated with selenium. A significant amount of surface runoff from landscape irrigation percolates to shallow groundwater and may become unusable. After treatment, municipal water is reused for agricultural irrigation or used to recharge groundwater.

Urban populations are expected to grow significantly in the next 20 years, primarily around the cities of Bakersfield and Fresno. Bakersfield is experiencing rapid growth due in part to influences from nearby metropolitan southern California.

In this region, six urban agencies have signed the Urban MOU.

URBAN INFORMATION
Tulare Lake Region

	Population	*Baseline per-capita water use*
1995:	1.7 million	311 gpcd
2020:	3.3 million	274 gpcd (304 if no conservation occurs)

Approximate CII use in 1995:	24% of per-capita use
Estimated CII use in 2020:	25% of per-capita use
Assumed CII reduction as a result of conservation measures:	
No Action Alternative:	4% (of 2020 projected per-capita water use)
CALFED:	7%
Assumed residential indoor use (average):	
2020 baseline	65 gpcd
2020 No Action Alternative	60 gpcd
2020 CALFED	55 gpcd
Assumed distribution system losses (as a percent of total urban use):	
Existing:	7%
No Action Alternative:	6%
CALFED:	5%
Assumed ratio of irrecoverable losses to total existing loss:	0.3 (30%)
Assumed existing urban landscape acreage:	70,000 acres
Assumed urban landscaped acreage in 2020:	130,000 acres
Assumed ET_o Value:	4.3 feet of water annually

Estimated Reduction in Irrecoverable Losses for Reallocation to Other Water Supply Uses

As discussed above, the Tulare Lake Region is characterized as having incidental reuse, especially of indoor residential water. Some indoor use percolates to groundwater after treatment and is relied on as a groundwater source, especially for agricultural users adjacent to wastewater treatment plant disposal areas. However, a significant amount of water evaporates after being treated at regional wastewater treatment plants. Reductions in the amount of evaporation loss can constitute a reduction in irrecoverable loss available for reallocation.

Although the region does have potential water savings that can be reallocated to other beneficial uses, the reduction in other losses provide other benefits, namely improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development. These benefits primarily relate to the savings in Table 5-9b.

Table 5-9a. Assumed Distribution of Landscaped Acreage among ET_0 Factors for the Tulare Lake Region (%)

			2020 NO ACTION		2020 CALFED	
ET_0 FACTOR	1995 ACRES (%)	BASE ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)
1.2	15	15	10	10	5	0
1.0	60	60	60	30	50	10
0.8	25	25	30	60	45	70
0.6						20
0.4						

Table 5-9b. Potential Conservation of Existing Losses (Including Irrecoverable Loss) for the Tulare Lake Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	15-20	15-20	30-40
Urban landscaping[1]	20-25	40-45	60-70
Commercial, industrial, institutional[1]	10-15	15-20	25-35
Distribution system[1]	10-15	10-15	20-30
Total	**55-75**	**80-100**	**135-175**

[1] For this region, it is assumed that 70% of all losses are recovered and available to the local water supply.

Table 5-9c. Potential Conservation of Irrecoverable Losses(Available for Reallocation) for the Tulare Lake Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	5-10	5-10	10-20
Urban landscaping[1,2]	7-10	18-20	25-30
Commercial, industrial, institutional.[1]	1-5	5-10	6-15
Distribution system[1]	2-5	2-5	4-10
Total	**15-30**	**30-45**	**45-75**

[1] For this region, it is assumed that only 30% of all loss reduction is available for reallocation.
[2] Urban landscaping values include both reduction in losses and changes to landscaping types. See Attachment B for more details on landscape conservation estimates.

5.6.4 UR4 - SAN FRANCISCO BAY

The San Francisco Bay Region is primarily urban, with very little agricultural acreage. The region represents merely 3% of the states's land. The region generally is cool and often foggy along the coast, with Mediterranean-like weather in its inland valleys. The coastal range creates numerous micro-climates and allows cool air to flow at times from the Pacific Ocean into the interior of the state. Coastal areas are often about 10 degrees cooler than the interior part of the region, and sometimes as much as 20-30 degrees cooler in summer than the regions of the Central Valley. In contrast to the Sacramento and Tulare Lake Regions, the San Francisco Bay Region's urban demand accounts for 20% of the total demand. (Environmental use is a little less than of 80% of the total.)

The region is characterized by single- and multi-family dwellings with smaller landscapes; large amounts of industry, including computer and electronics manufacturing; and many commercial businesses. The commercial and industrial water demands can be significant, accounting for almost one-third of the total urban demand. The region is heavily populated, with an average density of over 1,300 people per square mile.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is very minimal. The majority of unconsumed urban water ends up in the San Francisco Bay or is directly discharged to the Pacific Ocean. There is little opportunity for incidental reuse. For this reason, there is an increasing interest in capturing the discharges and recycling them back into the region. However, conservation measures also can help reduce the irrecoverable losses to these salt sinks. Almost all decreases in urban water use in this region, whether previously consumed or not, can provide a water supply benefit.

Urban populations are expected to expand only slightly, primarily because of limited land and other resources. However, even what is considered limited growth for this region can be significant when compared to the total projected populations in the Central Valley regions (see Figure 5-4).

In this region, 27 urban water agencies have signed the Urban MOU.

URBAN INFORMATION
San Francisco Bay Region

	Population	*Baseline per-capita water use*
1995:	5.8 million	177 gpcd
2020:	6.9 million	169 gpcd (199 if no conservation occurs)

Approximate CII use in 1995:	38% of per-capita use
Estimated CII use in 2020:	38% of per-capita use
Assumed CII reduction as a result of conservation measures:	
No Action Alternative:	4% (of 2020 projected per-capita water use)
CALFED:	7%
Assumed residential indoor use (average):	
2020 baseline	65 gpcd
2020 No Action Alternative	60 gpcd
2020 CALFED	55 gpcd
Assumed distribution system losses (as a percent of total urban use):	
Existing:	6%
No Action Alternative:	6%
CALFED:	5%
Assumed ratio of irrecoverable losses to total existing loss:	0.9 (90%)
Assumed existing urban landscape acreage:	155,000 acres
Assumed urban landscaped acreage in 2020:	180,000 acres
Assumed ET_o Value:	3.3 feet of water annually

Estimated Reduction in Irrecoverable Losses for Reallocation to Other Water Supply Uses

Most of the conservation potential in the San Francisco Bay Region would constitute a water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings also would provide other benefits, namely improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development.

Table 5-10a. Assumed Distribution of Landscaped Acreage among ET_o Factors for the San Francisco Bay Region (%)

			2020 NO ACTION		2020 CALFED	
ET_0 FACTOR	1995 ACRES (%)	BASE ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)
1.2	15	15	10	10	0	0
1.0	60	60	50	30	35	20
0.8	25	25	40	60	55	55
0.6					10	20
0.4						5

Table 5-10b. Potential Conservation of Existing Losses (Including Irrecoverable Loss) for the San Francisco Bay Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER *CALFED*	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	35-40	35-40	70-80
Urban landscaping[1]	25-30	55-60	80-90
Commercial, industrial, institutional[1]	15-20	30-35	45-55
Distribution system[1]	-	10-15	10-15
Total	**75-90**	**130-150**	**205-240**

[1] For this region, it is assumed that only 10% of all losses are recovered and available to the local water supply.

Table 5-10c. Potential Conservation of Irrecoverable Losses (Available for Reallocation) for the San Francisco Bay Region

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER *CALFED*	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	30-35	30-35	60-70
Urban landscaping[1,2]	20-25	50-55	70-80
Commercial, industrial, institutional.[1]	15-20	30-35	45-55
Distribution system[1]	-	10-15	10-15
Total	**65-80**	**120-140**	**185-220**

[1] For this region, it is assumed that 90% of all loss reduction is available for reallocation.

[2] Urban landscaping values include both reduction in losses and changes to landscaping types. See Attachment B for more details on landscape conservation estimates.

5.6.5 UR5 - CENTRAL COAST

The Central Coast Region encompasses land on the western side of the coastal mountains that is hydraulically connected to the Bay-Delta region. This region includes southern portions of the Santa Clara Valley and San Benito County, as well as the urban communities from San Luis Obispo south to Santa Barbara. These areas are included because of the recent completion of the Coastal Aqueduct, envisioned to provide SWP water to urban users along its route. Exported water from the San Felipe unit of the CVP is delivered to urban users in San Benito and Santa Clara Counties. In contrast to the Sacramento and Tulare Lake Regions, the Central Coast Region's urban demand accounts for 20% of the total demand. (Agriculture uses just less than 80% of the total.)

The region has a diverse climate with summer months cool along the coastal areas and warm inland. During winter, however, interior parts of the region become cooler than coastal areas. The region is characterized by largely single-family dwellings with relatively small landscapes, and limited commercial and industrial operations. The region has an average population density of just under 120 people per square mile. Most of these people are concentrated in the urban towns and cities.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is minimal. The majority of unconsumed urban water is directly discharged to the Pacific Ocean. There is little opportunity for incidental reuse. For this reason, there is an increasing interest in capturing the discharges and recycling them back into the region. However, conservation measures also can help reduce the irrecoverable losses to these salt sinks. Almost all decreases in urban water use in this region, whether previously consumed or not, can provide a water supply benefit.

In this region, 13 urban agencies have signed the Urban MOU.

URBAN INFORMATION
Central Coast Region

	Population	*Baseline Per-capita water use*
1995:	1.3 million	180 gpcd
2020:	1.9 million	164 gpcd (192 if no conservation occurs)

Approximate CII use in 1995:	32% of per-capita use
Estimated CII use in 2020:	33% of per-capita use
Assumed CII reduction as a result of conservation measures:	
No Action Alternative:	4% (of 2020 projected per-capita water use)
CALFED:	7%
Assumed residential indoor use (average):	
2020 baseline	65 gpcd
2020 No Action Alternative	60 gpcd
2020 CALFED	55 gpcd
Assumed distribution system losses (as a percent of total urban use):	
Existing:	8%
No Action Alternative:	7%
CALFED:	5%
Assumed ratio of irrecoverable losses to total existing loss:	1.0 (100%)
Assumed existing urban landscape acreage:	35,000 acres
Assumed urban landscaped acreage in 2020:	50,000 acres
Assumed ET_o Value:	2.8 feet of water annually

Estimated Reduction in Irrecoverable Losses for Reallocation to Other Water Supply Uses

All of the conservation potential in the Central Coast Region would constitute a water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings also would provide other benefits, namely improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development.

Table 5-11a. Assumed Distribution of Landscaped Acreage among ET_o Factors for the Central Coast Region (%)

			2020 NO ACTION		2020 CALFED	
ET_O FACTOR	1995 ACRES (%)	BASE ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)
1.2	5	5	3	0	0	0
1.0	20	20	15	10	5	0
0.8	55	55	40	30	25	15
0.6	20	20	42	55	60	65
0.4				5	10	20

Table 5-11b. Potential Conservation of Existing Losses (Including Irrecoverable Loss) for the Central Coast Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	10-15	10-15	20-30
Urban landscaping[1]	10-15	10-15	20-30
Commercial, industrial, institutional[1]	0-5	5-10	5-15
Distribution system[1]	0-5	5-10	5-15
Total	**20-40**	**30-50**	**50-90**

[1] For this region it is assumed that none of the losses are recovered and available to the local water supply.

Table 5-11c. Potential Conservation of Irrecoverable Losses (Available for Reallocation) for the Central Coast Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	10-15	10-15	20-30
Urban landscaping[1,2]	10-15	10-15	20-30
Commercial, industrial, institutional.[1]	0-5	5-10	5-15
Distribution system[1]	0-5	5-10	5-15
Total	**20-40**	**30-50**	**50-90**

[1] For this region, it is assumed that all loss reduction is available for reallocation.

[2] Urban landscaping values include both reduction in losses and changes to landscaping types. See Attachment B for more details on landscape conservation estimates.

5.6.6 UR6 - SOUTH COAST

The South Coast Region lies south of the Tehachapi Mountains and extends to the California border with Mexico. It is home for more than 50% of the state's population but represents only 7% of the state's total land area. Rivers and streams that originate in this region flow to the Pacific Ocean. The climate is Mediterranean-like, with warm and dry summers followed by mild and wet winters. It is projected that the region will increase from a 1990 population of 16 million to over 25 million by 2020. In sharp contrast to all the other regions, this region's urban demand accounts for 80% of the total demand. The region also imports about two-thirds of its water from areas outside the region, including the Colorado River, the Owens Valley, and the Bay-Delta.

The region is characterized by single- and multi-family dwellings with smaller landscapes, large amounts of industry, and many commercial businesses. The commercial and industrial water demands can be significant, accounting for over one-quarter of the total urban demand. This region also has the highest population density, with nearly 1,600 people per square mile of land.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is limited to inland reaches of the region. Coastal communities have little downstream reuse. The majority of unconsumed urban water (water passing through wastewater treatment plants) is directly discharged to the Pacific Ocean, resulting in little opportunity for incidental reuse. For this reason, there is an increasing interest in capturing the discharges and recycling them back into the region. However, conservation measures also can help reduce the irrecoverable losses to these salt sinks. Any decrease in water use in this region, whether previously consumed or not, can generate real water savings.

In this region, 89 urban agencies have signed the Urban MOU.

C-026449

URBAN INFORMATION
South Coast Region

	Population	*Baseline per-capita water use*
1995:	17.3 million	208 gpcd
2020:	24.3 million	186 gpcd (218 if no conservation occurs)

Approximate CII use in 1995:	32% of per-capita use
Estimated CII use in 2020:	32% of per-capita use
Assumed CII reduction as a result of conservation measures:	
No Action Alternative:	4% (of 2020 projected per-capita water use)
CALFED:	7%
Assumed residential indoor use (average):	
2020 baseline	65 gpcd
2020 No Action Alternative	60 gpcd
2020 CALFED	55 gpcd
Assumed distribution system losses (as a percent of total urban use):	
Existing:	7%
No Action Alternative:	6%
CALFED:	5%
Assumed ratio of irrecoverable losses to total existing loss:	0.8 (80%)
Assumed existing urban landscape acreage:	480,000 acres
Assumed urban landscaped acreage in 2020:	650,000 acres
Assumed ET_0 Value:	4.0 feet of water annually

Estimated Reduction in Irrecoverable Losses for Reallocation to Other Water Supply Uses

Most of the conservation potential in the South Coast Region would constitute a water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings would also provide other benefits, namely improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development.

C-026450

Table 5-12a. Assumed Distribution of Landscaped Acreage among ET_o Factors for the South Coast Region (%)

			2020 NO ACTION		2020 CALFED	
ET_O FACTOR	1995 ACRES (%)	BASE ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)	EXISTING ACRES (%)	NEW ACRES (%)
1.2	10	10	5	0	0	0
1.0	40	40	30	20	15	5
0.8	40	40	50	60	60	55
0.6	10	10	13	15	20	30
0.4			2	5	5	10

Table 5-12b. Potential Conservation of Existing Losses (Including Irrecoverable Loss) for the South Coast Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	130-140	130-140	260-280
Urban landscaping[1]	170-190	190-200	360-390
Commercial, industrial, institutional[1]	60-70	110-120	170-190
Distribution system1	50-60	50-60	100-120
Total	**410-460**	**480-520**	**890-980**

[1] For this region, it is assumed that 20% of all losses are recovered and available to the local water supply.

Table 5-12c. Potential Conservation of Irrecoverable Losses (Available for Reallocation) for the South Coast Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	100-115	100-115	200-230
Urban landscaping[1,2]	150-160	170-180	320-340
Commercial, industrial, institutional [1]	50-60	90-100	140-160
Distribution system[1]	40-50	40-50	80-100
Total	**340-385**	**400-445**	**740-830**

[1] For this region, it is assumed that 80% of all loss reduction is available for reallocation.

[2] Urban landscaping values include both reduction in losses and changes to landscaping types. See Attachment B for more details on landscape conservation estimates.

5.6.7 UR7 - COLORADO RIVER

The Colorado River Region includes a large area of the state's southeastern corner, the majority of which is desert or irrigated agriculture. The primary urban areas lie north and south of the Salton Sea. The resort-oriented communities of Palm Springs and Indio lie to the north, while the rural communities of Imperial and Brawley lie to the south. This area includes about 650,000 acres of irrigated agricultural land. The Salton Sea, located between the two urban areas, is a prominent feature. The sea is currently fed by rainfall from the surrounding desert mountains and by agricultural surface drainage. Rainfall in the mountains also recharges the groundwater aquifers that underlie the region. Groundwater plays a major role in providing for the urban demands, including the significant acreage devoted to golf courses. Urban water use comprises only about 5% of the region's total water use (agriculture uses 83%).

The region's climate is hot subtropical desert, with most of the annual precipitation falling as snow in the surrounding high mountains. Temperatures above 110 degrees are not uncommon during summer.

The region is characterized by single-family dwellings, some with large turf landscapes and others with desert landscape; commercial businesses; and resorts. The resort demand alone creates a significant need for water resources. The region has an average population density of around 25 people per square mile. Most of these people are concentrated in the urban towns and cities, not in the outlying desert or the Salton Sea area.

Unlike the Central Valley regions, downstream reuse of landscape runoff and treated wastewater is minimal. Although a large degree of groundwater reuse is associated with the resort golf areas, some of the urban water that is not consumptively used eventually reaches the Salton Sea. Conservation measures can help reduce the irrecoverable losses to this salt sink.

In this region, five urban agencies have signed the Urban MOU.

Special Conditions

Similar to agricultural conservation opportunities, the potential for real water savings to benefit the Bay-Delta depends on the use of the conserved water. For example, conservation savings in Palm Springs may be used to offset future demands. It is unlikely that savings would be transferred to another urban user as a replacement for imported Delta water. Therefore, the values shown for this region may provide little benefit to the Bay-Delta.

URBAN INFORMATION
Colorado River Region

	Population	*Baseline per-capita water use*
1995:	0.5 million	578 gpcd
2020:	1.1 million	522 gpcd (594 if no conservation occurs)

Approximate CII use in 1995:	27% of per-capita use
Estimated CII use in 2020:	28% of per-capita use
Assumed CII reduction as a result of conservation measures:	
No Action Alternative:	4% (of 2020 projected per-capita water use)
CALFED:	7%
Assumed residential indoor use (average):	
2020 baseline	65 gpcd
2020 No Action Alternative	60 gpcd
2020 CALFED	55 gpcd
Assumed distribution system losses (as a percent of total urban use):	
Existing:	12%
No Action Alternative:	8%
CALFED:	5%
Assumed ratio of irrecoverable losses to total existing loss:	0.3 (30%) Most urban use is in the Coachella Valley, where much of the deep percolation from golf courses or other losses actually recharge local aquifers.
Assumed existing urban landscape acreage:	35,000 acres
Assumed urban landscaped acreage in 2020:	75,000 acres
Assumed ET_o Value:	6.0 feet of water annually

Estimated Reduction of Irrecoverable Losses for Reallocation to Other Water Supply Uses

About 30% of the conservation potential in the Colorado River Region would constitute a water savings that could be made available to other beneficial uses, including offsetting future urban demands. Such savings also would provide other benefits, namely improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development.

Table 5-13a. Assumed Distribution of Landscaped Acreage among ET_0 Factors for the Colorado River Region (%)

			2020 NO ACTION		2020 CALFED	
ET_0 FACTOR	**1995 ACRES (%)**	**BASE ACRES (%)**	**EXISTING ACRES (%)**	**NEW ACRES (%)**	**EXISTING ACRES (%)**	**NEW ACRES (%)**
1.2	70	70	60	50	50	40
1.0	30	30	35	40	30	30
0.8			5	10	15	25
0.6					5	5
0.4						

Table 5-13b. Potential Conservation of Existing Losses (Including Irrecoverable Loss) for the Colorado River Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER *CALFED*	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	5-10	5-10	10-20
Urban landscaping[1]	20-25	25-30	45-55
Commercial, industrial, institutional[1]	5-10	10-15	15-25
Distribution system[1]	20-25	15-20	35-45
Total	**50-70**	**55-75**	**105-145**

[1] For this region, it is assumed that 70% of all losses are recovered and available to the local water supply.

Table 5-13c. Potential Conservation of Irrecoverable Losses (Available for Reallocation) for the Colorado River Region (TAF/Year)

USE	PROJECTED REDUCTION UNDER NO ACTION ALTERNATIVE	INCREMENTAL REDUCTION UNDER CALFED	TOTAL ESTIMATED REDUCTION
Residential indoor[1]	0-5	0-5	0-10
Urban landscaping[1,2]	15-20	20-25	35-45
Commercial, industrial, institutional[1]	0-5	0-5	0-10
Distribution system[1]	5-10	5-10	10-20
Total	**20-40**	**25-45**	**45-85**

[1] For this region, it is assumed that 30% of all loss reduction is available for reallocation.
[2] Urban landscaping values include both reduction in losses and changes to landscaping types. See Attachment B for more details on landscape conservation estimates.

5.7 SUMMARY OF ESTIMATED URBAN WATER CONSERVATION POTENTIAL

The following tables summarize the regional conservation estimates for urban regions.

Table 5-14. Estimated Conservation Potential of Projected Losses (Including Irrecoverable Losses) for All Urban Regions (TAF/Year)

REGION[1]	NO ACTION ALTERNATIVE CONSERVATION	INCREMENTAL CALFED CONSERVATION	TOTAL CONSERVATION POTENTIAL
Sacramento River	145-165	85-105	230-270
Eastside San Joaquin River	90-110	95-115	185-225
Tulare Lake	55-75	80-100	135-175
San Francisco Bay	75-90	130-150	205-240
Central Coast	20-40	30-50	50-90
South Coast	410-460	480-520	890-980
Colorado River	50-70	55-75	105-145
Total	**845-1,010**	**955-1,115**	**1,800-2,125**

Other than the irrecoverable portion, which is the only water available for reallocation, these savings provide improved water quality, changed timing of flow releases, reduced fishery impacts, reduced treatment costs, and potentially reduced need for additional water supply development.

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

Table 5-15. Estimated Conservation Potential of Irrecoverable Loss (a Subset of Total Loss) for All Urban Regions (TAF/Year)

REGION[1]	NO ACTION ALTERNATIVE CONSERVATION	INCREMENTAL CALFED CONSERVATION	TOTAL CONSERVATION POTENTIAL
Sacramento	5-9	4-9	9-18
Eastside San Joaquin River	3-7	6-11	9-18
Tulare Lake	15-30	30-45	45-75
San Francisco Bay	65-80	120-140	185-220
Central Coast	20-40	30-50	50-90
South Coast	340-385	400-445	740-830
Colorado River	20-40	25-45	45-85
Total	**470-590**	**615-745**	**1,085-1,335**

These savings, a subset of the values in Table 5-14, are available for reallocation to other water supply uses.

[1] Refer to Chapter 3 for information regarding the PSAs that comprise each CALFED region.

Although the total potential reduction associated with irrecoverable losses could amount to as much as 1.3 MAF, it must be recognized that amount this would require the majority of urban water users as well as urban water suppliers to implement most all available conservation measures. Achieving this amount will require significant local, state and federal support.

It also should be noted that the additional potential irrecoverable loss reduction resulting from the Water Use Efficiency Program is only slightly more than half of the total shown (745 TAF of 1.3 MAF). This demonstrates CALFED's assumption that existing trends will continue to generate conservation savings at rates greater than quantified by DWR or others. This results from No-Action factors such as the Central Valley Project Improvement Act (CVPIA) that are not fully accounted for in previous estimates of savings achievable under "full implementation" of urban BMPS.

In addition, a significant portion of the irrecoverable loss reduction is in the South Coast Region, which may or may not provide any Bay-Delta benefit. This will depend on how water suppliers in this region reallocate the water saved (Would water savings offset demand growth; reduce Colorado River or other imported, non-Delta supplies; or would they be "left in the Delta"?)

Slightly less than half of the reduction in existing loss estimated in Table 5-14 is composed of recoverable losses and is not available for reallocation for other water supply purposes. However, this significant conservation potential can provide valuable water quality, water management, and ecosystem benefits that are also key objectives of the CALFED Program. In addition, reduced losses may provide in-basin water management benefits and help reduce future demand projections.

C-026456

5.8 UNIT COST ESTIMATES FOR URBAN WATER USE EFFICIENCY PROGRAMS

The CALFED Water Use Efficiency Program will call on urban water suppliers to fully implement cost-effective Urban MOU Best Management Practices (BMPs). While many urban water suppliers have already made substantial progress towards satisfying the terms of the Urban MOU, others will be just starting out. Meeting CALFED water use efficiency objectives will require substantial conservation program investments in some regions. Determining which investments are cost-effective and which are not will be of key importance. This section presents unit cost ($/AF) estimates for eight different BMP programs. These programs are:

- Residential ULFT Rebate Program
- Residential ULFT Direct Installation Program
- Commercial & Industrial ULFT Rebate Program
- High-Efficiency Washing Machine Rebate Program
- Untargeted Residential Water Survey Program
- Targeted Residential Water Survey Program
- Low Flow Showerhead Distribution Program
- Residential Metering Program

Survey programs for large landscape and commercial/industrial users also were examined. However, the degree of heterogeneity across these programs both in terms of cost and design prevented the development of useful unit cost ranges.

Program unit cost estimates presented in this section are for active conservation (i.e., the cost to increase conservation above what it would be in the absence of intervention by water suppliers). To the degree possible the estimates account for, and therefore do not include, background conservation due to changes in plumbing codes, natural replacement of water using appliances and fixtures, and other factors which are not considered to be part of "active" conservation.

Two types of unit costs are presented: (1) simple unit cost and (2) discounted unit cost. A simple unit cost is defined as the present value of project costs divided by the total yield over the life of the project. A discounted unit cost is defined as the amortized cost of the project divided by its average annual yield. Both estimates are frequently used in project evaluations. Generally, discounted unit costs result in higher estimates than simple unit costs. In both cases a 4.5 percent discount rate is assumed.

These estimates are intended to demonstrate the likely range of cost water suppliers will experience implementing various BMP programs. It is important to emphasize, however, that these **estimates are for informational purposes only**. They are not being used by CALFED for project selection or ranking. Economic feasibility studies for specific projects and programs will occur in later design phases of the Urban Water Use Efficiency Program and during investigations performed by individual water suppliers.

Furthermore, it should be noted that unit costs are only half of the equation when evaluating the merits of a conservation program. Benefits achieved from the measure are the other half. Information on both costs and benefits are essential for appropriate judgments to be made regarding the appropriateness of any particular water conservation program.

5.8.1 Perspective of Unit Cost Analysis

Because the majority of conservation investments will be made at the local level, these estimates are presented from the perspective of an urban water supplier implementing the conservation program. Focusing on the supplier perspective helps to identify which BMP investments are likely to require CALFED cost-sharing assistance and which are not. It is CALFED's belief that in most cases BMPs will be cost effective from a statewide perspective. Those with low unit costs from the supplier's perspective are less likely to require cost-sharing assistance, while those with high unit costs are more likely to require assistance.

5.8.2 Limitations of Unit Cost Estimates

While unit costs can be indicative of cost-effectiveness, they do not directly address the question of economic feasibility. It is always possible that a conservation project with very high unit costs also has very high unit benefits, and vice-versa. Similarly, unit costs are useful for ranking projects only when (1) competing projects are expected to produce exactly the same result or (2) all results can be measured in terms of a single, non- monetary unit (say AF). Neither of these conditions will occur for the majority of water supply, conservation, and recycling projects CALFED may consider. Unit costs are therefore a useful first step to cost-benefit analysis, but they are not a substitute for it.

The estimates presented within this section also do not account for diminishing returns. Showerhead and ULFT distribution programs are both thought to be subject to diminishing returns as device saturation levels increase. For example, consider a 2.5 bathroom house which has a ULFT in the most used bathroom, but not the other two. As additional ULFT's are added, the total savings potential for the dollar investment is not as great as the first toilet replaced. This is because there are less flushes occurring to offset the invested cost. This translates to a higher cost per unit of savings. Conservation experts are starting to notice that unit costs in areas where these programs have been active for long periods are likely to be higher than the unit cost estimates presented in this section.

5.8.3 Data Sources for Unit Cost Estimates

The unit cost estimates shown in Table 5-16 were constructed using methods outlined in the CUWCC's "Guidelines for Preparing Cost-Effectiveness Analyses of Urban Water Conservation Best Management Practices" (Pekelney et al., 1996). Water supplier BMP implementation reports provided most of the program cost data used for these estimates. The cost data account for average expenditures for material, labor, and overhead costs incurred by water suppliers implementing these programs. In some instances it was necessary to supplement this cost data either with cost data from other sources or with engineering estimates. Published conservation program evaluations provided data for expected water savings and savings life expectancy. These studies included but were not limited to:

- THELMA H-Axis Washing Machine Water and Energy Savings Study (THELMA, 1997);
- Oak Ridge National Laboratory's H-Axis Washing Machine Water Savings Study (Oak Ridge, 1998);
- CUWCC's 1997 CII ULFT Savings Study (Whitcomb et al., 1997);
- Metropolitan Water District's 1994 Public Facilities Toilet Retrofits Evaluation (Bamezai et al., 1994);
- Metropolitan Water District's 1994 Ultra Low Flush Toilet Programs Evaluation (Bamezai et al., 1994);
- Metropolitan Water District's 1994 Residential Water Audit Program Evaluation (Bamezai et al., 1994).

Much of this data is compiled in the CUWCC's forthcoming "Guide to Data and Methods for Cost-Effectiveness Analysis of Urban Water Conservation Best Management Practices" (Pekelney et al.).

There is scant data on the extent of program free-ridership, savings decay, and natural replacement rates for these programs. Most of the estimates employ assumptions for these variables. The ranges for program unit costs reflect uncertainty regarding these assumptions as well as variations in program design that affect expected savings and administrative costs. All estimates were rounded to the nearest $100/AF.

TABLE 5-16. Unit Cost Estimates for Various BMP Programs

BMP Program	Simple Unit Cost [4] Estimate ($/AF)	Discounted Unit Cost [5] Estimate ($/AF)
Residential ULFT Rebates	$200 - $400	$300 - $600
Residential ULFT Direct Install	$100 - $300	$300 - $500
CII ULFT Replacement [1]	$200 - $500	$400 - $900
H-Axis Washer Rebates	$400 - $900	$800 - $1700
Home Survey - Untargeted	$700 - $1,000	$1,300 - $1,900
Home Survey - Targeted	$900 - $1,000	$1,700 - $1,900
Residential Metering [2]	$100	$200 - $300
Low Flow Showerhead Distribution	$200 - $300	$300 - $600
Landscape Audits [3]	N/A	N/A
CII Audits [3]	N/A	N/A

[1] Range is based on targeted versus untargeted replacements.
[2] No range for simple unit cost estimates because high and low estimates both rounded to $100.
[3] No estimate provided because of heterogeneity of program designs and costs.
[4] Simple unit cost = P.V. (Costs) ÷ Sum of Yield over Life of Project
[5] Discounted unit cost = Amortized Cost ÷ Average Annual Yield of Project

6. Water Recycling

Tables

Figures

6. Water Recycling

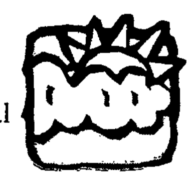
Water recycling offers significant potential to improve water supply reliability for California, one of the primary objectives of the CALFED Program. Water recycling is a safe, reliable, and locally controlled water supply. Tertiary treated, disinfected recycled water is permitted for all non-potable uses in California through Title 22 of the California Code of Regulations. With the majority of the state's population in coastal areas, the majority of resulting wastewater flows currently are discharged to the ocean and rendered unavailable for reuse. If these flows are recycled, they can represent a new and somewhat drought-proof source of supply for water users.

Currently, the total agricultural and urban water use in the state is about 42 MAF annually. Of this, the urban sector uses about 8.7 MAF, nearly 70% of which is used in the urban coastal areas of California (DWR 1997). In southern California, about 30% of this use goes directly to outdoor urban landscaping and does not generate a wastewater flow (MWD 1996). In hotter inland areas, this percentage can increase to more than 60% (DWR 1997). In coastal areas of the state, the remaining urban uses (indoor residential and CII) result in more than 2 MAF of wastewater being treated and discharged annually (BARWRP 1997). Recycling of any portion of this water constitutes a new water supply—a water supply that can be allocated to other beneficial uses.

By 2020, wastewater flows from coastal areas are expected to increase to over 3 MAF annually, even considering significant levels of future urban water conservation. This amount can provide substantial opportunities for water recycling and help achieve CALFED Program objectives for water supply reliability, water quality, and ecosystem restoration. Recycling creates a unique contribution to improved reliability by providing an additional source of water that is local rather than imported. Further, this source can be relatively resistant to drought, making it available when it is needed most. Perhaps most important, recycling often provides increased water for one beneficial use without reducing the water available for other beneficial uses. From a Bay-Delta perspective, recycling projects in export areas increase water supply without increasing Delta exports or reducing Delta outflow. Thus, water recycling projects can simultaneously help meet CALFED Program objectives for water supply reliability, water quality, and ecosystem restoration.

Potential benefits from water recycling include:

- Reduced demand for Delta exports
- Improved timing of diversions
- Increased carryover storage
- Reduced fish entrainment
- Reduced discharge of treated wastewater into useable surface water bodies
- Improved water quality
- Increased availability of Delta supplies for urban, agricultural, and environmental purposes



6.1 NEW WATER SUPPLY VS. TOTAL WATER RECYCLING

Water recycling increases total water supply by providing a new source of water previously "lost" to the ocean, bays, estuaries, and evaporation ponds. However, in non-coastal area regions (and even in minor portions of coastal regions), recycling of current wastewater flows does not provide additional new water supply because the treated wastewater already is discharged into rivers, streams, and aquifers where, in many cases, downstream users (including the environment) may depend on this flow. It is important to distinguish the new water supply potential from total water recycling because of the value of new water to water supply reliability; however, the total recycling potential is still important to help meet eco-system and water quality goals of the Program.

The amount of new water supply generated from recycled water depends on the type of water body that receives the discharged wastewater. These include:

- Rivers and streams
- Saline water bodies, such as the Pacific Ocean or San Francisco Bay
- Recharge and evaporation ponds

When treated wastewater is discharged into rivers or streams, it contributes to baseline flows downstream of the discharge point. This water may not be available for recycling without diminishing streamflow and causing impacts that may need to be mitigated with additional flow from other sources. To use terminology consistent with the analysis of urban and agricultural water conservation in this program plan, **recycling of this stream discharge would represent a reduction in applied water and contribute to total recycling but would not constitute a reduction in irrecoverable losses**. (See also the discussion in Section 4.4, "Recoverable vs. Irrecoverable Losses.")

Many communities in the Sacramento and San Joaquin Valleys fall into the first category—rivers and streams. For example, the Sacramento metropolitan area currently discharges most of its treated wastewater into the Sacramento River, downstream of Sacramento. This water is then part of the flow available in the Delta today. Therefore, the expanded use of recycled water by Sacramento would not contribute to CALFED's water reliability objective. It will contribute to local water supply reliability, but potentially at the expense of others. Primarily, it may result in positive contributions to CALFED's water quality and ecosystem restoration objectives.

As wastewater flows increase with population growth, however, the incremental increase in flows may be available as a new water supply to be recycled for use in and around these inland areas. In other valley communities with less secure water supplies, recycling may be an important way of reducing the need to obtain new water supplies. The Water Code requires the owner of a wastewater treatment plant currently discharging treated wastewater into a natural water course to petition the SWRCB prior to ceasing the discharge and beginning reclamation for other beneficial uses. The SWRCB can permit such a change only if the petitioner establishes that the change will not injure any legal user of that water.

The majority of the state's wastewater flow is generated in coastal areas and discharged to the ocean and San Francisco Bay—for example, Los Angeles, San Diego, and San Francisco. The recapture and recycling of wastewater from those regions could generate a new water supply and further CALFED water supply reliability, water quality, and ecosystem restoration objectives.

Many cities in the Sacramento-San Joaquin River watershed, including the cities of Fresno and Bakersfield, discharge to recharge and evaporation ponds. The wastewater is "disposed of" by percolating into the local aquifer or evaporating from the pond surfaces. Recycling the portion that evaporates under this discharge method would benefit CALFED's water reliability and other objectives. Recycling the portion percolating into useable groundwater may or may not further these objectives.

For purposes of this analysis, the evaluation of water recycling potential is limited to the ability to further CALFED's water supply reliability objective through water recycling in the state's three primary coastal areas, the San Francisco Bay Area, the Central Coast, and southern California. The ability to further CALFED's water quality and ecosystem restoration objectives through water recycling has not been analyzed. Similarly, CALFED did not analyze the potential for Central Valley water recycling to help meet any of these objectives.

6.2 UNDERSTANDING WATER RECYCLING OPPORTUNITIES

Water recycling is gaining in recognition as a viable supply source. More and more urban water agencies are analyzing and implementing water recycling projects for several different reasons, depending on their local conditions. Current drivers include:

- Increasingly stringent waste discharge requirements, which affect the timing and quantity of wastewater discharge as well as the type and level of treatment required prior to discharge (an example may include the California Toxics Rule which, if implemented as proposed, could favor more recycling).
- A need to secure more reliable sources of water to meet growing populations as other new supply alternatives become increasingly more difficult to find or implement.
- A need to offset physical or legislated reductions in some existing surface water and groundwater sources (the result of actions taken under the state and federal ESAs).
- Increasing use of integrated water resource planning policies that dictate local supply development actions to address environmental issues and enhance water supply reliability through the diversification of the sources of water made available to the customers.
- California Water Code provisions that define use of potable water for nonpotable purposes as a waste and unreasonable use.

However, the potential for water recycling is currently limited by several impediments, the greatest of such is considerations of local cost-effectiveness. Inter-jurisdictional issues (e.g., rights to wastewater resources), public acceptance of recycled water, and complex permitting and regulatory compliance processes also discourage some local agencies.

One of the more daunting impediments to water recycling noted by urban water agencies has been cost, especially as it is affected by the quality of the source water. The CALFED Program approach to water use efficiency (see Section 2) is based on cost-effectiveness. The CALFED Program proposes to encourage local water suppliers to analyze all options for reducing the mismatch between supply and demand. Further, through the actions detailed in Section 2, CALFED agencies will help water suppliers implement appropriate options starting with the least expensive. This is anticipated to result in identification of feasible recycling projects. CALFED acknowledges that there is limited information regarding the effect of source water quality on the costs of producing recycled water and is proposing to support necessary research (see Section 2.3.3). However, the Preferred Alternative does include actions targeting improvements in Delta water quality, the source for many potential water recycling projects. (For more information on source water quality improvement strategies, see the Water Quality Program Plan and the Revised Phase II Report.)

When considering local cost-effectiveness issues in the past, many agencies found several options to meet demands that were less expensive than water recycling. This statement is supported by findings of Reclamation's "Least-Cost CVP Yield Increase Plan" (DOI 1995). However, the Reclamation study did not attempt to evaluate the state-wide water supply reliability, water quality, and ecosystem benefits attributable to water recycling.

When water transfers are available as a source, they often provide the least expensive increment of additional water supply. Careful avoidance or mitigation of third-party impacts associated with water transfers can add to the cost, but transfers still may be a locally least-cost alternative. It should be noted that many transfers are conducted on a year-to-year basis, while water recycling provides a long-term supply. Difficulties in conveying water from a "seller" to a "buyer," especially if the transfer involves moving water across the Delta, also can reduce the reliability of transfers as an effective water supply option. Water recycling has the potential of enhancing the water transfer market by making additional water supplies available for transfer. The Water Code provides that a water right holder that has reduced its use of water as a result of recycling efforts is able to transfer the "saved" water, pursuant to applicable state and federal transfer laws.

For many agencies, water conservation measures also can be and have been implemented at a lower unit cost than recycling (see the urban conservation costs outlined in Section 5). Despite the extensive implementation of conservation measures that has occurred over the last decade, CALFED estimates that the potential for additional water conservation in the urban sector remains substantial—over 1.5 MAF. Even with full implementation of cost-effective water conservation measures, CALFED is predicting shortages in available water supply. Additional water recycling will be necessary to help reduce the mismatch between Bay-Delta water supplies and the current and projected beneficial uses dependent on its water.

For the reasons described above, recycling projects typically are evaluated by local water suppliers only in comparison to new supply development. The drivers listed previously, as well as shrinking opportunities for additional supply projects (with their associated impacts and the need to avoid or mitigate these impacts), are driving up the cost of new supply projects and making recycling more competitive. Nevertheless, several factors can continue to make new supply development more attractive to local water suppliers. In the past, many new supply projects have been planned, financed, and built by regional, state, or federal agencies, thus relieving local suppliers of the initial burdens of project development (although local agencies may pay back the costs over time through contractual arrangements). Like large storage projects, water recycling projects improve local water supply reliability and help meet CALFED Program objectives. Given the contribution of federal and state financial assistance to traditional water supply development, it may be appropriate for CALFED agencies to assume a planning and financing assistance role for recycling projects that help fulfill one or more CALFED objective.

Impediments to water recycling also make it difficult to project future levels of recycling. In particular, the inter-jurisdictional nature of water recycling tend to complicate projections. For example, one agency may secure raw water supplies for a region and deliver water to customers, while another agency may treat wastewater. Who is responsible for any recycled water? Water supply from a recycling project may need to move across agency boundaries in order to be delivered to customers. In addition, recycled water supplies in an area may be greater than demand in that area, resulting in recycled water that must be conveyed to another area if customers can be identified. CALFED could effectively address these institutional planning issues by providing technical and financial planning assistance for local planning efforts. CALFED's assurances program could include policies designed to encourage coordination of water recycling planning among water and wastewater agencies and ensure thorough examination of water recycling opportunities throughout the state. For example, water suppliers could be required to prepare water recycling plans that evaluate potential sources of recycled water and coordinate plans with wastewater utilities.

Other impediments to water recycling include the public and market perceptions. Local project sponsors are regularly called on to defend the need for water recycling. Public concern exists regarding the safeguard of potable supplies and perceptions that recycled water could adversely affect the quality of current water supplies. In addition, some agricultural commodity buyers have disallowed the use of recycled water on certain crops, primarily because of concerns about the public's willingness to purchase food crops grown with recycled water. Overcoming these public perceptions is a necessary prerequisite to achieve the water recycling potential identified by CALFED. Public education is an important effort where CALFED can provide a leadership role. CALFED and the CALFED agencies also can improve the understanding and acceptance of water recycling through their individual and collective public outreach efforts. To foster a high degree of public confidence in water recycling, CALFED could provide funding to support current public education programs, and research and development efforts.

Impediments to the implementation of recycling projects may require vigorous efforts by CALFED agencies to make these projects feasible. The water recycling assistance programs of CALFED and the CALFED agencies will require much additional refinement and input from stakeholders to maximize program effectiveness. Only through additional innovation and assistance will California be able to realize a significant increase in the use of recycled water. These actions are discussed in detail in Section 2 of this document.

6.3 DETERMINING WATER RECYCLING POTENTIAL

Water recycling is and will continue to be an important element of California's water management strategy. To emphasize this importance, the Legislature, in 1991, adopted goals for the beneficial use of recycled water to include achieving 700 TAF per year of recycling by 2000 and 1 MAF per year by 2010 (Cal. Water Code Section 13577). Currently, about 485 TAF of urban water recycling occurs or is under construction in the state, with more projects being completed over the next several years (DWR 1997).

CALFED acknowledges that there is much uncertainty in developing water recycling estimates because of limited information about the effects of source water quality on the feasibility of projects and due to numerous other impediments previously discussed. With this in mind, CALFED has developed a broad range of water recycling potential, as presented in Section 6.5.1. Furthermore, CALFED's estimates were developed for a few primary purposes:

- To provide information for programmatic-level impact assessments;
- To gain a better understanding of the order-of-magnitude role recycling can have in statewide water management; and,
- To aid CALFED in designing the appropriate types and levels of incentive programs and assurance mechanisms.

The estimates are not targets, objectives, or goals. CALFED is not mandating that these or any other levels of water recycling be achieved. CALFED is, however, requiring that many actions (see Section 2) be undertaken by water suppliers that will result in the implementation of more reuse projects, but the actual savings that will result cannot be more accurately estimated without extensive studies that are beyond the scope of this Programmatic EIS/EIR.

6.3.1 REGIONAL WATER RECYCLING STUDIES

About 2.1 MAF of treated wastewater is discharged by urban California into the Pacific Ocean and San Francisco Bay (BARWRP 1997). As populations continue to increase, the amount of discharge also will rise, potentially reaching more than 3 MAF by 2020. As identified in Section 2 under "Water Recycling Approach," the CALFED Program seeks to identify and encourage regional water recycling opportunities that maximize reuse at minimum cost.

Currently, two regional water recycling studies are under way. The Bay Area Regional Water Recycling Program (BARWRP), previously referred to as the Central California Regional Water Recycling Project, is in its second phase of feasibility analysis. The Southern California Comprehensive Water Reclamation and Reuse Study (SCCWRRS) also is in its second phase of feasibility analysis to identify means of maximizing the use of recycled water in southern California. The goal of these studies is to identify regional recycling systems and develop potential capital projects through comprehensive planning processes.

Since both programs are still in their development stages, clear estimates of water recycling potential are not available. Also unknown is the overlap that may exist between the regional recycling potentials and the values portrayed in survey results and other data (supplied later in this section). These projects will provide valuable insight into the future potential of recycling when they are complete. But for now, use of regional data for this analysis is limited to the projections of future wastewater flow generated by the anticipated populations in 2020 and existing (or soon to be completed) levels of local recycling.

The Bay Area Regional Water Recycling Program

The BARWRP is a partnership of 17 Bay Area water and wastewater agencies, DWR, and Reclamation. This partnership is committed to maximizing the beneficial reuse of highly treated wastewater to provide a safe, reliable, and drought-proof new water supply. The product of the BARWRP efforts is a comprehensive regional water recycling master plan released in September 1999.

The master planning process has led to some important innovations and preliminary conclusions regarding recycled water. Some of these are discussed below:

Importance to CALFED. BARWRP has demonstrated that recycled water is an important component in the CALFED solution and can provide a significant, cost-effective new source of water for California. As stated in BARWRP correspondence to the CALFED process, recycled water is a potentially significant water supply option and would help CALFED achieve its objectives for water supply, water quality, and ecosystem quality.

Innovative Approaches. Innovative approaches to project implementation have been developed by BARWRP to significantly increase the feasibility of recycled water use. Such approaches include (1) crossing jurisdictional boundaries to serve customers from the least-cost recycled water source, (2) promoting the application of highest quality water to the highest uses through water exchanges, and (3) promoting trade of recycled water use for Bay Area discharge credits in a watershed approach for pollutants of concern.

BARWRP has developed new tools for identification and evaluation of recycled water projects. One tool, the Evaluation Decision Methodology, carefully scrutinizes cost and benefit allocation among agencies for each alternative, sheds light on any disparities in cost and benefits, and helps highlight implementation strategies that should be taken to facilitate implementation.

Potential Recycled Water Demand. BARWRP has estimated that the wastewater treatment entities in the Bay Area will be generating recycled water volumes of approximately 670 TAF per year of water by 2010 and 730 TAF per year by 2040 (BARWRP 1999). For 2020, the estimate may be around 690 TAF annually (based on linear interpolation by CALFED staff). Current recycling levels are estimated by BARWRP at 20 TAF. This would leave approximately 670 TAF that ultimately could receive further treatment and be recycled by 2020.

BARWRP also has estimated a potential demand for recycled water of over 400 TAF per year by 2010. This demand includes satisfying existing demands for agriculture; irrigating parks, golf courses, and cemeteries; and industrial process requirements, as well as projected demands for environmental enhancement programs and major new residential and commercial developments.

BARWRP has analyzed the constraints that have inhibited implementation of this potentially important new water supply. These constraints include lack of a driving force for implementation, institutional barriers, and public perception issues. The chief constraint, however, has been lack of funding.

Recommended Recycling Levels. BARWRP, in its September 1999 Recycled Water Master Plan (BARWRP, 1999) recommends implementation of about 125 TAF of new water recycling by 2010 and 240 TAF by 2040. This represents over half the assessed demand of 400 TAF, but accounts for feasibility and acceptability issues that constrain satisfying the full demand.

The Southern California Regional Study

Although yet to determine a potential customer demand, the SCCWRRS has estimated that 2.47 MAF of treated wastewater would be available for recycling by 2010. By 2040, the estimate increases to 3.03 MAF annually. For 2020, the estimate may be around 2.6 MAF annually (based on linear interpolation by CALFED staff). Estimates of existing levels of water recycling are around 263 TAF annually. These estimates translate to roughly 2.3 MAF of additional treated wastewater that ultimately could receive further treatment and be recycled in 2020 (SCCWRRS, 1998). (It should be noted that there is disagreement among local water interests regarding existing levels of water recycling. However, for this document, CALFED is assuming the existing value is appropriate.)

Total Potential Treated Wastewater Flow Projected by the Regional Studies

Combined, the Bay Area and Southern California regional studies indicate about 3.3 MAF of wastewater being generated by 2020 (2.6 MAF from Southern California and 690 TAF from the Bay Area), not including any additional increment that would occur along the central coast (Monterey Bay area and Santa Barbara, although these are minor in comparison to the major population centers).

The approximately 500 TAF currently or soon to be recycled in California represents about 15% of the future treated wastewater stream. With additional projects in the feasibility and design phases, even more facilities are expected to be completed in the near future.

6.4 PROJECTED WATER RECYCLING UNDER THE NO ACTION ALTERNATIVE

To determine the effect of any incremental improvements in recycling as a result of a Bay-Delta solution, it is necessary to determine what level of recycling may occur in the future **without** a Bay-Delta solution. The CALFED Program No Action Alternative condition presented here is that estimate. Several assumptions used to develop this estimate are detailed in the following paragraphs.

6.4.1 SUPPLY AND DEMAND CONSTRAINTS ON POTENTIAL NO ACTION LEVELS

The No Action estimate presented later in this section indicates that a significant level of water will be recycled in 2020. Current levels of recycling (485 TAF) would increase to an estimated 1.0 MAF, representing an increase from about 15% up to 30% of the total wastewater flow (see discussion later). To make use of this recycled supply, however, there must be a demand. Customers must be available who can integrate recycled water with existing water sources, use it to replace existing sources, or use it as an entirely new source.

As shown in Table 6-1, customers of existing water recycling projects vary. However, the majority of current customers use the recycled water to meet plant ET requirements (either crop or landscape). Groundwater recharge represents the next most significant customer use. Use of recycled water by industry or for environmental uses has been limited to date but could represent significant potential, depending on the quality and timing of the available supply.

Table 6-1. Customers of Existing Water Recycling Projects

TYPE OF RECYCLING	1997 AMOUNT (TAF/YEAR)	PERCENT OF TOTAL
Agricultural irrigation	155	32
Landscape irrigation	82	17
Groundwater recharge	131	22
Industrial uses	34	7
Environmental uses	15	3
Sea water intrusion barrier	5	1
Other	63	13
Total	**485**	**100**

Source: DWR's California Water Plan Update, Bulletin 160-98, November, 1998

Timing of when recycled water is available to meet a customer's demand is among the most crucial limitations to the amount of recycling ultimately realized. For current agricultural and landscape irrigation uses, the demand is cyclical, peaking in summer but minimal in winter. The magnitude of variation in the cycle depends on such local conditions as climate and the type of plants (i.e., agricultural plants are harvested at the end of a seasonal but landscape plants may need some irrigation during winter, especially in Mediterranean climates like the South Coast). However, recycled water is generated on a relatively consistent basis, with very little seasonal fluctuation in the amount available. Thus, matching supply to demand can be limited by the type of demand. Strategies to overcome this include finding users whose demand is not seasonal, on a local or regional level, and storing recycled water for later use.

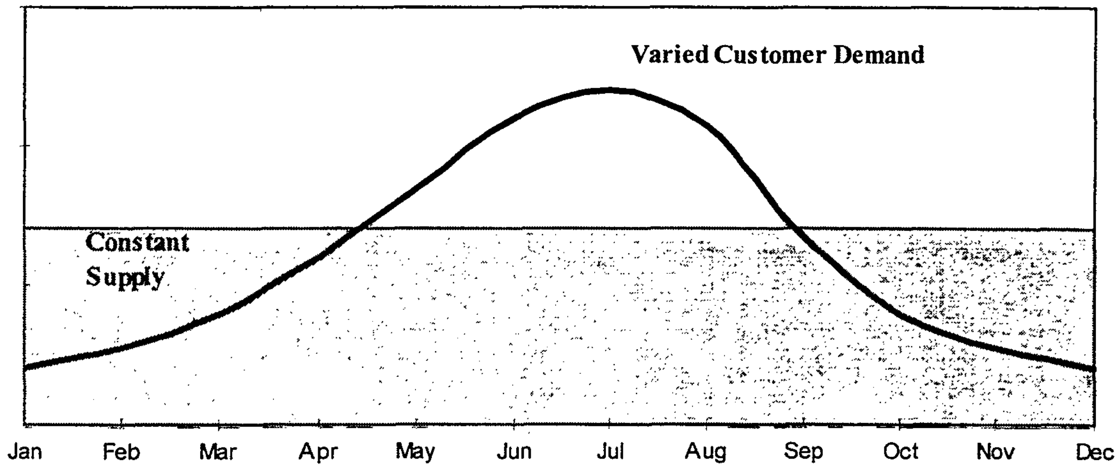


Figure 6-1. Supply/Demand Timing Difference

Note that only a portion of the water recycled can directly meet this customer's needs. The remainder must be stored or used by customers with a different demand pattern.

Figure 6-1 illustrates how recycling treated wastewater provides a relatively constant supply source, while some customer demands, such as agricultural irrigation, are more cyclical. This timing mismatch limits the amount of recycled water that can be used by seasonal customers without a method to store supplies during non-peak periods. The increased use of groundwater recharge to temporarily store recycled water or, as in some Southern California projects, to act as a barrier to sea water intrusion, provides added flexibility to manage the relatively constant supply and meet seasonal customer demands.

In addition, total water recycling levels are limited by the availability of customers in a particular geographic region. As a project looks for customers further away from the treatment plant, the cost of distribution can increase significantly. Lacking regional distribution facilities, agencies generating recycled water must look locally for customers, which can greatly limit the potential opportunities. Industrial and environmental uses can broaden the customer base.

Storing water in aquifers also can be limited in its ultimate applicability, depending on its purpose. If the water is being stored temporarily for later withdrawal and use, these limitations include:

- Recharge rates are limited by aquifer characteristics and recharge pond or injection well capacity.
- Locations for recharge ponds may be limited in heavily populated areas.
- Future additional storage potential in existing aquifers may be limited either as a result of storage already being used for recycled water or being used to temporarily store other surface sources.

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If the water is being placed into aquifers as a barrier to sea water intrusion, as is occurring with some recycling projects, these limitations may not cause as much concern. When recycled water is used as a barrier to salty water, it is not primarily intended to be removed and reused. It can continue to "push" more fresh water toward the ocean, increasing the thickness of the barrier. However, there may be a practical limit to how far or how much of a barrier is necessary compared to the cost of providing a barrier. Thus, a practical consideration may constrain this use of recycled water.

Surface storage of recycled water has yet to occur at any significant level. A project originally proposed in San Diego would have been the first to treat a significant quantity of wastewater and recycle it into San Diego's drinking water reservoir. There, the recycled water would have blended with other untreated water and been conveyed to the water treatment facility and into the potable system. This project would have recycled approximately 15 TAF of indirect potable reuse. However, due to outcry from the public regarding the acceptability of this type of recycling caused the project to be canceled. Direct potable reuse currently is prohibited by state regulation. Other indirect potable reuse sites are under consideration in the BARWRP and SCCWRRS.

Use of other surface facilities to temporarily store recycled water will be limited by the capacity of the reservoirs and the distance from the recycling plant (if reservoir sites are distant or upslope from a treatment plant, pumping the recycled water to the reservoir is costly)

Lacking adequate storage or a distribution system that would allow a more diverse, widely distributed customer base to be included, the potential for water recycling may reach an upper limit of feasibility. For this analysis, the No Action Alternative levels discussed in the following subsection are assumed by CALFED to represent a practical upper limit (1.0 MAF of total water recycling in 2020).

6.4.2 AVAILABLE DATA FOR USE IN ESTIMATING THE NO ACTION ALTERNATIVE LEVEL

As previously discussed in Section 2.2.4 of this document, under "Water Recycling Approach," DWR, in partnership with the WateReuse Association of California, conducted a Survey of Water Recycling Potential in 1995-96 to help identify and quantify local agencies' plans for future water recycling (DWR 1996). The 230 survey respondents identified 1996 water recycling levels at over 450 TAF per year, and projected the potential for recycling at 1.49 MAF annually by 2020. The respondents listed projects by stages of planning: conceptual, feasibility study, preliminary design, final design, and under construction. "Base" conditions include any current recycling projects (projects already in operation) plus all projects that were under construction at the time of the survey. By the end of 1997, with the recent completion of a few more local recycling projects, the base was increased to 485 TAF (from 450 TAF). Greater production from existing projects as well as completion of other projects still under construction are expected to increase the base to around 615 TAF by 2020 (DWR 1997). Further refinement and incorporation of these survey data were completed for use by DWR in the "California Water Plan Update, Bulletin 160-98 Public Draft." This refinement resulted in the following assumptions for use in this analysis:

- The base condition for 2020 is 615 TAF of total water recycling (of which 485 TAF already has been implemented — leaving 130 TAF in the permitting or construction phase, or as completed build-out of existing facilities).

- Of this total, 468 TAF is considered new water supply.

- The total represents approximately 15% of the 2020 wastewater flow generated.

Data from the survey regarding potential water recycling projects above the base were distributed over three hydrologic regions as "planned" or "conceptual" projects. "Planned" values indicate any recycling projects that are undergoing feasibility study, preliminary design, or final design. Conceptual values reflect what survey respondents believed to be feasible in the future, but no formal studies have been undertaken. Table 6-2 presents the survey information as incorporated into DWR data for use in the "California Water Plan Update, Bulletin 160-98 Public Draft" (DWR 1998).

ESTIMATES OF CURRENT WATER RECYCLING

Although the DWR survey identified about 450 TAF of existing urban recycling projects, another survey by the SWRCB identifies only 355 TAF (SWRCB 1998).

Comparing the two sources, it appears that the SWRCB summary has identified a much smaller amount of groundwater recharge from recycling. This accounts for about 80 TAF of the difference. Additional differences may be from recycling reported to DWR that is considered "nonreportable" by the SWRCB (in-plant service water, respondents including permitted levels rather than actual levels). The difference also may be explained by the SWRCB survey including only "new water" while the DWR survey is "total water."

The July 1998 SWRCB survey is still in draft. Revised values should be available shortly and may further clarify differences.

Table 6-2. Cumulative Estimates of Water Recycling in 2020 (TAF/Year)

	TOTAL WATER RECYCLING POTENTIAL				NEW WATER SUPPLY			
	SAN FRANCISCO BAY	CENTRAL COAST	SOUTH COAST	TOTAL	SAN FRANCISCO BAY	CENTRAL COAST	SOUTH COAST	TOTAL
Base	40	44	364	615[1]	35	42	328	468[2]
Planned	101	40	640	837[1]	92	38	569	699
Conceptual	-	-	-	131	-	-	-	31
Total	-	-	-	**1,583**	-	-	-	**1,198**

[1] The difference between the total for the three hydrologic regions shown and the total for base or planned recycling projects represents projects in the Central Valley that do not generate new water supply. As previously discussed, Central Valley regions have not been included in this analysis at this time.

[2] The difference between the total for the three hydrologic regions shown and the total for base projects represents projects in the North and South Lahontan and in the Colorado River hydrologic regions already in service and providing new water supply.

Source: Draft information developed for "California Water Plan Update, Bulletin 160-98 Public Draft" (DWR, 1998).

6.4.3 ASSUMED WATER RECYCLING POTENTIAL UNDER NO ACTION ALTERNATIVE CONDITIONS

Projected levels of urban wastewater recycling under the No Action Alternative conditions assume that the base value already has been fully implemented by 2020. This would mean that existing recycling would need to increase from 485 to 575 TAF, an addition of 90 TAF. (CALFED assumes that only 75% of the difference between existing levels and the 615-TAF value shown in Table 6-2 is achieved. Most of this increment represents expansion to build-out capacity of existing recycling facilities, however, according to industry sources, it is unlikely that more than 75% will actually be achieved under the No Action Alternative scenario [MacLaggan 1998]). CALFED assumes this value to represent the incremental base value. Figure 6-2 on the following page graphically displays CALFED's assumed relationship between the values in Table 6-2 and the assumed level of recycling under the No Action and with CALFED's Preferred alternatives.

For purposes of this document, CALFED assumes that the No Action Alternative condition represents implementation of **50%** of the planned values and the incremental increase in the base value of 90 TAF. Therefore, the No Action condition assumes that **510 TAF of additional recycling** will occur (derived by taking 50% of 837 TAF from Table 6-2 and adding it to the 90 TAF incremental increase in the base value). Combined with existing level of 485 TAF, this would represent about 995 TAF of annual wastewater recycling by 2020.

New water generated from recycling under the No Action Alternative is estimated at 415 TAF (derived by taking 50% of the 699 TAF from Table 6-2 plus 75% of the incremental base recycling).

The existing levels of recycling and the anticipated No Action Alternative increment, together comprising nearly 1.0 MAF, would indicate that about 30% of the 2020 wastewater flow could be recycled regardless of the outcome of the CALFED Bay-Delta Program

.CALFED's assumption of only 50% of the planned value shown in Table 6-2 being achieved under a No Action Alternative condition is based on two influencing factors:

- The Metropolitan Water District of Southern California (MWD) recently updated their Integrated Resource Plan (IRP), which evaluates at a multitude of water supply and demand management options. Their report establishes goals for a diverse mix of local and imported water resource elements that is optimized to meet future supply reliability in a cost-effective manner. The IRP set an aggressive 2020 water recycling and groundwater recovery goal of 500 TAF per year, of which 225 TAF are already being produced (MWD 1998). This represents only about half of the sum of base and planned values for the South Coast shown in Table 6-2.

- Analysis by the WateReuse Association of California indicates that the original survey that resulted in the values shown in Table 6-2 was completed when the drought of the 1990s was still fresh in the minds of those being surveyed. Also, it appears that actual implementation of projects is much less ambitious than survey respondents may indicate (MacLaggan 1998). This discrepancy may be a result of the difference between surveying a water purveyor's staff member in charge of studying recycling potential and actually having a project brought before the purveyor's board of directors for approval.

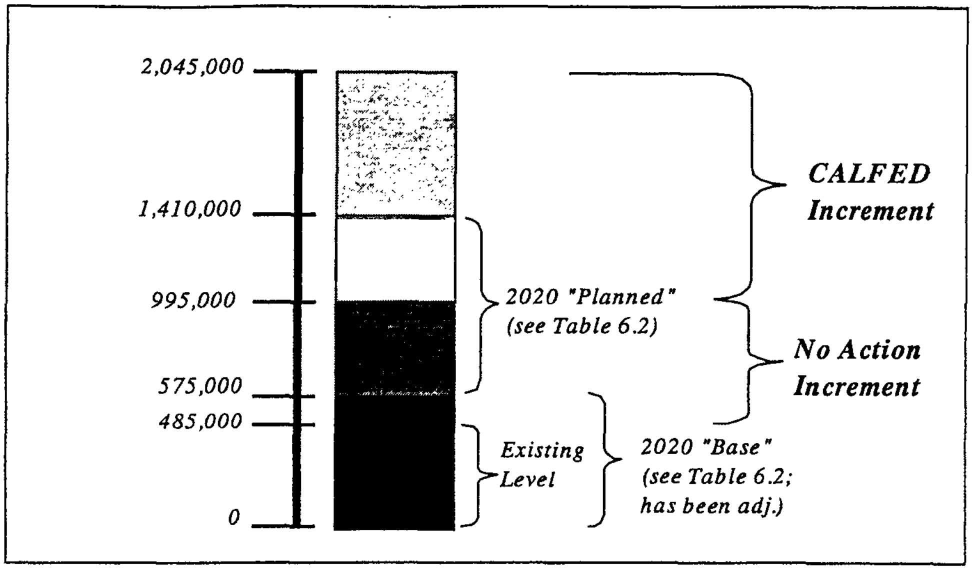

Figure 6-2. Increments of Existing and Anticipated Water Recycling
(These values are used to derive No Action and CALFED recycling levels.)

[It should be noted that the "California Water Plan Update, Bulletin 160-98" [DWR, November 1998] includes a lower level of water recycling for the South Coast Region than indicated in Table 6-2. According to DWR, other options, including resolution of the Colorado River water supply controversy and CALFED Program solutions would provide more water to this region at less cost than additional levels of water recycling. As a result only about 30% of the planned recycling potential shown in Table 6-2 for the South Coast, in addition to the South Coast's 2020 base recycling, was assumed to be implemented as part of Bulletin 160-98. However, the CALFED Program's No Action Alternative conditions do **not** include a CALFED Program solution and do not make judgement on how the Colorado River use issue is resolved. Thus, for purposes of this analysis, CALFED has assumed that 50% of the planned potential shown for the South Coast Region in Table 6-2 is included in the No Action Alternative level.)

6.5 ADDITIONAL WATER RECYCLING AS A RESULT OF THE CALFED PROGRAM

When a Bay-Delta solution is reached, it is anticipated that the actions outlined in Section 2 of this document would facilitate the implementation of the No Action Alternative levels of water recycling and probably facilitate additional levels.

For greater levels of water recycling to occur, the CALFED Program needs to provide solutions to several of the constraints discussed earlier. At a minimum, these include availability of financial support, assistance in resolving the issue of supply and demand timing, the need for regional distribution to reach a broader customer base, and improvements in source water quality at the Delta. Undertaking a stronger leadership role by state and federal governments will also aid in achieving greater levels of water recycling.

Without resolution of these issues, levels of water recycling could be expected to increase but not much beyond the identified planned levels shown in Table 6-2 (i.e., the additional 50% of the planned value **not** assumed to occur under No Action Alternative probably would be implemented with modest financial support through CALFED). The extent to which additional recycling occurs beyond this level under a Bay-Delta solution will depend on CALFED helping solve institutional and physical challenges. CALFED intends to work with local agencies to overcome these potentially limiting factors. Figure 6-2 graphically displays CALFED's assumed range of incremental improvement over No Action Alternative conditions. As indicated on the figure, CALFED assumes that, by helping overcome impediments, statewide urban water recycling could reach over 2.0 MAF annually.

6.5.1 ESTABLISHING AN UPPER LIMIT OF WATER RECYCLING POTENTIAL

To develop an upper limit of recycling potential, CALFED has assumed that the issue of supply and demand timing, and other impediments previously discussed, are solved such that their remaining presence does not impede the implementation of cost-effective water recycling projects. Thus, significantly increased levels of water recycling beyond No Action Alternative levels are possible. Given this assumption, the extent of future recycling levels depends on the future wastewater flow present in 2020 and any remaining limiting factors.

Since a CALFED Bay-Delta solution also anticipates extensive urban conservation, it can be expected that the wastewater flow generated in 2020 will be decreased comparably. The level of reduction, however, will depend on the types of conservation measures implemented and their impact on the wastewater flow (for example, changes in the type of urban landscape will affect the consumption of water but will not affect flows to a wastewater treatment plant).

For this analysis, CALFED has assumed the increment of urban conservation expected to result from a Bay-Delta solution will reduce wastewater flows by 7.5% from the anticipated 2020 No Action Alternative level (the CALFED increment of urban conservation was projected at 5-10%, with a significant portion obtained through indoor residential and CII conservation; see Section 5). Therefore, the previous estimates of a total wastewater flow of 690 TAF in the Bay Area and 2.6 MAF in the South Coast (see previous discussion in this section regarding the regional projects), will be reduced to 640 TAF and 2.4 MAF respectively; or about 3.1 MAF combined.

Of this total wastewater flow, the No Action Alternative condition is expected to already have resulted in about 1.0 MAF of water recycling annually (the sum of the base and 50% of the planned values in Table 6-2). Subtracting this amount from the total wastewater flow potential of 3.1 MAF leaves about 2.1 MAF of treated wastewater still being discharged to coastal waters.

It is impossible to say whether water recycling projects ever could be implemented to achieve 100% recycling, but it is unlikely that such would occur. Many factors work against this, including:

- The distance between potential customers and water recycling sources;
- Physical restrictions of existing treatment plants (space, inflow capacity);
- The limitation of storage;
- Infeasible cost or technology limitations;
- Poor water quality of incoming waste stream (high salinity levels); and
- Other impediments, such as public or market perceptions, local laws or ordinances, a bias in favor of new supply development over recycling, and other institutional/ challenges.

Even assuming that the issue of supply and demand timing is addressed, these factors are still likely to limit the incremental recycling of the remaining 2.1 MAF.

Considering the factors listed above, **CALFED has assumed for this analysis that a maximum of 50% of the remaining 2020 wastewater flow could realistically be recycled.** Fifty percent of 2.1 MAF is about 1.05 MAF annually. When combined with the No Action Alternative water recycling increment of 510 TAF, the expected increase in total water recycling **above existing levels** would be over 1.5 MAF annually.

When existing recycling programs are included, the sum would represent about 65%, or two-thirds, of the total 2020 wastewater flow—slightly over 2.0 MAF. Additional indirect potable reuse, direct potable reuse, expansion of treatment plants, and technological advances all could eventually drive the level of recycling up even further.

CALFED has assumed that, based on the No Action Alternative values, the new water supply generated from this additional increment of total water recycling is about 790 TAF annually (75% of 1.05 MAF). This increment would be new water available for allocation to other beneficial uses. Table 6-3 shows how these quantities may be distributed among the three hydrologic regions, using No Action Alternative values as a basis.

To allow for this level of total water recycling, the various impediments listed directly above and at the beginning of this section, as well as the supply and demand timing issue all must be adequately resolved. Otherwise, the CALFED Program would result only in facilitated implementation of levels much lower than this.

As a result, a broad range of water recycling potential is expected for the CALFED Program increment; ranging from 460 TAF of additional recycling up to 1.05 MAF. In terms of a percentage of the total wastewater flow, the increment would range roughly from **30 to 65% of the projected wastewater flow.**

6.6 SUMMARY OF STATEWIDE WATER RECYCLING POTENTIAL

The table below provides a summary of the potential water recycling estimated to occur both under the No Action Alternative and CALFED Program conditions. The combined total water recycling potential represents an upper range of 65% recycling of the total 2020 wastewater flows. **Note that these values are absent the existing recycling levels of 485 TAF.**

Table 6-3. Summary of Incremental Statewide 2020 Water Recycling Potential (TAF/Year)

	NO ACTION INCREMENT (INCREMENTAL "BASE" PLUS "PLANNED")		CALFED PROGRAM INCREMENT	
	TOTAL WATER RECYCLING	NEW WATER SUPPLY	TOTAL WATER RECYCLING	NEW WATER SUPPLY
San Francisco Bay	53	48	50-170[2]	40-130[2]
Central Coast	35	33	30-70[2]	20-50[2]
South Coast	392	349	350-810[2]	260-610[2]
Total	**510[1]**	**455[1]**	**460-1,050**	**345-790**
Combined water recycling potential (No Action Alternative + CALFED increment)			970-1,560[1]	800-1,245[1]

[1] The three hydrologic region values do not add up to the total because of recycling that occurs in other areas of the state (see Table 6-2).

[2] These regional values were prorated from the total based on the distribution of the No Action Alternative regional values. (For example, for the No Action Alternative increment, the South Coast represents about 77% of the total new water supply. Therefore, the South Coast's CALFED increment is assumed to be 77% of the CALFED increment total).

7. References

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7. References

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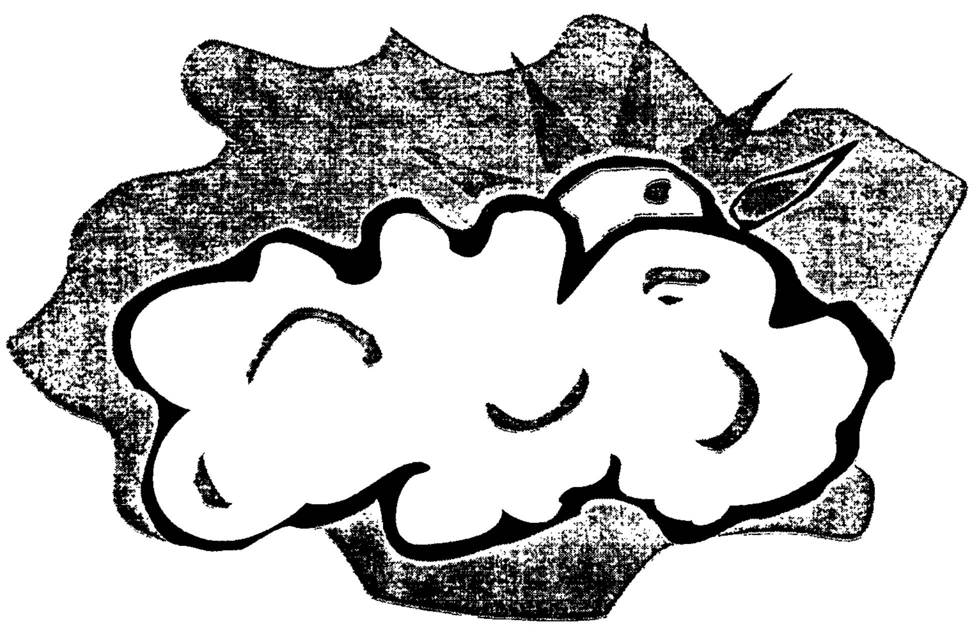


ATTACHMENT A

DETERMINATION OF POTENTIAL AGRICULTURAL CONSERVATION SAVINGS

Determination of Potential Agricultural Conservation Savings (Low End of Range)
Sacramento River

Input Data from DWR

Applied Water	6,278	(1,000 af)
Depletion	4,321	(1,000 af)
ET of Applied Water	4,096	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Requirement = 4%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	2	based on region variation
meas/price:	2	in water districts)
	4	(points for this region's districts of 4 points for average)
	1	= **adjustment factor**
	33%	= district portion
	67%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**2182**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	**225**	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**1,957**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	10%	(Irrecov divided by total existing losses)
Portion lost to leaching	17	(Leach Req. * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	251	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	1,914	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	0	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	1,914	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	766	0	766
CALFED Increment =	next 30%	0.30	574	0	574
Remaining =	final 30%	0.30	574	0	574
			1,914	0	1,914

Summary of Savings:

Existing Applied Water Use = 6,278

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	511	383	894
District	--	255	191	446
Total	2,182	766	574	1,340

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	511	383	894
District	--	255	191	446
Total	1,957	766	574	1,340

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	0	0	0
District	--	0	0	0
Total	225	0	0	0

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
Sacramento River

Input Data from DWR

Applied Water	6,278	(1,000 af)
Depletion	4,321	(1,000 af)
ET of Applied Water	4,096	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Requirement = 2%

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	2	based on region variation
meas/price:	2	in water districts)
	4	(points for this region's districts of 4 points for average)
	1	**= adjustment factor**
	33%	= district portion
	67%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	2182	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	225	(Diff betw. Depletion and ETAW)
Total Recoverable losses	1,957	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	10%	(Irrecov divided by total existing losses)
Portion lost to leaching	8	(Leach Req. * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	126	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	2,048	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	91	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	1,957	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	819	36	783
CALFED Increment =	next 30%	0.30	614	27	587
Remaining =	final 30%	0.30	614	27	587
			2,048	91	1,957

Summary of Savings:

Existing Applied Water Use = 6,278

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	546	410	956
District	--	273	205	478
Total	2,182	819	614	1,434

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	522	392	914
District	--	261	196	457
Total	1,957	783	587	1,370

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	24	18	42
District	--	12	9	21
Total	225	36	27	64

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
Delta

Input Data from DWR

Applied Water	1,116	(1,000 af)
Depletion	780	(1,000 af)
ET of Applied Water	758	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 6%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	1	(adjustment factor
flexibility:	0	based on region variation
meas/price:	1	in water districts)
	2	(points for this region's districts of 4 points for average)
	0.5	**= adjustment factor**
	17%	= district portion
	83%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**358**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	**22**	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**336**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	6%	(Irrecov divided by total existing losses)
Portion lost to leaching	3	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	45	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	311	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	**0**	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	**311**	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	124	0	124
CALFED Increment =	next 30%	0.30	93	0	93
Remaining =	final 30%	0.30	93	0	93
			311	0	311

Summary of Savings:

Existing Applied Water Use = 1,116

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	104	78	182
District	--	21	16	37
Total	358	124	93	217

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	104	78	182
District	--	21	16	37
Total	336	124	93	217

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	0	0	0
District	--	0	0	0
Total	22	0	0	0

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
Delta

Input Data from DWR

Applied Water	1,116	(1,000 af)
Depletion	780	(1,000 af)
ET of Applied Water	758	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 4%

2. % lost to Channel Evap/ET[3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	(adjustment factor
tailwater:	1	based on region variation
flexibility:	0	in water districts)
meas/price:	1	
	2	(points for this region's districts of 4 points for average)
	0.5	**= adjustment factor**
	17%	= district portion
	83%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	358	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	22	(Diff betw. Depletion and ETAW)
Total Recoverable losses	336	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	6%	(Irrecov divided by total existing losses)
Portion lost to leaching	2	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	22	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	334	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	0	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	334	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction[1] (1,000 ac-ft)	Irrec. Loss Reduction[2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	134	0	134
CALFED Increment =	next 30%	0.30	100	0	100
Remaining =	final 30%	0.30	100	0	100
			334	0	334

Summary of Savings:

Existing Applied Water Use = 1,116

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	111	83	194
District	--	22	17	39
Total	358	134	100	234

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	111	83	194
District	--	22	17	39
Total	336	134	100	234

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	0	0	0
District	--	0	0	0
Total	22	0	0	0

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
Westside San Joaquin River

Input Data from DWR

Applied Water	1,361	(1,000 af)
Depletion	1,041	(1,000 af)
ET of Applied Water	973	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 14%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	1	
tailwater:	1	(adjustment factor
flexibility:	1.5	based on region variation
meas/price:	1	in water districts)
	4.5	(points for this region's districts of 4 points for average)
	1.125	**= adjustment factor**
	37%	= district portion
	63%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**388**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	**68**	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**320**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	18%	(Irrecov divided by total existing losses)
Portion lost to leaching	24	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	54	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	310	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	0	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	310	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	124	0	124
CALFED Increment =	next 30%	0.30	93	0	93
Remaining =	final 30%	0.30	93	0	93
			310	0	310

Summary of Savings:

Existing Applied Water Use = 1,361

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	77	58	135
District	--	46	35	81
Total	388	124	93	217

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	77	58	135
District	--	46	35	81
Total	320	124	93	217

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	0	0	0
District	--	0	0	0
Total	68	0	0	0

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
Westside San Joaquin River

Input Data from DWR

Applied Water	1,361	(1,000 af)
Depletion	1,041	(1,000 af)
ET of Applied Water	973	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 10%

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	1	
tailwater:	1	(adjustment factor
flexibility:	1.5	based on region variation
meas/price:	1	in water districts)
	4.5	(points for this region's districts of 4 points for average)
	1.125	**= adjustment factor**
	37%	= district portion
	63%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**388**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	68	(Diff betw. Depletion and ETAW)
Total Recoverable losses	320	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	18%	(Irrecov divided by total existing losses)
Portion lost to leaching	17	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	27	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	344	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	**24**	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	**320**	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	137	9	128
CALFED Increment =	next 30%	0.30	103	7	96
Remaining =	final 30%	0.30	103	7	96
			344	24	320

Summary of Savings:

Existing Applied Water Use = 1,361

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	86	64	150
District	--	52	39	91
Total	388	137	103	241

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	80	60	140
District	--	48	36	84
Total	320	128	96	224

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	6	4	10
District	--	4	3	7
Total	68	9	7	17

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
Eastside San Joaquin River

Input Data from DWR

Applied Water	4,043	(1,000 af)
Depletion	2,885	(1,000 af)
ET of Applied Water	2,781	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 4%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	2	based on region variation
meas/price:	0	in water districts)
	2	(points for this region's districts of 4 points for average)

0.5 = adjustment factor

17% = district portion
83% = on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**1262**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	**104**	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**1,158**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	8%	(Irrecov divided by total existing losses)
Portion lost to leaching	9	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	162	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	1,091	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	**0**	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	**1,091**	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	436	0	436
CALFED Increment =	next 30%	0.30	327	0	327
Remaining =	final 30%	0.30	327	0	327
			1,091	0	1,091

Summary of Savings:

Existing Applied Water Use = 4,043

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	364	273	637
District	--	73	55	128
Total	1,262	436	327	764

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	364	273	637
District	--	73	55	128
Total	1,158	436	327	764

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	0	0	0
District	--	0	0	0
Total	104	0	0	0

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
Eastside San Joaquin River

Input Data from DWR

Applied Water	4,043	(1,000 af)
Depletion	2,885	(1,000 af)
ET of Applied Water	2,781	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 2%

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	2	based on region variation
meas/price:	0	in water districts)
	2	(points for this region's districts of 4 points for average)
	0.5	**= adjustment factor**
	17%	= district portion
	83%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**1262**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	104	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**1,158**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	8%	(Irrecov divided by total existing losses)
Portion lost to leaching	5	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	81	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	1,177	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	19	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	**1,158**	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	471	7	463
CALFED Increment =	next 30%	0.30	353	6	347
Remaining =	final 30%	0.30	353	6	347
			1,177	19	1,158

Summary of Savings:

Existing Applied Water Use = 4,043

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	392	294	686
District	--	78	59	137
Total	1,262	471	353	824

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	386	290	676
District	--	77	58	135
Total	1,158	463	347	811

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	6	5	11
District	--	1	1	2
Total	104	7	6	13

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
Tulare Lake Basin

Input Data from DWR

Applied Water	9,209	(1,000 af)
Depletion	7,496	(1,000 af)
ET of Applied Water	6,894	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 12%
   adjustment factor = 1.25

2. % lost to Channel Evap/ET[3] = 3%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0.5	
tailwater:	1	(adjustment factor
flexibility:	1.5	based on region variation
meas/price:	1.5	in water districts)
	4.5	(points for this region's districts of 4 points for average)
	1.125	**= adjustment factor**
	37%	= district portion
	63%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	2315	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	602	(Diff betw. Depletion and ETAW)
Total Recoverable losses	1,713	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	26%	(Irrecov divided by total existing losses)
Portion lost to leaching	269	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	276	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	1,770	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	57	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	1,713	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction[1] (1,000 ac-ft)	Irrec. Loss Reduction[2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	708	23	685
CALFED Increment =	next 30%	0.30	531	17	514
Remaining =	final 30%	0.30	531	17	514
			1,770	57	1,713

Summary of Savings:

Existing Applied Water Use = . 9,209

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	443	332	775
District	--	265	199	464
Total	2,315	708	531	1,239

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	429	321	750
District	--	257	193	450
Total	1,713	685	514	1,199

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	14	11	25
District	--	9	6	15
Total	602	23	17	40

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
Tulare Lake Basin

Input Data from DWR

Applied Water	9,209	(1,000 af)
Depletion	7,496	(1,000 af)
ET of Applied Water	6,894	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction =	8%
adjustment factor =	1.25
2. % lost to Channel Evap/ET [3] =	2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0.5	
tailwater:	1	(adjustment factor
flexibility:	1.5	based on region variation
meas/price:	1.5	in water districts)
	4.5	(points for this region's districts of 4 points for average)
	1.125	= **adjustment factor**
	37%	= district portion
	63%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	2315	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	602	(Diff betw. Depletion and ETAW)
Total Recoverable losses	1,713	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	26%	(Irrecov divided by total existing losses)
Portion lost to leaching	143	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	184	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	1,987	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	274	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	1,713	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	795	110	685
CALFED Increment =	next 30%	0.30	596	82	514
Remaining =	final 30%	0.30	596	82	514
			1,987	274	1,713

Summary of Savings:

Existing Applied Water Use = 9,209

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	497	373	870
District	--	298	223	521
Total	2,315	795	596	1,391

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	429	321	750
District	--	257	193	450
Total	1,713	685	514	1,199

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	69	51	120
District	--	41	31	72
Total	602	110	82	192

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
San Francisco Bay

Input Data from DWR

Applied Water	97	(1,000 af)
Depletion	86	(1,000 af)
ET of Applied Water	74	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 6%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	0	based on region variation
meas/price:	1	in water districts)
	1	(points for this region's districts of 4 points for average)
	0.25	**= adjustment factor**
	8%	= district portion
	92%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	23	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	12	(Diff betw. Depletion and ETAW)
Total Recoverable losses	11	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	52%	(Irrecov divided by total existing losses)
Portion lost to leaching	2	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	4	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	17	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	6	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	11	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	7	2	4
CALFED Increment =	next 30%	0.30	5	2	3
Remaining =	final 30%	0.30	5	2	3
			17	6	11

Summary of Savings:

Existing Applied Water Use = 97

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	6	5	11
District	--	1	0	1
Total	23	7	5	12

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	4	3	7
District	--	0	0	0
Total	11	4	3	8

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	2	2	4
District	--	0	0	0
Total	12	2	2	4

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
San Francisco Bay

Input Data from DWR

Applied Water	97	(1,000 af)
Depletion	86	(1,000 af)
ET of Applied Water	74	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 4%

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	0	based on region variation
meas/price:	1	in water districts)
	1	(points for this region's districts of 4 points for average)
	0.25	= **adjustment factor**
	8%	= district portion
	92%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	23	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	12	(Diff betw. Depletion and ETAW)
Total Recoverable losses	11	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	52%	(Irrecov divided by total existing losses)
Portion lost to leaching	2	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	2	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	20	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	9	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	11	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	8	3	4
CALFED Increment =	next 30%	0.30	6	3	3
Remaining =	final 30%	0.30	6	3	3
			20	9	11

Summary of Savings:

Existing Applied Water Use = 97

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	7	5	12
District	--	1	0	1
Total	23	8	6	14

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	4	3	7
District	--	0	0	0
Total	11	4	3	8

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	3	2	5
District	--	0	0	0
Total	12	3	3	6

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
Central Coast

Input Data from DWR

Applied Water	48	(1,000 af)
Depletion	39	(1,000 af)
ET of Applied Water	38	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 6%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	0	based on region variation
meas/price:	1	in water districts)
	1	(points for this region's districts of 4 points for average)
	0.25	**= adjustment factor**
	8%	= district portion
	92%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**10**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	1	(Diff betw. Depletion and ETAW)
Total Recoverable losses	9	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	10%	(Irrecov divided by total existing losses)
Portion lost to leaching	0.23	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	1.92	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	8	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	**0.00**	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	8	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	3	0	3
CALFED Increment =	next 30%	0.30	2	0	2
Remaining =	final 30%	0.30	2	0	2
			8	0	8

Summary of Savings:

Existing Applied Water Use = 48

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	3	2	5
District	--	0	0	0
Total	10	3	2	5

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	3	2	5
District	--	0	0	0
Total	9	3	2	5

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	0	0	0
District	--	0	0	0
Total	1	0	0	0

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
Central Coast

Input Data from DWR

Applied Water	48	(1,000 af)
Depletion	39	(1,000 af)
ET of Applied Water	38	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 4%

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0	
tailwater:	0	(adjustment factor
flexibility:	0	based on region variation
meas/price:	1	in water districts)
	1	(points for this region's districts of 4 points for average)

0.25 = adjustment factor
8% = district portion
92% = on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**10**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	1	(Diff betw. Depletion and ETAW)
Total Recoverable losses	9	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	10%	(Irrecov divided by total existing losses)
Portion lost to leaching	0.15	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	0.96	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	9	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	**0.00**	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	9	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	4	0	4
CALFED Increment =	next 30%	0.30	3	0	3
Remaining =	final 30%	0.30	3	0	3
			9	0	9

Summary of Savings:

Existing Applied Water Use = 48

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	3	2	5
District	--	0	0	0
Total	10	4	3	6

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	3	2	5
District	--	0	0	0
Total	9	4	3	6

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	0	0	0
District	--	0	0	0
Total	1	0	0	0

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
South Coast

Input Data from DWR

Applied Water	755	(1,000 af)
Depletion	665	(1,000 af)
ET of Applied Water	542	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 14%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0.5	
tailwater:	0.5	(adjustment factor
flexibility:	0.5	based on region variation
meas/price:	2	in water districts)
	3.5	(points for this region's districts of 4 points for average)
	0.875	**= adjustment factor**
	29%	= district portion
	71%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	213	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	123	(Diff betw. Depletion and ETAW)
Total Recoverable losses	90	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	58%	(Irrecov divided by total existing losses)
Portion lost to leaching	44	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	30	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	139	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	49	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	90	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	56	20	36
CALFED Increment =	next 30%	0.30	42	15	27
Remaining =	final 30%	0.30	42	15	27
			139	49	90

Summary of Savings:

Existing Applied Water Use = 755

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	39	30	69
District	--	16	12	28
Total	213	56	42	97

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	26	19	45
District	--	10	8	18
Total	90	36	27	63

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	14	10	24
District	--	6	4	10
Total	123	20	15	34

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
South Coast

Input Data from DWR

Applied Water	755	(1,000 af)
Depletion	665	(1,000 af)
ET of Applied Water	542	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 10%

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	0.5	
tailwater:	0.5	(adjustment factor
flexibility:	0.5	based on region variation
meas/price:	2	in water districts)
	3.5	(points for this region's districts of 4 points for average)
	0.875	**= adjustment factor**
	29%	= district portion
	71%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**213**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	123	(Diff betw. Depletion and ETAW)
Total Recoverable losses	90	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	58%	(Irrecov divided by total existing losses)
Portion lost to leaching	31	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	15	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	167	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	77	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	**90**	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	67	31	36
CALFED Increment =	next 30%	0.30	50	23	27
Remaining =	final 30%	0.30	50	23	27
			167	77	90

Summary of Savings:

Existing Applied Water Use = 755

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	47	35	82
District	--	19	15	34
Total	213	67	50	117

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	26	19	45
District	--	10	8	18
Total	90	36	27	63

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	22	16	38
District	--	9	7	16
Total	123	31	23	54

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (Low End of Range)
Colorado River

Input Data from DWR

Applied Water	2,812	(1,000 af)
Depletion	2,742	(1,000 af)
ET of Applied Water	2,177	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 14%

2. % lost to Channel Evap/ET [3] = 4%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	1	
tailwater:	2	(adjustment factor
flexibility:	1	based on region variation
meas/price:	1	in water districts)
	5	(points for this region's districts of 4 points for average)
	1.25	**= adjustment factor**
	42%	= district portion
	58%	= on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**635**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	**565**	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**70**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	89%	(Irrecov divided by total existing losses)
Portion lost to leaching	271	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	112	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	251	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	181	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	70	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	101	73	28
CALFED Increment =	next 30%	0.30	75	54	21
Remaining =	final 30%	0.30	75	54	21
			251	181	70

Summary of Savings:

Existing Applied Water Use = 2,812

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	59	44	103
District	--	42	31	73
Total	635	101	75	176

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	16	12	28
District	--	12	9	21
Total	70	28	21	49

Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	42	32	74
District	--	30	23	53
Total	565	73	54	127

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

Determination of Potential Agricultural Conservation Savings (High End of Range)
Colorado River

Input Data from DWR

Applied Water	2,812	(1,000 af)
Depletion	2,742	(1,000 af)
ET of Applied Water	2,177	(1,000 af)

Assumptions for Calculations

1. Ave. Leaching Fraction = 10%

2. % lost to Channel Evap/ET [3] = 2%

3. Assumed allocation of conservation betw District and On-farm
district portion = 1/3 of savings * "adjustment factor"

canal lining:	1	(adjustment factor
tailwater:	2	based on region variation
flexibility:	1	in water districts)
meas/price:	1	
	5	(points for this region's districts of 4 points for average)

1.25 = adjustment factor
42% = district portion
58% = on-farm portion

Calculations from Input Data

	(1,000 af)	
Total Existing Losses	**635**	(Diff betw. Applied Water and ETAW)
Total Irrecoverable losses	**565**	(Diff betw. Depletion and ETAW)
Total Recoverable losses	**70**	(Diff betw. Applied Water and Depletion)
Ratio of Irrecoverable Loss	89%	(Irrecov divided by total existing losses)
Portion lost to leaching	194	(Leach Fraction * ETAW * Irrec. Loss Ratio * Adj. Factor)
Portion lost to Channel Evap/ET	56	(Applied Water * % lost to Channel Evap/ET)
Total Loss Conservation Potential	385	(Total Existing loss - portion to leaching - portion to channel evap/ET)
Irrecoverable Portion	315	(Irrec loss - portion to leaching - portion lost to channel evap/ET)
Recoverable Portion	70	(Total Existing loss - Irrecoverable Loss Portion)

Incremental Distribution of Conservable Portion of Losses

		Distrib. Factor	Applied Water Reduction [1] (1,000 ac-ft)	Irrec. Loss Reduction [2] (1,000 ac-ft)	Rec. Loss Reduction (1,000 ac-ft)
No Action Increment =	1st 40%	0.40	154	126	28
CALFED Increment =	next 30%	0.30	116	95	21
Remaining =	final 30%	0.30	116	95	21
			385	315	70

Summary of Savings:

Existing Applied Water Use = 2,812

Total Potential Reduction of Application

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	90	67	157
District	--	64	48	112
Total	635	154	116	270

Recovered Losses with Potential for Rerouting Flows

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	16	12	28
District	--	12	9	21
Total	70	28	21	49

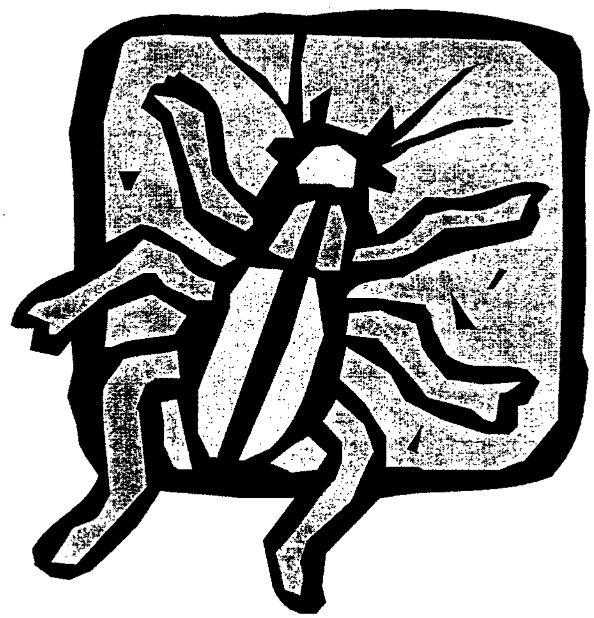
Potential for Recovering Currently Irrecoverable Losses

(1,000af)	Existing	No Action	CALFED	Total
On-Farm	--	74	55	129
District	--	52	39	91
Total	565	126	95	221

Notes:
1. Calculated as the distribution factor times the "conservable portion" of the total existing loss. The first 40% of savings potential occurs under *No Action*. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
2. Calculated as the distribution factor times the "conservable portion" of irrecoverable loss. The first 40% of savings potential occurs under No Action. The next 30% of saving potential is the CALFED increment. The final 30% is considered "non-conservable".
3. Derived from comparing consumptive conveyance loss values from USBR *Least-Cost CVP Yield Increase Plan*, T.A #3 (Sept. 1995) to applied water values for the region. A range of 2 to 4% was used to account for uncertainty. This value accounts for consumption by bank and riparian vegetation and channel evaporation.

ATTACHMENT B

DETERMINATION OF URBAN LANDSCAPE WATER SAVINGS FROM CONSERVATION



Determination of Urban Landscape Water Savings from Conservation

Sacramento

Exist. acres = 100,000
2020 acres = 145,000
ETo (af/ac) = 4.2

Distribution of acres (%)			Analysis of 2020 Conditions compared to 1995					
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	100	100	50	30	44	40	10	31
1.0			25	30	27	30	10	24
0.8			25	40	30	30	75	44
0.6					0		5	2
0.4					0			0

Resultant area (acres)			Analysis of 2020 Conditions compared to 1995					
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	100,000	145,000	50,000	13,500	63,500	40,000	4,500	44,500
1.0	0	0	25,000	13,500	38,500	30,000	4,500	34,500
0.8	0	0	25,000	18,000	43,000	30,000	33,750	63,750
0.6	0	0	0	0	0	0	2,250	2,250
0.4	0	0	0	0	0	0	0	0
sum =	100,000	145,000	100,000	45,000	145,000	100,000	45,000	145,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	504,000	730,800	320,040	224,280
1.0	0	0	161,700	144,900
0.8	0	0	144,480	214,200
0.6	0	0	0	5,670
0.4			0	0
Total water use =	504,000	730,800	626,220	589,050
Incremental Savings		---	104,580	37,170
	Reduction from Base =		14%	5%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	1,890
	Savings from ET Reduction=		0%	5%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	104,580	35,280

Total % Reduction (Base to CALFED)
19%

Total Amount from ET Reduction
1%

Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-93 p.155) 0.05 (modified to reflect outdoor water use realities)

Real Water Savings = Reduced ET + (ratio * reduced losses)

Base to No Action =	5,229
No Action to CALFED =	3,654
Total =	8,883

Remaining Applied Water Reduction = total reduction - real water savings

Base to No Action =	99,351
No Action to CALFED =	33,516
Total =	132,867

Determination of Urban Landscape Water Savings from Conservation

Eastside San Joaquin

Exist. acres = 65,000
2020 acres = 120,000
ETo (af/ac) = 4.3

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	85	85	50	30	41	20	5	13
1.0	10	10	25	30	27	40	5	24
0.8	5	5	25	40	32	40	80	58
0.6					0		10	5
0.4					0			0

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	55,250	102,000	32,500	16,500	49,000	13,000	2,750	15,750
1.0	6,500	12,000	16,250	16,500	32,750	26,000	2,750	28,750
0.8	3,250	6,000	16,250	22,000	38,250	26,000	44,000	70,000
0.6	0	0	0	0	0	0	5,500	5,500
0.4	0	0	0	0	0	0	0	0
sum =	65,000	120,000	65,000	55,000	120,000	65,000	55,000	120,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	285,090	526,320	252,840	81,270
1.0	27,950	51,600	140,825	123,625
0.8	11,180	20,640	131,580	240,800
0.6	0	0	0	14,190
0.4			0	0
Total water use =	324,220	598,560	525,245	459,885
Incremental Savings		---	73,315	65,360
	Reduction from Base =		12%	11%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	4,730
	Savings from ET Reduction=		0%	7%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	73,315	60,630

Total % Reduction (Base to CALFED)
23%

Total Amount from ET Reduction
3%

Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-93 p.155) 0.05 (modified to reflect outdoor water use realities)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 3,666
No Action to CALFED = 7,762
Total = 11,427

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 69,649
No Action to CALFED = 57,599
Total = 127,248

Determination of Urban Landscape Water Savings from Conservation

Tulare

Exist. acres = 70,000
2020 acres = 130,000
ETo (af/ac) = 4.3

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	15	15	10	10	10	5	0	3
1.0	60	60	60	30	46	50	10	32
0.8	25	25	30	60	44	45	70	57
0.6					0		20	9
0.4					0			0

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	10,500	19,500	7,000	6,000	13,000	3,500	0	3,500
1.0	42,000	78,000	42,000	18,000	60,000	35,000	6,000	41,000
0.8	17,500	32,500	21,000	36,000	57,000	31,500	42,000	73,500
0.6	0	0	0	0	0	0	12,000	12,000
0.4	0	0	0	0	0	0	0	0
sum =	70,000	130,000	70,000	60,000	130,000	70,000	60,000	130,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	54,180	100,620	67,080	18,060
1.0	180,600	335,400	258,000	176,300
0.8	60,200	111,800	196,080	252,840
0.6	0	0	0	30,960
0.4			0	0
Total water use =	294,980	547,820	521,160	478,160
Incremental Savings		---	26,660	43,000
		Reduction from Base =	5%	8%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	10,320
		Savings from ET Reduction=	0%	24%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	26,660	32,680

Total % Reduction (Base to CALFED)
13%

Total Amount from ET Reduction
15%

Ratio of Depletion Reduction to Applied Water Savings 0.3
(from Bull. 160-93 p.155)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 7,998
No Action to CALFED = 20,124
Total = 28,122

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 18,662
No Action to CALFED = 22,876
Total = 41,538

Determination of Urban Landscape Water Savings from Conservation

San Francisco

Exist. acres = 155,000
2020 acres = 180,000
ETo (af/ac) = 3.3

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	15	15	10	10	10	0	0	0
1.0	60	60	50	30	47	35	20	33
0.8	25	25	40	60	43	55	55	55
0.6					0	10	20	11
0.4					0		5	1

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	23,250	27,000	15,500	2,500	18,000	0	0	0
1.0	93,000	108,000	77,500	7,500	85,000	54,250	5,000	59,250
0.8	38,750	45,000	62,000	15,000	77,000	85,250	13,750	99,000
0.6	0	0	0	0	0	15,500	5,000	20,500
0.4	0	0	0	0	0	0	1,250	1,250
sum =	155,000	180,000	155,000	25,000	180,000	155,000	25,000	180,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	92,070	106,920	71,280	0
1.0	306,900	356,400	280,500	195,525
0.8	102,300	118,800	203,280	261,360
0.6	0	0	0	40,590
0.4			0	1,650
Total water use =	501,270	582,120	555,060	499,125
Incremental Savings		---	27,060	55,935
	Reduction from Base =		5%	10%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	15,180
	Savings from ET Reduction=		0%	27%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	27,060	40,755

Total % Reduction (Base to CALFED)
14%

Total Amount from ET Reduction
18%

Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-93 p.155) — 0.9 (modified to reflect outdoor water use realities)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 24,354
No Action to CALFED = 51,860
Total = 76,214

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 2,706
No Action to CALFED = 4,076
Total = 6,782

Determination of Urban Landscape Water Savings from Conservation

Central Coast

Exist. acres = 35,000
2020 acres = 50,000
ETo (af/ac) = 2.8

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	5	5	3	0	2	0	0	0
1.0	20	20	15	10	14	5	0	4
0.8	55	55	40	30	37	25	15	22
0.6	20	20	42	55	46	60	65	62
0.4				5	2	10	20	13

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	1,750	2,500	1,050	0	1,050	0	0	0
1.0	7,000	10,000	5,250	1,500	6,750	1,750	0	1,750
0.8	19,250	27,500	14,000	4,500	18,500	8,750	2,250	11,000
0.6	7,000	10,000	14,700	8,250	22,950	21,000	9,750	30,750
0.4	0	0	0	750	750	3,500	3,000	6,500
sum =	35,000	50,000	35,000	15,000	50,000	35,000	15,000	50,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	5,880	8,400	3,528	0
1.0	19,600	28,000	18,900	4,900
0.8	43,120	61,600	41,440	24,640
0.6	11,760	16,800	38,556	51,660
0.4			840	7,280
Total water use =	80,360	114,800	103,264	88,480
Incremental Savings		---	11,536	14,784
	Reduction from Base =		10%	13%
Incr. Savings from Reduced ET (<0.8 ETo)		---	8,092	10,808
	Savings from ET Reduction=		70%	73%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	3,444	3,976

Total % Reduction (Base to CALFED)
23%

Total Amount from ET Reduction
72%

Ratio of Depletion Reduction to Applied Water Savings 1.0
(from Bull. 160-93 p.155)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 11,536
No Action to CALFED = 14,784
Total = 26,320

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 0
No Action to CALFED = 0
Total = 0

Determination of Urban Landscape Water Savings from Conservation

South Coast

Exist. acres = 480,000
2020 acres = 650,000
ETo (af/ac) = 4.0

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	10	10	5	0	4	0	0	0
1.0	40	40	30	20	27	15	5	12
0.8	40	40	50	60	53	60	55	59
0.6	10	10	13	15	14	20	30	23
0.4			2	5	3	5	10	6

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	48,000	65,000	24,000	0	24,000	0	0	0
1.0	192,000	260,000	144,000	34,000	178,000	72,000	8,500	80,500
0.8	192,000	260,000	240,000	102,000	342,000	288,000	93,500	381,500
0.6	48,000	65,000	62,400	25,500	87,900	96,000	51,000	147,000
0.4	0	0	9,600	8,500	18,100	24,000	17,000	41,000
sum =	480,000	650,000	480,000	170,000	650,000	480,000	170,000	650,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	230,400	312,000	115,200	0
1.0	768,000	1,040,000	712,000	322,000
0.8	614,400	832,000	1,094,400	1,220,800
0.6	115,200	156,000	210,960	352,800
0.4			28,960	65,600
Total water use =	1,728,000	2,340,000	2,161,520	1,961,200
Incremental Savings		---	178,480	200,320
	Reduction from Base =		8%	9%
Incr. Savings from Reduced ET (<0.8 ETo)		---	47,280	83,920
	Savings from ET Reduction=		26%	42%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	131,200	116,400

Total % Reduction (Base to CALFED)
16%

Total Amount from ET Reduction
35%

Ratio of Depletion Reduction to Applied Water Savings 0.8
(from Bull. 160-93 p.155)

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 152,240
No Action to CALFED = 177,040
Total = 329,280

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 26,240
No Action to CALFED = 23,280
Total = 49,520

Determination of Urban Landscape Water Savings from Conservation

Colorado

Exist. acres = 35,000
2020 acres = 75,000
ETo (af/ac) = 6.0

Distribution of acres (%)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	70	70	60	50	55	50	40	45
1.0	30	30	35	40	38	30	30	30
0.8			5	10	8	15	25	20
0.6					0	5	5	5
0.4					0			0

Resultant area (acres)		Analysis of 2020 Conditions compared to 1995						
			No Action			CALFED		
ETo Factor	1995	Base	Exist.	New	Comb.	Exist.	New	Comb.
1.2	24,500	52,500	21,000	20,000	41,000	17,500	16,000	33,500
1.0	10,500	22,500	12,250	16,000	28,250	10,500	12,000	22,500
0.8	0	0	1,750	4,000	5,750	5,250	10,000	15,250
0.6	0	0	0	0	0	1,750	2,000	3,750
0.4	0	0	0	0	0	0	0	0
sum =	35,000	75,000	35,000	40,000	75,000	35,000	40,000	75,000

Applied Water (acre-feet)

ETo Factor	1995	Base	No Action	CALFED
1.2	176,400	378,000	295,200	241,200
1.0	63,000	135,000	169,500	135,000
0.8	0	0	27,600	73,200
0.6	0	0	0	13,500
0.4			0	0
Total water use =	239,400	513,000	492,300	462,900
Incremental Savings		---	20,700	29,400
		Reduction from Base =	4%	6%
Incr. Savings from Reduced ET (<0.8 ETo)		---	0	4,500
		Savings from ET Reduction=	0%	15%
Incr. Savings from Reduced Losses (>0.8 ETo)		---	20,700	24,900

Total % Reduction (Base to CALFED)
10%

Total Amount from ET Reduction
9%

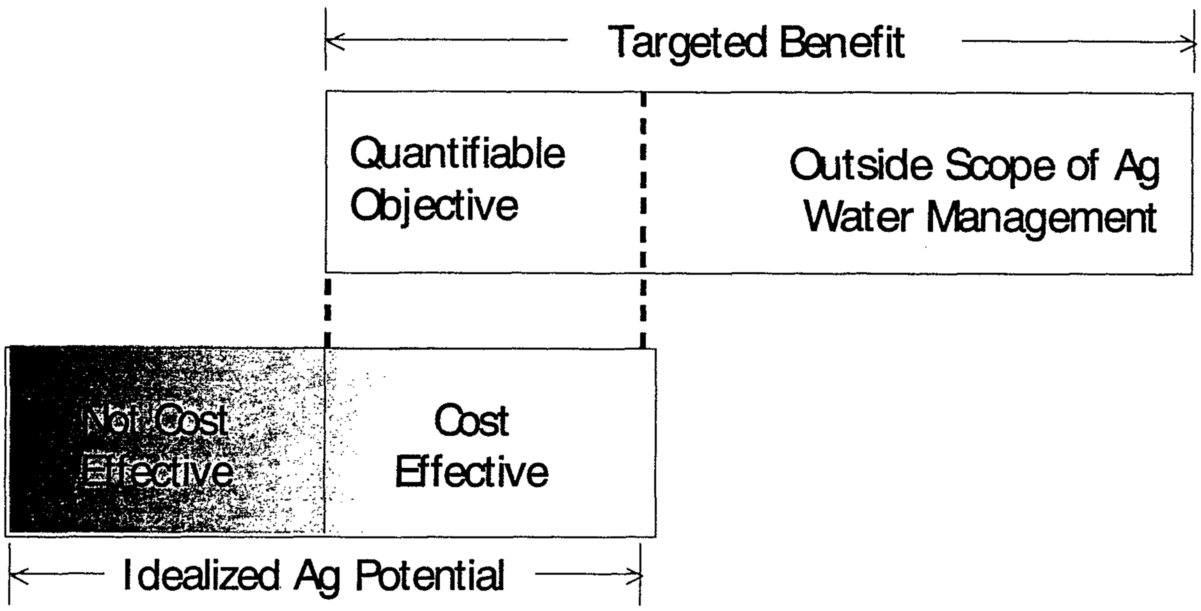
Ratio of Depletion Reduction to Applied Water Savings (from Bull. 160-94a p.155) 0.9

Real Water Savings = Reduced ET + (ratio * reduced losses)
Base to No Action = 18,630
No Action to CALFED = 26,910
Total = 45,540

Remaining Applied Water Reduction = total reduction - real water savings
Base to No Action = 2,070
No Action to CALFED = 2,490
Total = 4,560

Attachment C

Explanation and Examples of Targeted Benefits And Quantifiable Objectives



CALFED Agricultural Water Use Efficiency

June 23, 2000

Draft
Agricultural Water Use Efficiency
Explanation and Examples of Targeted Benefits and Quantifiable Objectives

Table of Contents

I. Introduction

Background

The CALFED Bay-Delta Program is a cooperative effort among state and federal agencies and the public to ensure a healthy ecosystem, reliable water supplies, good quality water, and stable levees in California's Bay-Delta system. One of the Program elements common to the potential solutions developed by CALFED is Water Use Efficiency (WUE). The CALFED WUE Program is unique nationally in its magnitude and its aggressive approach to water management. The WUE program is organized into agricultural, urban, recycling and managed wetlands categories, but this document focuses solely on Agriculture Water Use Efficiency (Ag WUE).

The Ag WUE element was developed in cooperation with a steering committee made up of agencies with regulatory responsibilities for Delta water, and agricultural and environmental stakeholders. Built on the concept of thinking globally (the health and functionality of the entire Bay-Delta system) and acting locally (within the communities whose practices impact that system), Ag WUE leverages the efforts of existing, locally-governed organizations to create locally defined actions in response to CALFED's centrally developed objectives. These objectives drive the Ag WUE element, fostering cooperation among the stakeholders to create locally designed and initiated solutions to Delta problems and overcome barriers to adoption of more efficient water management practices.

Ag WUE's foundation is built on three equally important concepts: 1) incentive based actions, 2) quantified objectives and 3) locally driven leadership. These concepts are mortared together by continuous monitoring and adaptive management. In practice, this translates to a program built on solid theory and science, grounded in practical experience, and is able to constantly test its hypotheses and alter its path in response the real world experiences of its implementers, both at the administrative and on-the-ground levels.

Locally Cost-Effective Implementation

Very little will be discussed about the Water Use Efficiency Program without invoking the words "cost-effective." Implementation of locally cost-effective water use efficiency practices is a fundamental building block of the WUE element. By definition, locally cost-effective practices are those for which the water supplier or user receives benefits in excess of their costs. CALFED expects local entities (as the primary beneficiaries) to fund these practices. CALFED intends to facilitate implementation of these practices through cooperation with the Agricultural Water Management Council (AWMC), technical assistance and low interest loans.

When Ag WUE's projects or priorities are *not* locally cost effective, but are cost-effective when viewed from a statewide perspective, CALFED anticipates providing State and Federal assistance in the form of incentive grants. The proposed grant program will tailor the amount of local cost share (if any) on a project-by-project basis to reflect the level of local benefits.

Targeted Benefits and Quantifiable Objectives.

In defining Ag WUE, CALFED has taken a major step forward by developing Targeted Benefits. A Targeted Benefit is a quantified region-specific expression of a CALFED objective that could be partially addressed through Ag WUE. Objectives are related to improving water quality, quantity, timing and instream flow. Although each Targeted Benefit can be partially addressed through Ag WUE, it is possible that it can only be fully achieved through means that fall outside the category of agricultural water management (Figure 1).

The Ag WUE contribution to a given targeted benefit is estimated through an analysis of flowpaths and resource economics. The result of this analysis is a range of quantifiable objectives which represent the practical, cost effective (from the State-wide perspective) contribution Ag WUE can make towards achieving the Targeted Benefit (Figure 2).

Incentive-Driven Local Actions.

The WUE program looks to agricultural regions for the solutions to the Bay Delta's problems. Rather than imposing top-down, one-size-fits-all requirements, the Program relies on incentives to encourage local entities to identify and implement creative actions to achieve the Targeted Benefits and Quantifiable Objectives in a cost-effective manner. CALFED will use a competitive grant/loan program as the best mechanism to assure that the investments in water use efficiency are cost effective. Regional differences will dictate that the exact cost-effective measures will vary according to local need and situation, but the competitive nature of the program would fund the most cost-effective measures for a given locale first.

Monitoring and Adaptive Management.

Adaptive management strategies will be combined with a vigorous monitoring and evaluation component of all CALFED-funded WUE actions. These monitoring efforts will verify and refine the WUE conceptual model and provide timely and effective reaction to unforeseen conditions and events.

Anticipated Funding.

During the first four years of Stage 1, CALFED proposes State and Federal government investment of $500 million (1/2 state and 1/2 federal) into Water Use Efficiency, with an additional $500 million coming from local matching funds. CALFED expects to direct a substantial amount of this funding commitment to the Agricultural WUE program. At the end of the first four years of its Implementation Phase, CALFED will prepare a more comprehensive evaluation of WUE program implementation. At that time, CALFED may increase or reduce its targeted conservation goals to reflect actual implementation experience and redirect investments to achieve the most effective water use efficiency results. CALFED may also introduce new programs if necessary and appropriate.

Purpose of this Document

This document is intended to provide an overview of CALFED's Ag WUE element, with explanation and examples of its key concepts and impact area. It is not intended to provide a comprehensive methodology of the work done to create the program. This document explains the concepts of Targeted Benefits and Quantifiable Objectives to provide the public with an opportunity to familiarize themselves with the nature and progress of WUE's work to date. CALFED plans to produce a more thorough methodology as part of a peer review of Quantifiable Objectives in late July, 2000.

Figure 1. Targeted Benefit Schematic.

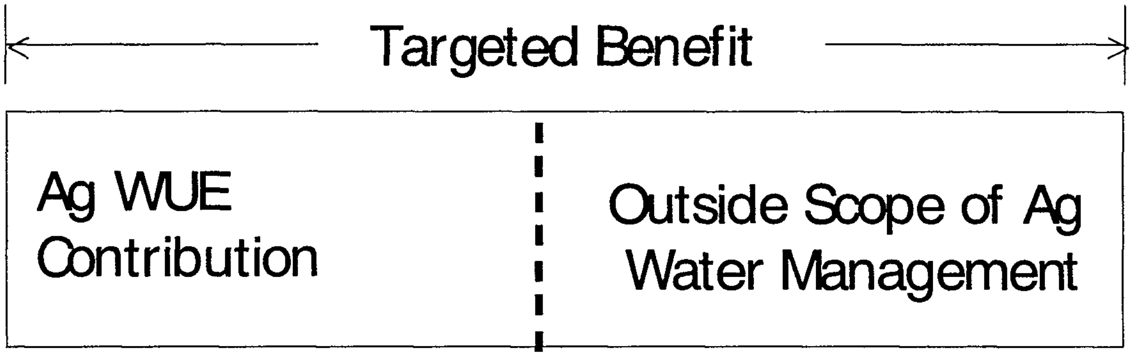
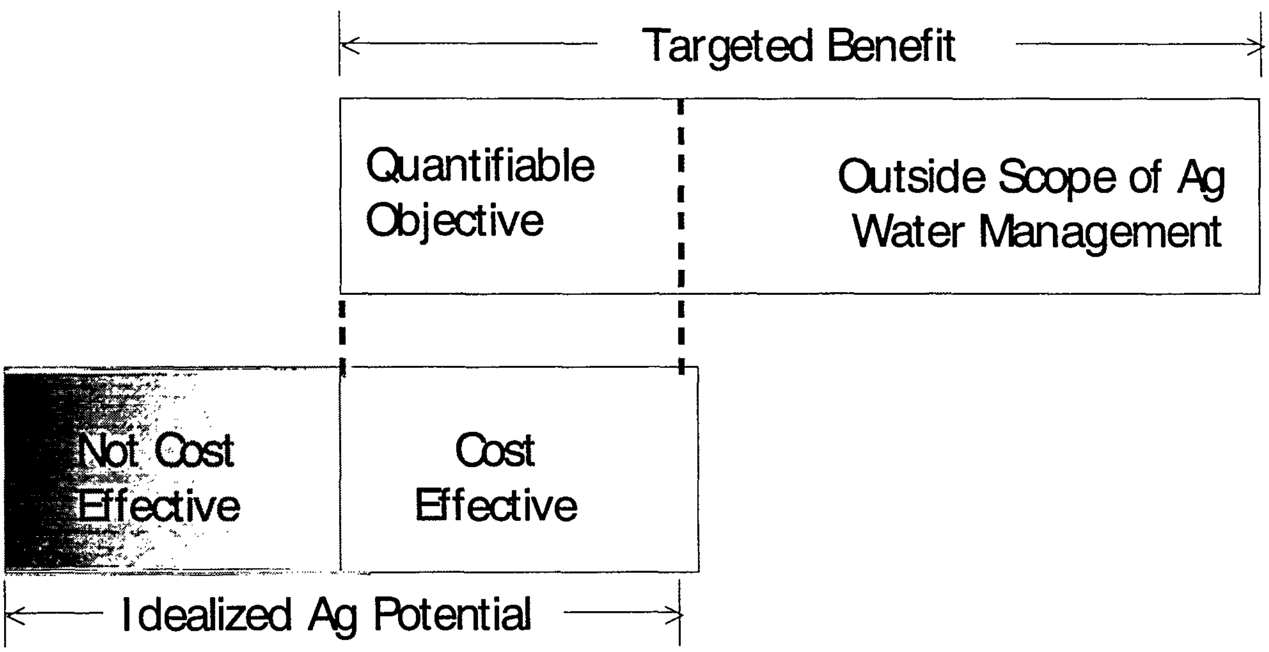


Figure 2. Quantifiable Objective is the Cost-Effective Ag WUE Contribution to a Targeted Benefit



II. Central Valley Water Balance Information

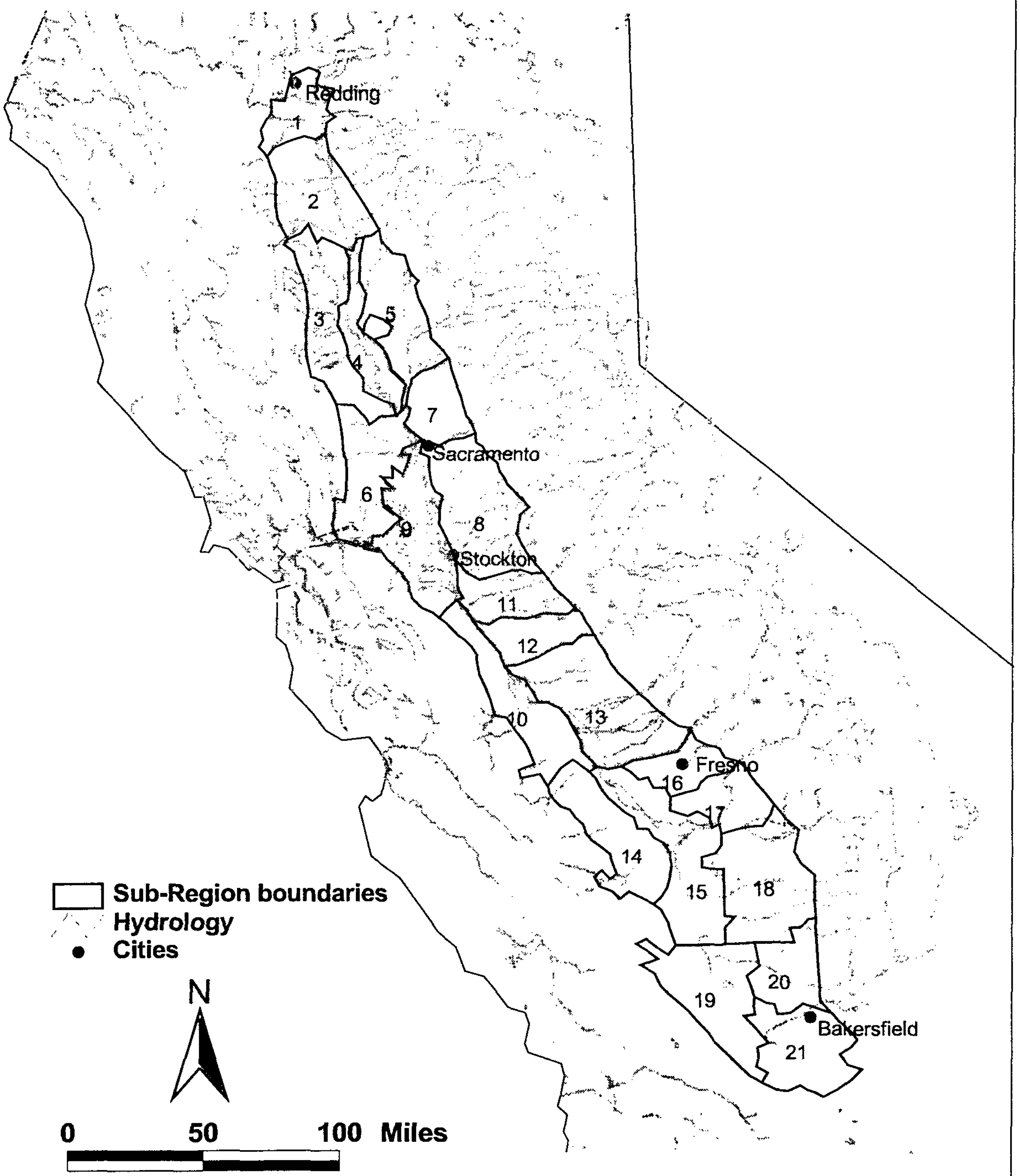
The Central Valley of California is an alluvial plain that extends from Redding in the north to Bakersfield in the south, encompassing approximately 20,000 square miles. Surrounded by the Klamath, Cascade and Sierra Nevada mountain ranges, and drained by the Sacramento River, the Sacramento Valley forms the northern portion of the Central Valley. The San Joaquin Valley makes up the southern portion of the Central Valley and is bounded on the east by the Sierra Nevada and on the west by the Coast Ranges. Two geologic features define the San Joaquin Valley: the San Joaquin Basin, drained by the San Joaquin River and the Tulare Basin, a hydrologically closed basin partially drained by the San Joaquin River in extremely wet years.

The primary data source for the Quantifiable Objectives computations is the USBR's Central Valley Ground and Surface Water Model (CVGSM). The CVGSM data set was chosen because it provides a comprehensive and systematic view of both the land and water use in the Central Valley. The model divides the Central Valley into 21 geographic Sub-Regions (Fig. 3) and the same divisions are used to organize this document. Within the CVGSM, information is available about Land Use (Fig. 4), Cropping Patterns (Fig. 5), and overall water balance (Fig. 6). The Land Use and Cropping Patterns are based on the "recent land use information" (Central Valley Project – Programmatic Environmental Impact Statement, 1999).

The CVGSM data set was compiled from several sources including the California Department of Water Resources (DWR) Detailed Analysis Unit (DAU) structure, the United States Geological Survey (USGS) streamflow gauging stations and USBR and Department of Water Resources diversion data. Figures 3-6 are included to provide an overview of the data used to develop Quantifiable Objectives.

Table 1 lists the abbreviated categories of Targeted Benefits and provides a snapshot of the Targeted Benefits in each sub-region. Each check mark (✓) in this Table represents one or more Targeted Benefit for the given Sub-Region.

Figure 3. Sub-Region Boundaries
Central Valley Ground and Surface Water Model



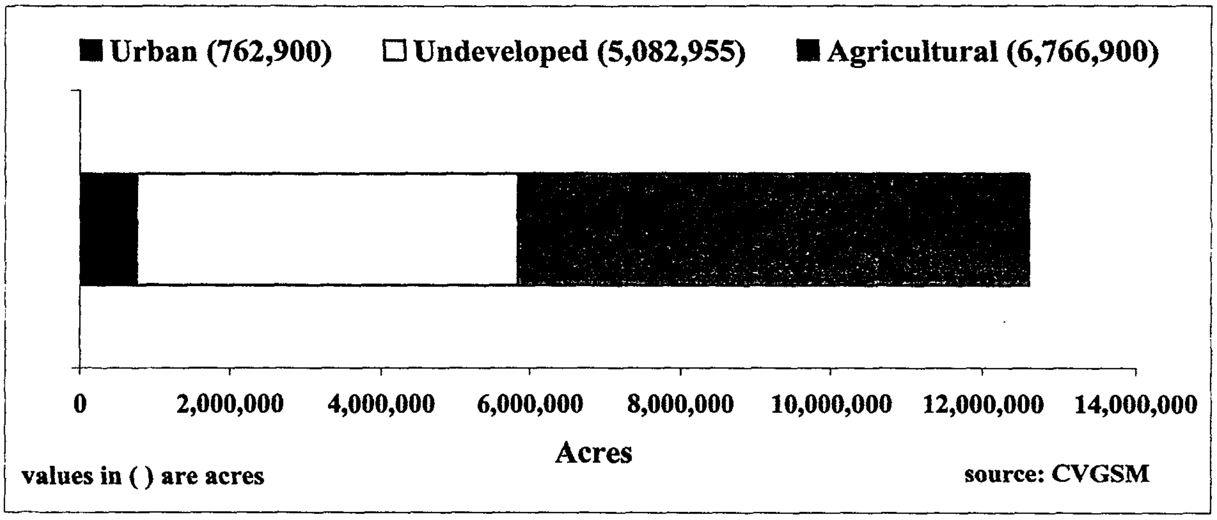


Figure 4. Land Use, Central Valley.

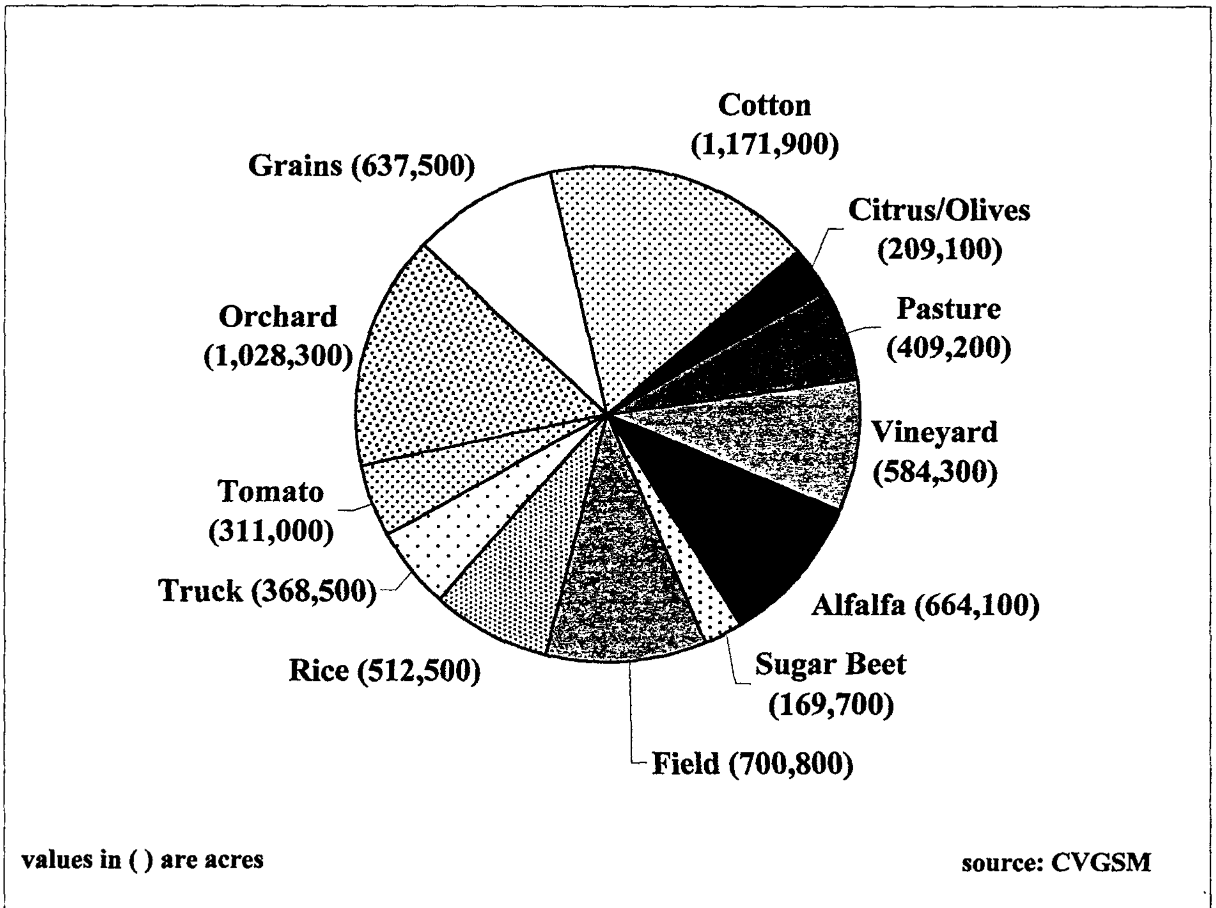
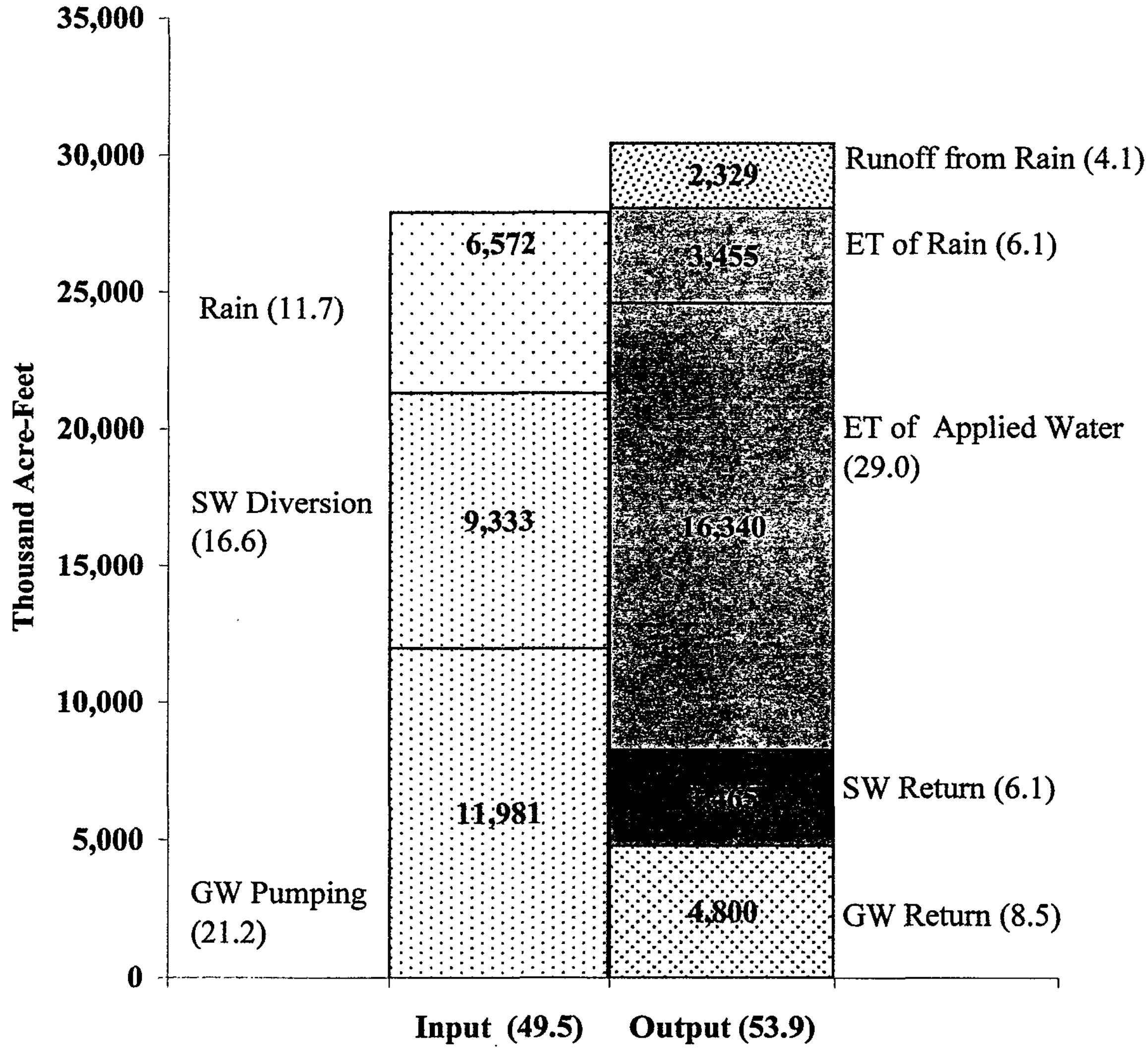


Figure 5. Cropping Pattern, Central Valley.



Note: values in ( ) have units of acre-inches per acres.
SW = Surface Water, GW = Ground Water

Figure 6. Overall Water Balance, Average Year, Sacramento - San Joaquin Valley.

Table 1. Categories of Targeted Benefits by Sub-Region

Targeted Benefits will be achieved by altering flow paths of irrigated agriculture.

Region		Sub-Region	Flow / Timing	Nutrients	Group A Pesticides	Pesticides	Salinity	Native Constituents	Temperatures	Sediments	Long-Term Diversion Flexibility	Nonproductive Evaporation	Short-Term Diversion Flexibility	Flows to Salt Sinks
			Abbreviated Categories of Targeted Benefits*											
				Quality							Quantity			
Sacramento Valley	1	Redding Basin	✔								✔	✔		
Sacramento Valley	2	Sacramento Valley, Chico Landing to Red Bluff	✔			✔			✔		✔	✔		
Sacramento Valley	3	Sacramento Valley, Colusa Basin	✔		✔	✔	✔				✔	✔		
Sacramento Valley	4	Mid-Sacramento Valley, Chico Landing to Knights Landing	✔			✔	✔				✔	✔		
Sacramento Valley	5	Lower Feather River and Yuba River	✔		✔	✔	✔		✔		✔	✔		
Sacramento Valley	6	Sacramento Valley Floor, Cache Creek, Putah Creek, and Yolo Bypass	✔			✔					✔	✔		
Sacramento Valley	7	Lower Sacramento River below Verona	✔			✔	✔		✔		✔	✔		
Delta / Tributary	8	Valley Floor east of Delta	✔						✔		✔	✔		
Delta / Tributary	9	Sacramento - San Joaquin Delta	✔	✔	✔	✔	✔	✔	✔		✔	✔	✔	✔
West Side SJ Valley	10	Valley Floor west of San Joaquin River	✔		✔	✔	✔	✔		✔	✔	✔		✔
East Side SJ Valley	11	Eastern San Joaquin Valley above Tuolomne River	✔	✔	✔	✔	✔		✔		✔	✔		
East Side SJ Valley	12	Eastern Valley Floor between Merced and Tuolomne Rivers	✔		✔	✔	✔		✔		✔	✔		
East Side SJ Valley	13	Eastern Valley Floor between San Joaquin and Merced Rivers	✔		✔	✔	✔		✔		✔	✔		
West Side SJ Valley	14	Westlands Area				✔					✔	✔		✔
Southern SJ Valley	15	Mid-Valley Area									✔	✔		✔
Southern SJ Valley	16	Fresno Area	✔		✔	✔	✔		✔		✔	✔		
Southern SJ Valley	17	Kings River Area									✔	✔		✔
Southern SJ Valley	18	Kaweah and Tule River Area									✔	✔		✔
Southern SJ Valley	19	Western Kern County									✔	✔		✔
Southern SJ Valley	20	Eastern Kern County									✔	✔		
Southern SJ Valley	21	Kern River Area									✔	✔		✔

✔ represents 1 or more TB

* Definitions of Targeted Benefit Categories are presented in Table 2.

Table 2. Definition of Targeted Benefit Categories

Abbreviated Category	Definition
Flow / Timing	Provide flow to improve ecosystem conditions
Nutrients	Reduce nutrients to enhance and maintain beneficial uses of water (Eco, Ag, M&I)
Group A Pesticides	Reduce group A pesticides (aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexane [including lidane], endosulfan and toxaphene) to enhance and maintain beneficial uses of water (Eco, Ag, M&I)
Pesticides	Reduce pesticides to enhance and maintain beneficial uses of water (Eco, Ag, M&I)
Salinity	Reduce salinity to enhance and maintain beneficial uses of water(Eco, Ag & M&I)
Native Constituents	Reduce native constituents (selenium, boron, molybdenum, organic carbon) to enhance and maintain beneficial uses of water (Eco, Ag & M&I)
Temperatures	Reduce temperatures to enhance and maintain aquatic species populations
Sediments	Reduce sediments to enhance and maintain beneficial uses of water (Eco, Ag, M&I)
Long-Term Diversion Fl	Provide long term diversion flexibility to increase the water supply for beneficial uses (Eco, Ag, M&I)
Nonproductive Evaporati	Decrease nonproductive evaporation and transpiration to increase the water supply for beneficial uses (Eco, Ag, M&I)
Short-Term Diversion Fl	Provide short-term diversion flexibility to make water available to the Environmental Water Account in a timely
Flows to Salt Sinks	Decrease flows to salt sinks to increase the water supply for beneficial uses (Eco, Ag, M&I)

III. Explanation and Examples of Quantifiable Objectives

The following draft tables and figures are provided as illustrative examples of the format that will be used to report all 199 Targeted Benefits and their associated Quantifiable Objectives. The following are an incomplete set of Figures 11.1 through 11.3 and Tables 11.1 through 11.5, describing the Flow Paths, Targeted Benefits, and Quantifiable Objectives for Sub-Region 11. When completed, this document will contain completed figures and tables for all 21 Sub-Regions that comprise the Central Valley. Tables 11.1 through 11.3 provide a complete listing of the 16 Targeted Benefits for Sub-Region 11. However, Tables 11.4 and 11.5 only provide description of three of the 16 Quantifiable Objectives associated with the Targeted Benefits because other Quantifiable Objectives have not yet been defined.

There are three categories of Ag WUE Targeted Benefits:

- Streamflow and Timing: providing more that provide more flow along a given river segment to meet specified needs, at a specific time (such as fish spawning)
- Water Quality: improving water quality by lessening the load of harmful contaminants, providing greater oxygenation, reducing silt, etc.
-
- Water Quantity: increasing available water resources by reducing irrecoverable flows, such as evaportranspiration, or enabling flexibility in water diversion (such as groundwater conjunctive use).

Table 11.1 Descriptive Lists of Targeted Benefits

Table 11.1 describes each Targeted Benefit including geographic location, probable beneficiary, timing, and availability of quantitative data and conceptual completeness. The Targeted Benefits have been made as specific as possible, but where specificity is not available, or not possible, an explanation is given. The primary sources for the Targeted Benefits include CALFED's Ecosystem Restoration Program Plan (ERPP), the State Water Resources Control Board 303(d) list of impaired water bodies, and discussions with Agriculture Water Use Efficiency Senior Technical Advisors.

Column (1), TB#: is an index used to uniquely identify each Sub-Region's Targeted Benefit. Some Targeted Benefits span more than one Sub-Region. Where these multi-Sub-Region Targeted Benefits occur, the TB number of the corresponding identical Targeted Benefit is listed in brackets. For example, the Targeted Benefit given as TB #112 (Provide flow to improve aquatic ecosystem conditions in the San Joaquin River) spans three other Sub-Regions and is repeated as TBs 131, 148, 171.

Column (2), Location: refers to the specific place that a Targeted Benefit applies. For example Row #123 refers to the San Joaquin River at Vernalis. If the location refers to a water body such as Stanislaus River (TB #113) without additional specificity, then the Targeted Benefit applies to the entire water body (see Table 11.1).

Column (3), Category of Targeted Benefits: is provided for context and to allow the list of Targeted Benefits to be sorted by category.

Column (4), Beneficiary: is the intended recipient of the benefits of the given Targeted Benefit. The codes for the three beneficiaries are as follows:

- **Eco:** the ecosystem (fish flows, wetlands, etc.),
- **Ag:** agriculture (water quality, water supply), and
- **M&I:** municipal and industrial users (water quality and water supply).

Column (5), General Time-Frame: identifies the general time, either type of year or time of year that a change in flow, water quality, or quantity is needed to achieve the Targeted Benefit in order to have the intended affect on the beneficiary.

Column (6), Conceptual Completeness: describes our understanding of the cause and effect relationship between the Targeted Benefit in quantifiable water flow, timing, or quality terms, and intended effect on the beneficiary. The primary source used to assign the Conceptual Completeness ratings for the ecosystem-related Targeted Benefits was CALFED's Ecosystem Restoration Program Plan. The Conceptual Completeness sources for the other Targeted Benefits were the best available data and judgment. The following three categories were used to describe the different levels of Conceptual Completeness:

1) **Complete:** the relationship between cause and effect is well known and achievement of the Targeted Benefit will result in the desired affect on the beneficiary. For example, for TB #127, see Table 11.1, (Decrease nonproductive ET to increase water supply for beneficial uses), we are confident that reducing evaporative losses will reduce irrecoverable losses and increase the amount of water available for beneficial uses.

2) **Incomplete:** the conceptual linkage between Targeted Benefit and the intended beneficiary has been established, but the cause and effect is not fully understood. For example, TB #113, see Table 11.1, (Provide flow to improve aquatic ecosystem conditions in the Stanislaus River) is conceptually incomplete because the fisheries specialists are confident that improved flows will lead to improved aquatic ecosystems, but they are uncertain of the correlation between the amount of flow and the extent of ecosystem improvement.

3) **Undefined:** indicates that additional research and evaluation are required before a conceptual link can be made between the Targeted Benefit and the desired affect on the beneficiary.

Table 11.2 Quantified Targeted Benefits

Table 11.2 provides the source and description of each Quantified Targeted Benefit (QTB) associated with Sub-Region 11. The QTB expresses the target in language that describes the desired condition in flow/timing, quality, or quantity terms assumed to be necessary to achieve the Targeted Benefit, given the current level of scientific understanding. (This is the level of understanding between the desired Targeted Benefit and the necessary quantified conditions in water flow, quality, or quantity terms to achieve it.)

Column (1), Row#: is the same unique TB # used in all Tables.

Column (7), Source and Description of Quantified Targeted Benefit: provides the citation and text upon which the QTB is based. For example, TB #113 (Provide flow to improve aquatic ecosystem conditions in the Stanislaus River) was derived from the ERPP through text that seeks to, "maintain specified follow regimes: for example, provide the base flows in the Stanisluas River below Goodwin Dam in critical, dry, and below-normal years, minimum flows should be 200 to 300 cfs, except for a flow event of 1,500 cfs for 30 days in April and May." In addition, the Core team suggests that there is a "...10 day October flow event of 1500 cfs." The following citation codes are used in this Column 7 and Column 8 (Tables 1.3 through 21.3):

4) **Calculated:** the given value is computed

5) **Change given:** the Quantified Targeted Benefit Change

6) **Core**: Ag WUE senior technical advisors: Regional Liaisons, Water Supply, Water Quality, and Biologists (personal communications, 1999 - 2000)

7) **CVGSM**: Output or input data from the CVGSM (CVPIA PEIS, 1999)

8) **CVHJVIP:** Central Valley Habitat Joint Venture Implementation Plan, April 19, 1990 (CVHJVIP)

9) **ERPP**: Draft Ecosystem Restoration Program Plan (June, 1999)

10) **NA:** Data not available or not applicable

11) **RWQCB:** Regional Water Quality Control Board

12) **RWS (ICP):** Refuge Water Supply Interagency Cooperative Program (1998)

13) **TBD:** To be determined

14) **303(d)**: List of Impaired Water Bodies, 303(d) (State Water Resources Control Board, 1999)

Table 11.3 Quantified Targeted Benefit Change

Table 11.3 tables provide information about some of the data used to develop the reference condition, the Quantified Targeted Benefit and the Quantified Targeted Benefit Change associated with Sub-Region 11. The QTBC is the quantified value of the required change or improvement in water flow, quantity, or quality at specific places and times, necessary to achieve the Targeted Benefit.

Column (8), Data Source: provides the citation for the data use in the Reference Condition, Quantified Targeted Benefit, and Targeted Benefit Change columns. The same citation codes (ERPP, Core, 303d, etc.) are used in these three columns as in Column 7 for the source of Quantified Targeted Benefits.

15) ***Reference Condition:*** is the quantitative representation of the current state of the water resource that must be affected to achieve the Targeted Benefit. For example, the Reference Condition (RC) for TB #113, see Table 11.3, (Provide flow to improve aquatic ecosystem conditions in the Stanislaus River) would be the existing flows in Bear Creek during specified interest times.

16) ***Quantified Targeted Benefit:*** is the numerically quantified expression of the given Targeted Benefit as defined above. For example, for TB #113, see Table 11.3, (Provide flow to improve aquatic ecosystem conditions in the Stanislaus River), the Quantified Targeted Benefit is the desired flow condition(s): In critical, dry, and below-normal years, the base flows below Goodwin Dam should be 200 to 300 cfs. There should be a flow event of 1,500 cfs for 30 days in April and May.

17) ***Quantified Targeted Benefit Change:*** is the water flow timing, quality, or quantity change needed to achieve the Targeted Benefit as described above. The QTBC is determined in most cases by taking the difference between the Reference Condition and the Quantified Targeted Benefit as follows:

Quantified Targeted Benefit Change = Quantified Targeted Benefit – Reference Condition

Columns (9), Data Availability: represents a summary of the availability of quantitative information for the Reference Condition, Quantified Targeted Benefit, and Quantified Targeted Benefit Change columns. The following categories are used to describe data availability:

- **Not available**: quantitative data is nonexistent or severely limited in scope. For example, there are a few anecdotal references for the Targeted Benefit "Reduce temperatures to enhance and maintain aquatic species populations" but they have yet to be established through rigorous research or practice.

- **Insufficient**: through conferences with Ag WUE technical specialists, data and studies have been cited, but quantitative data has not yet been found.

range of base flows for various year types. Through conferences with aquatic ecosystem specialists, we have determined that these flow targets were developed as part of an adaptive approach that did not have a firm scientific foundation.

- **Unproven – precise**: accepted quantitative data exists, but no supporting documentation is available to justify precise quantitative values. For example, the TB #125, see Table 11.3, (Reduce temperatures to enhance and maintain aquatic species populations) calls for less than 56 degrees Fahrenheit from October 15th to February 15th, and less than 65 degrees Fahrenheit from April 1st to May 31st. Although no supporting documentation has been provided for this acreage target, this is considered an accepted value among aquatic specialists.

- **Proven – precise**: precise quantitative values and supporting documentation are available for these Targeted Benefits. For example, TB #121, see Table 11.3, (Reduce pesticides to enhance and maintain beneficial uses of water in the Stanislaus River) calls for reducing diazinon. In this case, the target concentration has been established and documented by the US EPA.

Column (10), Range QTB of Values: provides a summary of the range of Quantified Targeted Benefit Change values. In most cases a range of values will be given. More detail on the derivation and range of values is provided in the Detail section for each TB in each Sub-Region (see Detail TB #s, below).

Column (11), Specific Time-Frame: identifies the specific year type and/or time of year that the Quantified Targeted Benefit is needed (e.g. specific months, season, year type, etc.). For example, for TB #123, see Table 11.3, (Reduce salinity to enhance and maintain beneficial uses of water), the specific timing is April through August and from September through March.

Table 11.4 Quantifiable Objectives

Column (12), Range of Available Agricultural Potential: states the volume of water that is available after improving the farm and district irrigation efficiency from existing efficiency to improved efficiency values. The range shown in this column is a summary of the values provided in the Details 113, 121, and 127. For example, for TB# 113, the Available Agricultural Potential ranges from 73 to 268 TAF/year. The higher value in the range would result from a higher level of investment in improving irrigation efficiency. The methodology used to determine values of the Available Agricultural Potential for several months, year types, and investment levels are provided below.

Column (13), Quantifiable Objective: represents the practical, cost effective (from a State-wide standpoint) contribution that can be made to the given Targeted Benefit through changes in agricultural water management. Four levels of Quantifiable Objectives are computed for each Targeted Benefit. Each level represents a different investment in on-farm and district water management practices to change the given flow path. The range of contribution (in TAF/year) and unit cost (in $/AF. year) for each of the four levels presented in this column.

Table 11.5. Affected Flow Paths and Possible Actions

Column 14), Affected Flow Paths: A Flow Path is the course that water follows between entering and a given water balance area. The Flow Paths considered in the Quantifiable Objective methodology are shown in Figure 4. *Column (14)* indicates which flow paths would need to be changed to achieve the Quantifiable Objective.

Column 15), Possible Actions: There are many possible ways to make the flow path changes described in Column 14. The possible actions listed in Column 15 are a sample of practices that growers or water suppliers could employ to generate the desired changes. These possible actions are only a sample and do not represent an exhaustive list of practices or prescriptive requirements.

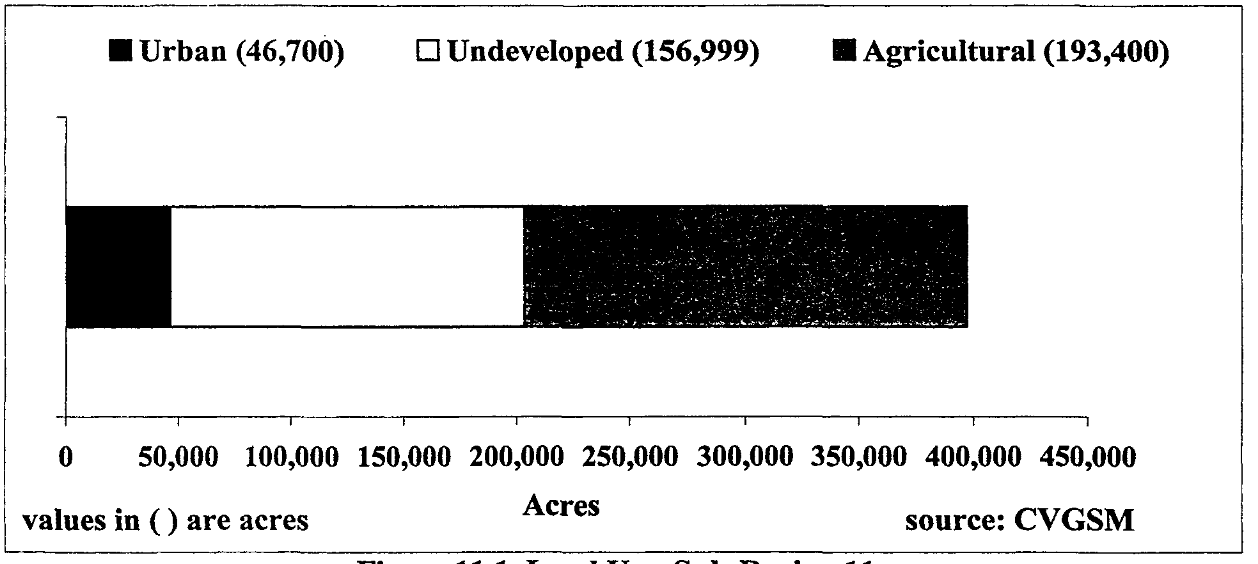


Figure 11.1 Land Use, Sub-Region 11, Eastern San Joaquin Valley above Tuolomne River.

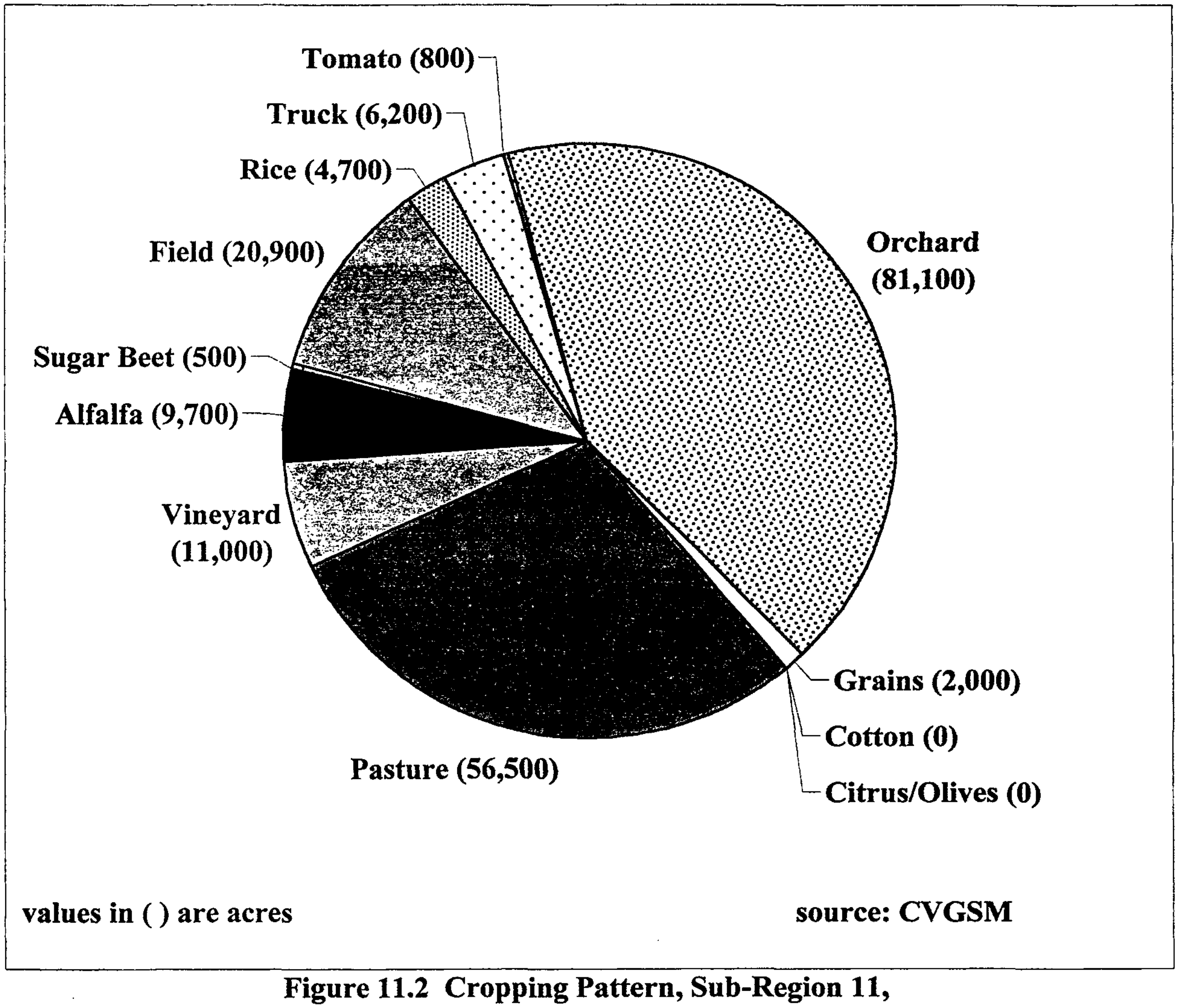
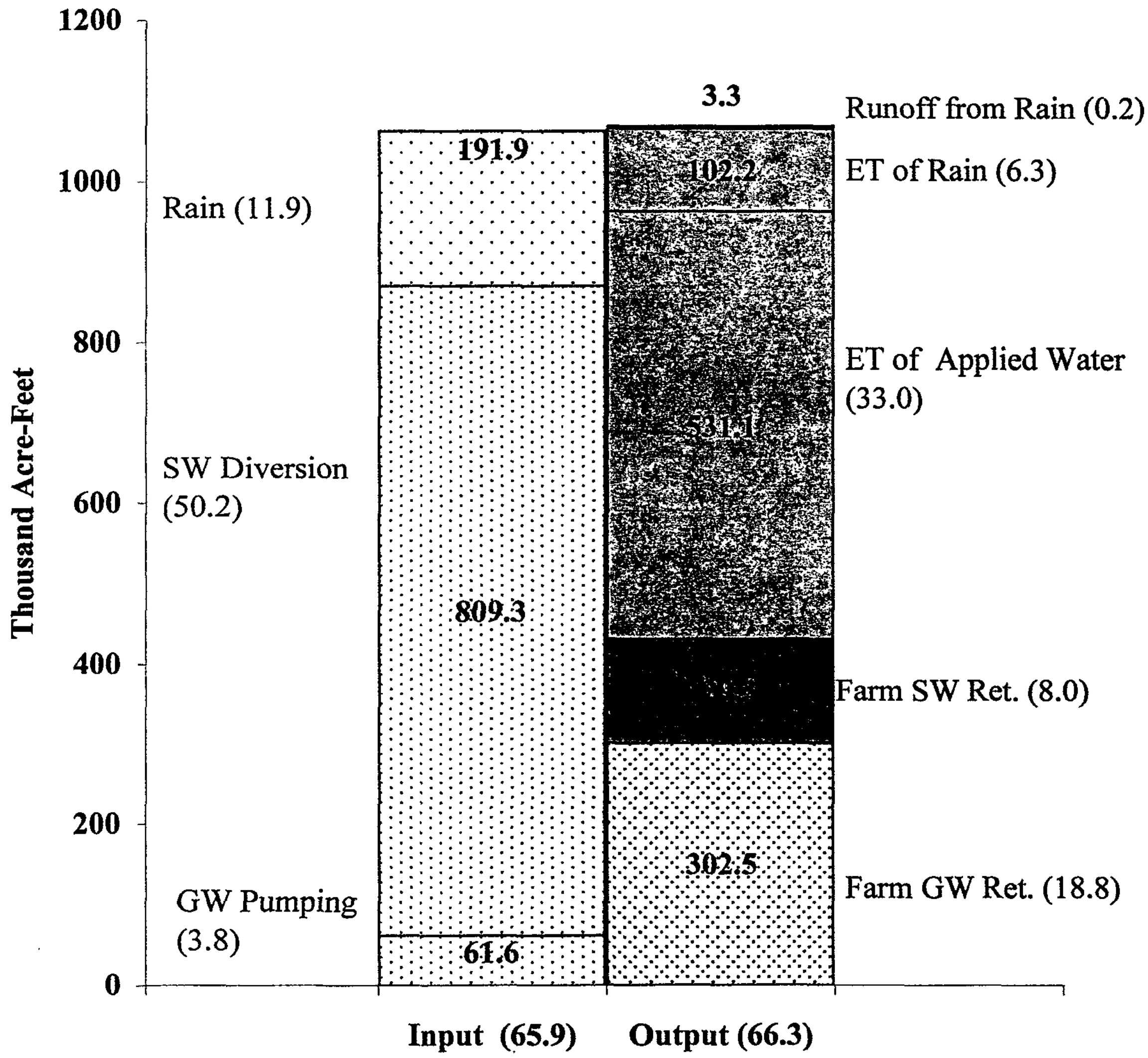


Figure 11.2 Cropping Pattern, Sub-Region 11, Eastern San Joaquin Valley above Tuolomne River.



Note: values in ( ) have units of acre-inches per acres.
SW = Surface Water, GW = Ground Water

source:CVGSM

Figure 11.3. Overall Water Balance, Average Year, Sub-Region 11, Eastern San Joaquin Valley above Tuolomne River.

Table 11.1. Descriptive List of Targeted Benefits, Sub-Region 11, Eastern San Joaquin Valley above Tuolumne River					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
112 [131, 148, 171]	San Joaquin River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall	Incomplete
113	Stanislaus River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
114 [132]	Tuolumne River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Incomplete
115 [93, 134, 150, 172]	San Joaquin River	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
116	Stanislaus River	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
117 [135]	Tuolomne River	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
118	Harding	TB Moved to Subregion 12			
119	Harding	TB Moved to Subregion 12			
120 [82, 101, 137, 152, 173]	San Joaquin River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
121	Stanislaus River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
122 [138]	Tuolomne River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
123 [104, 140, 154, 174]	San Joaquin River at Vernalis	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
124 [143, 157, 175]	San Joaquin River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	TBD	Incomplete
125	Stanislaus River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
126 [143]	Tuolomne River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
127	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
128	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
129 [110, 146, 160]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete

Table 11.2. Quantified Targeted Benefits, Sub-Region 11, Eastern San Joaquin Valley above Tuolumne River	
TB # (1) [duplicate]	**Source and Description of Quantified Targeted Benefit (7)**
112 [131, 148, 171]	ERPP: Manage flow releases from tributary streams to provide adequate upstream and downstream passage of fall-run and late-fall-run chinook salmon, resident rainbow trout, and steelhead and spawning and rearing habitat for American shad, splittail, and sturgeon
113	ERPP: Maintain specified flow regimes: for example, provide the base flows in the Stanislaus River below Goodwin Dam in critical, dry, and below-normal years, minimum flows should be 200 to 300 cfs, except for a flow event of 1,500 cfs for 30 days in April and May.
114 [132]	ERPP: Maintain specified flow releases: for example, in critical and below years 50 cfs Jun-Sept, 100 cfs Oct 1-15, 150 cfs from Oct- May plus 11,091 AF pulse flow. Core: Provide the following flows and water depths for all life stages of chinook/steelhead fish: 10 day flow of 1500 cfs in October, water depth of approximately 2 feet in spawning reach from Oct. through May.
115 [93, 134, 150, 172]	303(d): Reduce [Group A pesticide] and DDT to ____.
116	303(d): Reduce _______ [Group A pesticide] to ____.
117 [135]	303(d): Reduce _______ [Group A pesticide] to ____.
118	TB Moved to Subregion 12
119	TB Moved to Subregion 12
120 [82, 101, 137, 152, 173]	303(d): Reduce chlorpyrifos and diazinon to ____.
121	303(d): Reduce diazinon to <0.04 ug L^{-1}
122 [138]	303(d): Reduce diazinon to _____.
123 [104, 140, 154, 174]	Core: Reduce salinity levels at 0.7 dS/m April 1 - August 1, 1.0 dS/m September 1 - March 31 at Vernalis. 303d: Reduce salinity to _____.
124 [143, 157, 175]	ERPP: Manage reservoir releases and other factors to provide suitable water temperatures for key resources from the Merced River confluence to Vernalis
125	ERPP: Provide suitable water temperatures for salmon spawning area during the fall and winter and to the mouth of the river durning the spring as follows: Oct 15 to Feb 15 - 56F and Apr 1 to Core: May 31 - 65F.
126 [143]	ERPP: Provide suitable water temperatures for salmon spawning area during the fall and winter and to the mouth of the river durning the spring as follows: Oct 15 to Feb 15 - 56F and Apr 1 to Core: May 31 - 65F.
127	Core: Reduce unwanted ET by 4,800 acre-feet per year.
128	Core: Enhance the effectiveness of potential conjunctive use programs by reducing flows to groundwater to _____ acre feet per year during periods of shortage; and increasing flows to groundwater to _____ acre feet per year during periods of excess.
129 [110, 146, 160]	ERPP/ Core: Cooperatively manage ____ acres of ag lands and restore ____ acres of seasonal, semipermanent, and permanent wetlands consistent with the CV Habitat Jt Venture and N. Am. Waterfowl Mgmt. Plan.

Table 11.3. Quantified Targeted Benefit Change, Sub-Region 11, Eastern San Joaquin Valley above Tuolumne River								
	Reference Condition		Quantified Targeted Benefit		Quantified Targeted Benefit Change			
TB # (1) [duplicate]	Data Source (8)	Data Availability (9)	Data Source (8)	Data Availability (9)	Data Source (8)	Data Availability (9)	Range of Values (10)	Specific Time-Frame (11)
112 [131, 148, 171]	CVGSM	Unproven-precise	ERPP	Not available	Not available	Non-existant	Not available	Varies
113	CVGSM	Unproven-precise	ERPP	Rough estimate	Calculated	Rough estimate	15.4 - 238 TAF	Year round
114 [132]	CVGSM	Unproven-precise	ERPP	Rough estimate	Calculated	Rough estimate	TBD	Varies
115 [93, 134, 150, 172]	TBD	TBD	TBD	Proven - precise	Calculated	TBD	TBD	TBD
116	TBD	TBD	TBD	Proven - precise	Calculated	TBD	TBD	TBD
117 [135]	TBD	TBD	TBD	Proven - precise	Calculated	TBD	TBD	TBD
118	TB Moved to Subregion 12							
119	TB Moved to Subregion 12							
120 [82, 101, 137, 152, 173]	TBD	TBD	TBD	Proven - precise	Calculated	TBD	TBD	TBD
121	USGS Circ. 1159	Proven - precise	US EPA	Proven - precise	Calculated	Proven - precise (limited)	0-0.046 ug L^{-1}	Jan-Feb
122 [138]	TBD	TBD	TBD	Proven - precise	Calculated	TBD	TBD	TBD
123 [104, 140, 154, 174]	RWQCB	Proven - precise	RWQCB	Proven - precise	Calculated	Proven - precise	15.4 - 238 TAF	Year round
124 [143, 157, 175]	TBD	TBD	ERPP	Not available	Not available	Not available	Not available	Not available
125	TBD	TBD	ERPP	Unproven - precise	Calculated	TBD	TBD	Year round
126 [143]	TBD	TBD	ERPP	Unproven - precise	Calculated	TBD	TBD	Year round
127	CVGSM	Unproven-precise	Core	Rough estimate	Calculated	Rough estimate	4.8 TAF	TBD
128	CVGSM	Unproven-precise	Core	Rough estimate	Calculated	Rough estimate	TBD	TBD
129 [110, 146, 160]	CVHJVIP	Insufficient	CVHJVIP	Uproven - precise	Not available	Insufficient	Not available	Not available

Table 11.4. Quantifiable Objective, Sub-Region 11, Eastern San Joaquin Valley above Tuolumne River					
TB # (1) [duplicate]	Available Agricultural Potential (12)	Quantifiable Objective (13)			
		Level 1	Level 2	Level 3	Level 4
112 [131, 148, 171]	TBD				
113	73 - 268 TAF/Yr	15.4 - 71.6 TAF @ 120 $/AF/Yr	15.4 -125.6 TAF @ 126 $/AF/Yr	15.4 -154.6 TAF @ 147 $/AF/Yr	15.4 -190.7 TAF @ 157 $/AF/Yr
114 [132]	TBD				
115 [93, 134, 150, 172]					
116					
117 [135]					
118	TB Moved to Subregion 12				
119	TB Moved to Subregion 12				
120 [82, 101, 137, 152, 173]	TBD				
121	Eliminate Runoff from Rain (Jan-Feb)	Dependent on local cultural costs (cover cropping, furrow diking) and incentives for reducing late season irrigations			
122 [138]	TBD				
123 [104, 140, 154, 174]					
124 [143, 157, 175]					
125					
126 [143]					
127	4.8 TAF/Yr	Cost is $742/AF/Yr			
128	TBD				
129 [110, 146, 160]					

Table 11.5. Affected Flow Paths and Possible Actions, Sub-Region 11, Eastern San Joaquin Valley above Tuolumne River

TB # (1) [duplicate]	Affected Flow Paths	Possible Actions
112 [131, 148, 171]	TBD	
113	Reduce farm surface and subsurface return flows:	Improve farm irrigation management (such as irrigation scheduling) and more uniform irrigation methods (such as shorter furrows, sprinkler, or drip
114 [132]	TBD	
115 [93, 134, 150, 172]		
116		
117 [135]		
118	TB Moved to Subregion 12	
119	TB Moved to Subregion 12	
120 [82, 101, 137, 152, 173]	TBD	
121	Elimination of farm runoff from rain during January and February on fields that receive diazinon-based dormant sprays and drain to the Stanislaus River:	Cover crop, furrow or field diking, and reduction in late-season irrigation. Note: significant contributions to this Targeted Benefit could also be made through changes in chemical applications which are outside the scope of AgWUE.
122 [138]	TBD	
123 [104, 140, 154, 174]		
124 [143, 157, 175]		
125		
126 [143]		
127	Reduce ETAW on 19,340 acres of tree, vine and truck crops	Reduce ET flows using improved irrigation methods (primarily with drip), planned deficit irrigation, and greater planting densities.
128	TBD	
129 [110, 146, 160]		

Detail 113

This section provides a detailed description of the methodology used to develop Quantifiable Objective 113. CALFED plans to complete the remaining Quantifiable Objectives by October 2000.

Step 1. Quantified Targets

Step 1 provides Quantified Target values by month and year type for the given Targeted Benefit. The Quantified Target provides a numerical value of "where we want to get to." Data are expressed as a water volume or a chemical concentration. For example, Targeted Benefit 113, Flow and Water Quality on the Stanislaus River, has two Quantified Targets:

A. Quantified Targeted (ERPP)
Flow regimes requested by the CALFED Ecosystem Restoration Program to restore salmon runs and,

B. Quantified Targeted Benefit (Water Quality)
Requested flow regimes from the US Bureau of Reclamation to meet water quality requirements at Vernalis.

The values from A and B were combined to give the Quantified Targeted Benefit for the flow/timing and water quality requirements on the Stanislaus River.

Step 2. Reference Condition

The Reference Condition quantifies the current condition of the constituent or flow that is targeted. TB #113, (Provide flow to improve aquatic ecosystem conditions in the Stanislaus River) focuses on altering river flows at specific times. The Reference Condition for this and other flow/timing Targeted Benefits is the flow in the targeted river reach for each month and year-type. For TB# 113, flow data did not exist for the targeted river reach, which is the reach of the Stanislaus River downstream of the two largest diversions and upstream of the confluence with the San Joaquin River. The flow for the targeted reach was computed as the difference between the stream flow upstream of the targeted reach (gauged at Goodwin Dam) and historical diversion data (for Oakdale and South San Joaquin Irrigation Districts) as follows:

Reference Condition = Stanislaus River inflow to Sub-Region 11(gauged at Goodwin Dam) - Historical Diversions from Stanislaus River (primarily Oakdale and South San Joaquin Irrigation Districts)

Step 3. Quantified Targeted Benefit Change

The Quantified Targeted Benefit Change is numerical representation of then change required to move us to the Targeted Benefit or the difference between the Targeted Benefit and the Reference Condition as follows:

Quantified Targeted Benefit Change = Targeted Benefit – Reference Condition

Step 4. Streamflow Data Conversion

The CVGSM breaks the Central Valley into 21 Sub-Regions. However, in some cases the area that affects a Targeted Benefit is only a portion of a Sub-Region. The subset of Sub-Region 11 that affects TB#113 is the Stanislaus River service area. Flow path data do not exist for this service area. The flow path values are approximated by proportioning the data from the Sub-Region by the following ratio for each month and year-type:

Diversion Ratio = Stanislaus River Diversions –Total Sub-Region 11 Stream Diversions

Step 5. Flow Path Elements

A Flow Path is the course that water follows between entering and leaving a given water balance area. The Flow Paths considered in the Quantifiable Objective methodology are provided for each month and year type in Step 5.

Although all flow paths are listed, only the flow paths that can affect the given Targeted Benefit are used in computing its Quantifiable Objective. For Targeted Benefit areas that are subsets of a given Sub-Region, the flow path values are proportioned using the diversion ratios in Step 4. For TB #113 (flow in the Stanislaus River), the flow path elements are computed as follows.

Flow Path Value for Stanislaus River service area = Diversion Ratio x Flow Path Value for Sub-Region 11

Step 6. Idealized Agricultural Potential (Farm and District)

This Step shows the maximum amount of water available if irrigated agriculture was perfect. This idealized potential, although impossible to achieve, is computed to provide the theoretical outer bound of contribution toward the Targeted Benefit. This bookend value is computed as the sum of all flow paths that can affect the Targeted Benefit. For TB#113 it is the sum of all district and farm surface and subsurface return flow values.

The Idealized Agricultural Potential is computed as two components: 1) District Potential and 2) Farm Potential. These components are computed separately because they represent distinctly different flow paths.

Step 7. Available Agricultural Potential (Farm)

The Quantifiable Objective, by definition, is the **local** and statewide cost-effective contribution toward the Targeted Benefit. This level of investment in Ag WUE would be equivalent to the statewide benefits generated.

However, it is virtually impossible to quantify the statewide benefits of a single Quantifiable Objective because an acceptable metric for the value of ecological resources is not readily available. CALFED intends to compute a range of Quantifiable Objectives for each Targeted Benefit and use a comparative analysis to select among the range of Quantifiable Objectives. This comparative analysis will consider the relative importance of the Targeted Benefits and the costs of their associated Quantifiable Objectives.

The range of Quantifiable Objectives is comprised of farm and district components of Available Agricultural Potential. The Available Agricultural Potential is the portion of the Idealized Potential that can be practically achieved. Step 7 computes the farm component of the Available Potential by considering the costs of changing the on-farm irrigation efficiency from its Existing level to High and Very High levels. The cost of moving to each of these target levels is computed as part of the analysis.

To move from the Existing efficiency to High or Very High requires a change in the management level and/or hardware of the farm irrigation systems. Possible changes in management level and hardware were based on logical progressions along the marginal on-farm cost curve for each major crop group in the given Sub-Region. For example, to achieve the High efficiency the new irrigation systems will likely have a greater amount of improved management of furrow irrigation system versus drip irrigation systems. However, to achieve the Very High level a much greater amount of drip irrigation systems would be installed. The cost estimates for the on-farm efficiency improvements were taken from data developed for the CVPIA-PEIS, 1994. The improved efficiency levels vary by Sub-Region. Sub-Region 11 the High level occurs at 77% and Very High occurs at 82% (computed as the percent of diverted water that is evapotranspired).

The definitions of High and Very High efficiency will be selected for each Sub-Region based on judgment and experience. For Sub-Region 11, Very High efficiency was selected as the point along the Sub-Regional marginal cost curve at which cost begin to escalate significantly. The High efficiency level was selected as the point approximately mid-way between Existing and Very High Efficiency.

The farm component of Available Agricultural Potential is the change in the targeted flow paths that would occur in moving from existing to High and Very High efficiency. For example, the targeted flow paths for TB# 113 (flows in the Stanislaus River) are all district and farm return flow paths. Therefore the farm component of the Available Agricultural Potential is the reduction in farm surface and subsurface return flow that would result from changing efficiency from 62% (existing) to 75% (High) and 87% (Very High).

Step 8. Available Agricultural Potential (District)

The district or water supplier component of Available Agricultural Potential is computed similarly but with a few notable differences. First, the district component is subdivided into surface and subsurface subcomponents because distinctly different practices are employed to reduce these two flow paths. Subsurface district return flow is primarily made of canal seepage which is addressed through canal lining, piping, or seepage recovery methods. District surface losses are primarily composed of operational spillage which is typically addressed through increased operational labor, canal automation, canal interceptors and canal automation.

Unlike the farm efficiency, limited data exist describing the marginal cost of altering these two flow paths. Using data from the Imperial Irrigation District canal lining project, it was estimated that subsurface return flows would be 8 % of district diversions at High Efficiency and 4 % of diversions at Very High Efficiency. An even more limited data set based on the history of Imperial Irrigation District spill reduction efforts was used to estimate that surface return flows would be 10 % of district diversions at High Efficiency and 4 % of diversions at Very High Efficiency. The cost of achieving these levels was also estimated.

Step 9. Quantifiable Objective

To compute the Quantifiable Objective, the farm and district components of the Available Agricultural Potential are combined and compared to the Targeted Benefit. The High and Very High potentials are combined into four Quantifiable Objective levels as follows:

Quantifiable Objective Level	Farm Efficiency	District Efficiency
1	Existing	High
2	High	High
3	High	Very High
4	Very High	Very High

These four levels were defined using judgment and experience and reflect the expected transition from existing to higher efficiency levels.

If the Targeted Benefit is less than the combined Available Agricultural Potential, then the Quantifiable Objective can fully achieve the Targeted Benefit and is set equal to that value. If the Available Agricultural Potential is less than the Targeted Benefit, the Quantifiable Objective is equal to the Available Agricultural Potential.

Details 121 and 127

The data and computations representing Quantifiable Objectives #121 and 127 are also provided. A detailed description of these computations will be included as part of a comprehensive methodology to be produced in late July 2000.

Detail 113, Flow/Timing Stanislaus River

Step 1. Quantified Targets

A. Fish Flow Targets for the Stanislaus River (from upper reach to San Joaquin River)
source: CALFED Ecosystem Restoration Program Plan — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	15.3	13.9	15.3	53.8	53.8	11.9	12.3	12.3	11.9	12.3	14.9	15.3	242.8
2) Dry	16.9	15.2	16.9	53.8	53.8	11.9	12.3	12.3	11.9	15.3	16.3	16.9	253.4
3) B Norm	18.4	16.6	18.4	71.6	71.6	14.9	15.3	15.3	14.9	15.3	17.8	18.4	308.6
4) A Norm	21.5	19.4	21.5	89.1	92.1	47.5	18.4	18.4	17.8	21.5	20.8	21.5	409.5
5) Wet	24.6	22.2	24.6	89.1	92.1	89.1	18.4	18.4	17.8	21.5	23.8	24.6	466.0
Average	18.9	17.1	18.9	69.9	71.0	32.4	15.1	15.1	14.6	16.9	18.3	18.9	327.3

B. Additional Flow Requirements to Meet Water Quality Permit at Vernalis on the S. Joaquin R. (TB# 123)
source: USBR Planning Unit — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.0	0.0	0.0	6.0	1.0	39.0	30.0	20.0	0.0	4.0	0.0	0.0	100.0
2) Dry	0.0	1.0	1.0	6.0	0.0	34.0	38.0	28.0	0.0	2.0	0.0	0.0	110.0
3) B Norm	0.0	0.0	0.0	3.0	0.0	28.0	41.0	38.0	1.0	1.0	0.0	0.0	112.0
4) A Norm	0.0	0.0	0.0	0.0	0.0	0.0	22.0	24.0	0.0	0.0	0.0	0.0	46.0
5) Wet	0.0	0.0	0.0	0.0	0.0	0.0	8.0	19.0	0.0	1.0	0.0	0.0	28.0
Average	0.0	0.2	0.2	3.3	0.3	21.5	28.1	25.2	0.2	1.8	0.0	0.0	80.7

C. Combined Flow Requirements for Fish and Water Quality
source: calculated = Step 1A. + Step 1B. — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	15.3	13.9	15.3	59.8	54.8	50.9	42.3	32.3	11.9	16.3	14.9	15.3	342.8
2) Dry	16.9	16.2	17.9	59.8	53.8	45.9	50.3	40.3	11.9	17.3	16.3	16.9	363.4
3) B Norm	18.4	16.6	18.4	74.6	71.6	42.9	56.3	53.3	15.9	16.3	17.8	18.4	420.6
4) A Norm	21.5	19.4	21.5	89.1	92.1	47.5	40.4	42.4	17.8	21.5	20.8	21.5	455.5
5) Wet	24.6	22.2	24.6	89.1	92.1	89.1	26.4	37.4	17.8	22.5	23.8	24.6	494.0
Average	18.9	17.3	19.2	73.2	71.3	53.9	43.2	40.3	14.8	18.6	18.3	18.9	408.0

Step 2. Reference Condition

A. Stanislaus River Flow (1922-1990) at Goodwin Dam
source: CVGSM — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	12.3	14.2	36.3	62.0	75.4	76.7	63.8	51.4	33.6	10.6	10.3	15.6	462.3
2) Dry	26.0	34.9	52.3	119.8	158.9	115.9	83.9	68.4	38.1	14.8	10.0	41.0	763.9
3) B Norm	47.5	51.1	67.5	154.4	233.9	150.2	80.4	70.3	45.0	17.7	28.3	57.1	1003.4
4) A Norm	55.8	77.0	146.1	188.1	267.8	162.9	93.3	72.3	38.3	23.8	11.6	29.4	1166.4
5) Wet	103.7	100.4	132.9	191.7	301.3	239.9	124.3	105.1	75.5	41.8	28.9	49.8	1495.2
Average	44.7	51.7	83.8	136.5	195.4	141.1	86.6	71.0	44.0	20.4	16.3	35.8	927.5

B. Stanislaus Diversions (1980-1989) Primarily Taken Out at Oakdale and South San Joaquin

source: CVGSM — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	5.0	7.6	20.0	52.7	59.0	57.8	58.8	50.8	31.7	10.7	1.6	1.6	357.3
2) Dry	7.8	5.1	16.2	56.5	75.0	71.3	67.0	56.9	31.7	16.7	1.8	0.9	406.9
3) B Norm	2.9	7.9	16.3	46.4	69.5	74.5	72.8	65.6	43.5	14.2	2.0	0.7	416.5
4) A Norm	1.4	6.6	16.1	45.4	75.7	77.9	75.9	65.8	44.4	17.0	3.5	1.0	430.6
5) Wet	3.4	2.6	11.9	41.1	74.0	81.9	84.5	83.0	56.4	13.7	2.4	2.9	457.8
Average	4.2	6.1	16.5	49.0	69.9	71.4	70.5	62.8	40.3	14.3	2.2	1.4	408.7

C. Reference Condition for Reach Below Oakdale and South San Joaquin Diversions

source: calculated = Step 2A. - Step 2B. — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	7.4	6.6	16.4	9.3	16.4	18.9	5.0	0.6	1.8	-0.1	8.6	14.1	104.9
2) Dry	18.2	29.8	36.0	63.2	83.9	44.6	16.9	11.5	6.5	-1.9	8.2	40.1	357.0
3) B Norm	44.6	43.2	51.2	107.9	164.4	75.7	7.6	4.6	1.5	3.5	26.3	56.4	586.9
4) A Norm	54.4	70.4	130.1	142.7	192.1	85.0	17.4	6.5	-6.0	6.8	8.1	28.4	735.9
5) Wet	100.3	97.8	121.0	150.6	227.3	158.0	39.8	22.1	19.1	28.1	26.5	46.9	1037.4
Average	40.5	45.6	67.3	87.5	125.5	69.7	16.1	8.2	3.7	6.1	14.1	34.4	518.7

Step 3. Quantified Targeted Benefit Change

A. Quantified Targeted Benefit Change

source: calculated = Step 1C. - Step 2C. — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	8.0	7.3	0.0	50.4	38.3	32.0	37.3	31.6	10.1	16.3	6.2	1.3	238.9
2) Dry	0.0	0.0	0.0	0.0	0.0	1.3	33.4	28.8	5.4	19.3	8.1	0.0	96.3
3) B Norm	0.0	0.0	0.0	0.0	0.0	0.0	48.7	48.7	14.4	12.8	0.0	0.0	124.6
4) A Norm	0.0	0.0	0.0	0.0	0.0	0.0	23.0	35.9	23.9	14.7	12.7	0.0	110.1
5) Wet	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0	0.0	15.4
Average	2.1	1.9	0.0	13.2	10.0	8.6	29.3	32.1	11.2	13.4	6.0	0.3	128.1

Step 4. Streamflow Data Conversion

A. Total Diversions Sub-Region 11

source: CVGSM

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	8.9	12.1	39.3	85.6	91.8	95.0	98.2	84.0	48.1	23.5	7.1	6.7	600.3
2) Dry	10.2	8.4	32.7	96.5	122.9	116.9	109.7	95.0	55.6	32.6	6.6	4.8	691.9
3) B Norm	6.2	10.1	33.6	81.6	119.4	127.1	120.8	107.3	72.5	19.8	5.0	2.7	706.1
4) A Norm	2.2	11.5	31.6	79.8	127.7	131.6	123.3	107.4	73.5	44.1	13.8	6.6	753.3
5) Wet	4.7	3.2	18.8	70.9	121.2	137.2	139.4	126.7	91.4	28.1	13.2	11.0	766.0
Average	6.6	9.5	32.1	83.6	115.0	119.2	116.2	101.8	65.9	30.0	9.1	6.3	695.4

B. Stanislaus:Sub-Region 11 Streamflow Diversion Ratio

source: calculated = Step 2B./Step 4A

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1) Critical	0.56	0.63	0.51	0.62	0.64	0.61	0.6	0.61	0.66	0.46	0.23	0.23
2) Dry	0.76	0.60	0.50	0.59	0.61	0.61	0.61	0.60	0.57	0.51	0.27	0.19
3) B Norm	0.47	0.78	0.49	0.57	0.58	0.59	0.60	0.61	0.60	0.72	0.39	0.27
4) A Norm	0.61	0.57	0.51	0.57	0.59	0.59	0.62	0.61	0.60	0.39	0.25	0.16
5) Wet	0.72	0.81	0.63	0.58	0.61	0.60	0.61	0.66	0.62	0.49	0.18	0.26
Average	0.62	0.66	0.52	0.59	0.61	0.60	0.61	0.61	0.61	0.50	0.26	0.22

Step 5. Water Flow Path Elements

A. Farm Rain Sub-Region 11 * Step 4B. (inflow) — Flow Path Not Affected
source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	15.6	12.9	8.3	7.2	4.2	1.4	0.0	0.5	1.7	2.9	3.4	4.9	63.1
2) Dry	19.2	15.4	14.8	6.8	4.5	0.5	0.1	0.2	2.6	5.9	4.9	4.2	79.1
3) B Norm	16.8	28.7	12.8	11.1	3.9	0.5	0.0	0.2	0.4	5.8	12.0	9.0	101.1
4) A Norm	21.9	21.0	18.3	11.2	1.6	0.6	0.6	0.9	1.2	5.3	6.7	6.8	96.1
5) Wet	39.4	36.8	29.2	20.3	3.2	0.7	0.8	0.2	4.5	6.6	5.3	12.9	160.0
Average	21.7	21.5	15.9	10.7	3.5	0.8	0.3	0.4	2.0	5.1	6.1	7.1	95.0

B. Ground Water Diversions Sub-Region 11 * Step 4B. (inflow)
source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.6	0.6	7.7	5.9	6.5	8.3	8.3	3.2	0.0	2.9	0.4	0.3	44.8
2) Dry	0.7	0.3	2.3	3.0	3.9	8.2	8.2	3.1	0.0	2.7	0.4	0.4	33.1
3) B Norm	0.5	0.4	1.7	2.7	3.6	7.8	8.3	3.1	0.0	3.7	0.5	0.5	32.7
4) A Norm	0.5	0.3	1.2	2.6	3.6	7.7	8.3	3.0	0.0	2.0	0.4	0.2	29.9
5) Wet	0.4	0.6	1.5	2.6	3.7	7.8	7.8	3.2	0.0	2.3	0.3	0.3	30.6
Average	0.6	0.5	3.3	3.6	4.4	8.0	8.2	3.1	0.0	2.7	0.4	0.3	35.0

C. ETAW Sub-Region 11 * Step 4B. (outflow) — Flow Path Not Affected
source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.3	0.9	9.5	25.6	48.3	59.8	65.2	56.8	41.9	13.5	1.6	0.6	323.9
2) Dry	0.6	0.8	4.7	24.1	46.1	61.8	68.9	57.9	35.6	14.0	2.0	0.0	316.5
3) B Norm	0.1	0.6	5.9	20.0	44.5	59.5	68.0	59.1	39.0	20.3	2.1	0.3	319.4
4) A Norm	0.3	0.5	4.5	20.0	47.5	60.4	69.0	58.6	38.5	9.8	0.8	0.1	310.0
5) Wet	0.0	0.5	5.4	14.3	47.5	60.4	67.7	63.2	36.8	12.4	0.4	0.0	308.6
Average	0.3	0.7	6.2	21.4	47.0	60.4	67.6	58.8	38.6	13.7	1.4	0.2	316.2

D. Farm Surface Water Return Sub-Region 11 * Step 4B. (outflow, recoverable)
source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.0	0.0	3.5	9.1	11.1	12.3	12.4	10.8	8.3	2.8	0.6	0.4	71.2
2) Dry	0.0	0.0	2.6	9.2	11.4	13.7	14.3	12.1	8.2	3.2	0.8	0.3	75.8
3) B Norm	0.0	0.0	2.6	9.2	11.3	13.2	14.6	12.8	8.7	4.3	1.0	0.4	78.0
4) A Norm	0.0	0.0	2.5	9.2	11.5	13.4	14.9	12.8	8.8	2.4	0.8	0.3	76.4
5) Wet	0.0	0.0	3.1	9.3	11.8	13.5	14.7	13.7	9.0	2.9	0.5	0.4	78.8
Average	0.0	0.0	2.9	9.2	11.4	13.1	14.0	12.3	8.5	3.0	0.7	0.4	75.5

E. Farm Runoff from Rain Sub-Region 11 * Step 4B. (outflow, irrecoverable) — Flow Path Not Affected
source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
2) Dry	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.7
3) B Norm	0.6	0.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	1.7
4) A Norm	0.5	0.5	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.6
5) Wet	1.6	1.7	1.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	5.6
Average	0.5	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	1.7

F. Farm Ground Water Flow Sub-Region 11 * Step 4B. (outflow, recoverable)

source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	10.5	6.2	12.5	27.6	15.2	9.2	5.5	4.8	4.5	1.7	2.3	4.5	104.4
2) Dry	12.8	8.1	13.7	29.3	19.5	15.9	13.0	12.4	10.8	3.7	3.8	4.3	147.3
3) B Norm	12.1	20.1	12.3	34.8	20.0	17.4	15.1	14.9	10.9	3.0	9.5	8.9	179.0
4) A Norm	16.1	13.8	17.0	35.1	18.5	17.7	16.3	15.6	11.9	3.6	6.3	6.9	178.7
5) Wet	31.4	26.5	27.0	43.9	20.5	17.9	16.0	16.0	15.0	4.4	4.8	12.9	236.4
Average	15.8	13.7	16.0	33.3	18.4	15.1	12.6	12.1	10.1	3.2	5.0	7.0	162.2

G. Surface Water Diversions Sub-Region 11 * Step 4B. (inflow)

source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	1.2	1.4	16.1	55.3	68.2	72.8	74.7	68.6	51.1	14.8	3.1	2.4	429.7
2) Dry	1.7	1.6	14.8	59.2	73.0	83.2	88.2	79.5	51.2	17.1	4.0	2.1	475.7
3) B Norm	1.0	2.1	15.8	59.7	72.1	82.5	89.7	83.9	56.0	23.4	5.4	2.9	494.6
4) A Norm	1.4	1.5	16.0	60.0	73.9	83.9	92.2	84.1	56.4	13.0	3.9	1.9	488.2
5) Wet	1.9	2.0	19.8	61.0	76.1	84.5	91.0	89.5	57.5	16.4	2.6	3.2	505.6
Average	1.4	1.7	16.4	58.7	72.3	80.7	86.2	79.9	54.1	16.5	3.7	2.4	474.2

H. District Surface and Ground Water Return Flows * Step 4B. (outflow)

source: CVGSM — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.8	0.9	3.9	14.9	18.0	19.3	19.6	18.7	13.2	3.4	1.5	1.2	115.4
2) Dry	1.2	2.1	4.1	17.2	19.2	22.2	23.6	22.5	13.7	4.0	2.1	0.8	132.7
3) B Norm	0.7	2.4	5.8	16.9	20.0	22.5	23.5	23.8	15.4	5.5	2.9	1.3	140.6
4) A Norm	1.2	1.6	5.9	17.7	20.7	23.2	24.4	23.6	15.9	3.1	2.0	1.0	140.2
5) Wet	2.2	1.8	7.1	18.3	21.7	23.4	25.3	25.2	16.1	3.9	1.3	1.9	148.2
Average	1.2	1.7	5.2	16.9	19.7	21.9	23.0	22.4	14.7	3.9	1.9	1.2	133.6

I. District Evaporation Flows * Step 4B. (outflow)

source: CVGSM — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.2	0.2	0.8	3.1	3.8	4.1	4.1	4.0	2.8	0.7	0.3	0.2	24.3
2) Dry	0.2	0.4	0.9	3.6	4.0	4.6	5.0	4.7	2.9	0.8	0.4	0.2	27.7
3) B Norm	0.1	0.5	1.2	3.5	4.2	4.7	4.9	5.0	3.2	1.2	0.6	0.3	29.3
4) A Norm	0.2	0.3	1.2	3.7	4.3	4.8	5.1	4.9	3.3	0.7	0.4	0.2	29.2
5) Wet	0.4	0.4	1.5	3.8	4.5	4.9	5.3	5.3	3.4	0.8	0.3	0.4	30.8
Average	0.2	0.3	1.1	3.5	4.1	4.6	4.8	4.7	3.1	0.8	0.4	0.2	27.9

Step 6. Idealized Agricultural Potential (Farm and District)

A. Idealized Agricultural Potential (Farm)

source: calculated = Step 5D. + Step 5F. — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	10.5	6.2	16.0	36.7	26.3	21.5	18.0	15.5	12.8	4.5	2.8	4.9	175.6
2) Dry	12.8	8.1	16.3	38.5	30.9	29.6	27.3	24.6	18.9	6.9	4.6	4.6	223.1
3) B Norm	12.1	20.1	14.9	44.0	31.3	30.6	29.7	27.7	19.6	7.4	10.5	9.3	257.0
4) A Norm	16.1	13.8	19.5	44.2	30.0	31.0	31.1	28.5	20.7	6.0	7.0	7.1	255.0
5) Wet	31.4	26.5	30.1	53.2	32.3	31.4	30.6	29.8	24.0	7.2	5.3	13.4	315.1
Average	15.8	13.7	18.9	42.5	29.8	28.2	26.6	24.4	18.6	6.2	5.7	7.4	237.7

B. Idealized Agricultural Potential (District)

source: calculated = Step 5H. + Step 5I. Thoudand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.9	1.1	4.8	18.0	21.7	23.4	23.7	22.7	16.0	4.1	1.8	1.4	139.7
2) Dry	1.5	2.5	4.9	20.7	23.2	26.9	28.6	27.2	16.6	4.9	2.5	0.9	160.5
3) B Norm	0.9	2.8	7.0	20.4	24.1	27.1	28.4	28.8	18.6	6.6	3.4	1.5	169.8
4) A Norm	1.5	2.0	7.2	21.4	25.0	28.0	29.5	28.5	19.2	3.7	2.4	1.1	169.4
5) Wet	2.6	2.1	8.6	22.1	26.2	28.3	30.6	30.5	19.4	4.7	1.5	2.3	179.0
Average	1.4	2.0	6.3	20.3	23.8	26.5	27.8	27.1	17.8	4.7	2.3	1.4	161.4

Step 7. Farm Quantifiable Objective Component

A. EXISTING Farm Efficiency = ETAW/(ETAW + Idealized Agricultural Potential)

source: calculated = Step 5C./(Step 5C. + Step 6A.) Irrigation Season

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1) Critical	---	---	0.37	0.41	0.65	0.74	0.8	0.79	0.77	0.75	---	---	0.68
2) Dry	---	---	0.22	0.38	0.60	0.68	0.72	0.70	0.65	0.67	---	---	0.62
3) B Norm	---	---	0.28	0.31	0.59	0.66	0.70	0.68	0.67	0.73	---	---	0.61
4) A Norm	---	---	0.19	0.31	0.61	0.66	0.69	0.67	0.65	0.62	---	---	0.59
5) Wet	---	---	0.15	0.21	0.60	0.66	0.69	0.68	0.61	0.63	---	---	0.56
Average	---	---	0.25	0.33	0.61	0.68	0.72	0.71	0.67	0.69	---	---	0.62

HIGH and VERY HIGH efficiency levels are based on shifting the irrigation systems in the most cost effec manner for the various crop categories. The reference used to develop irrigation system efficiencies was the Performance Cost Study prepared for the PEIS of the CVPIA in 1994.

B. HIGH Farm Efficiency at 75% Overall Efficiency

source: calculated to give overall efficiency using a max efficiency of 85% Irrigation Season

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Average
1) Critical	---	---	0.50	0.55	0.79	0.85	0.85	0.85	0.85	0.85	---	---	0.79
2) Dry	---	---	0.30	0.51	0.73	0.82	0.85	0.85	0.79	0.81	---	---	0.76
3) B Norm	---	---	0.38	0.42	0.71	0.80	0.85	0.83	0.81	0.85	---	---	0.75
4) A Norm	---	---	0.25	0.42	0.75	0.80	0.84	0.82	0.79	0.75	---	---	0.73
5) Wet	---	---	0.20	0.28	0.72	0.80	0.84	0.83	0.74	0.77	---	---	0.70
Average	---	---	0.34	0.45	0.74	0.82	0.85	0.84	0.80	0.81	---	---	0.75

C. HIGH Available Agricultural Potential after improving from existing Eff to 75% Eff

If Rain > Diversion then monthly value of available water is set to 0 (this assumes irrigation is negligible)

source: calculated = Step 5C./Step 7A. - Step 5C./Step 7B. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	6.4	15.7	13.3	10.9	6.5	5.5	5.4	2.1	---	---	65.9
2) Dry	---	---	5.3	15.8	13.7	16.3	15.2	14.3	9.7	3.7	---	---	94.1
3) B Norm	---	---	5.3	16.2	13.5	16.1	17.4	15.5	10.4	3.8	---	---	98.1
4) A Norm	---	---	0.0	16.2	13.8	16.3	17.8	15.5	10.6	2.8	---	---	93.1
5) Wet	---	---	0.0	17.1	14.2	16.4	17.5	16.6	10.8	3.5	---	---	96.1
Average	---	---	3.6	16.2	13.7	14.9	14.2	12.8	9.1	3.1	---	---	87.5

D. HIGH Additional Potential from Reoperation of Reservoir @ 75% Efficiency

source: calculated based on Step 3A., Step 7C. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	0.0
2) Dry	---	---	0.0	0.0	0.0	7.5	0.0	0.0	4.3	0.0	---	---	11.8
3) B Norm	---	---	0.0	0.0	0.0	8.0	0.0	0.0	0.0	0.0	---	---	8.0
4) A Norm	---	---	0.0	0.0	0.0	8.1	0.0	0.0	0.0	0.0	---	---	8.1
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	0.0
Average	---	---	0.0	0.0	0.0	4.6	0.0	0.0	0.9	0.0	---	---	5.4

E. VERY HIGH Farm Efficiency at 87% Overall Efficiency

source: calculated to give overall efficiency using a max efficiency of 92%

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Irrigation Season
1) Critical	---	---	0.70	0.78	0.92	0.92	0.9	0.92	0.92	0.92	---	---	0.90
2) Dry	---	---	0.42	0.73	0.92	0.92	0.92	0.92	0.92	0.92	---	---	0.89
3) B Norm	---	---	0.54	0.59	0.92	0.92	0.92	0.92	0.92	0.92	---	---	0.88
4) A Norm	---	---	0.36	0.59	0.92	0.92	0.92	0.92	0.92	0.92	---	---	0.87
5) Wet	---	---	0.29	0.40	0.92	0.92	0.92	0.92	0.92	0.92	---	---	0.84
Average	---	---	0.48	0.64	0.92	0.92	0.92	0.92	0.92	0.92	---	---	0.87

F. VERY HIGH Available Agricultural Potential after improving from existing Eff to 87% Eff

If Rain > Diversion then monthly value of available water is set to 0 (this assumes irrigation is negligible)

source: calculated = Step 5C./Step 7A. - Step 5C./Step 7E. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	12.0	29.3	22.1	16.3	12.3	10.6	9.2	3.3	---	---	115.1
2) Dry	---	---	9.9	29.5	26.9	24.2	21.4	19.5	15.9	5.7	---	---	152.9
3) B Norm	---	---	9.8	30.2	27.4	25.4	23.8	22.6	16.2	5.6	---	---	160.9
4) A Norm	---	---	0.0	30.3	25.9	25.8	25.2	23.4	17.3	5.1	---	---	152.9
5) Wet	---	---	0.0	31.9	28.2	26.1	24.7	24.3	20.8	6.2	---	---	162.1
Average	---	---	6.7	30.1	25.7	23.0	20.7	19.3	15.3	5.0	---	---	145.8

G. VERY HIGH Additional Potential from Reoperation of Reservoir @ 87% Efficiency

source: calculated based on Step 3A., Step 7F. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	0.0
2) Dry	---	---	0.0	0.0	0.0	11.5	0.0	0.0	10.4	0.0	---	---	21.9
3) B Norm	---	---	0.0	0.0	0.0	12.7	0.0	0.0	1.9	0.0	---	---	14.6
4) A Norm	---	---	0.0	0.0	0.0	12.9	2.2	0.0	0.0	0.0	---	---	15.1
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	0.0
Average	---	---	0.0	0.0	0.0	7.2	0.5	0.0	2.4	0.0	---	---	10.0

Step 8. District Quantifiable Objective Component

A. EXISTING District Loss Fraction

source: calculated = (Step 5H. + Step 5I.)/Step 2B.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Irrigation Season
1) Critical	---	---	0.24	0.34	0.37	0.40	0.4	0.45	0.50	0.38	---	---	0.39
2) Dry	---	---	0.30	0.37	0.31	0.38	0.43	0.48	0.53	0.29	---	---	0.39
3) B Norm	---	---	0.43	0.44	0.35	0.36	0.39	0.44	0.43	0.47	---	---	0.41
4) A Norm	---	---	0.45	0.47	0.33	0.36	0.39	0.43	0.43	0.22	---	---	0.39
5) Wet	---	---	0.73	0.54	0.35	0.35	0.36	0.37	0.34	0.35	---	---	0.39
Average	---	---	0.41	0.42	0.34	0.37	0.40	0.44	0.46	0.34	---	---	0.39

HIGH and VERY HIGH Disrtict efficiencies were developed based on existing district improvement proje
Projects include the Imperial Irrigation District - Metroploitan Water District and a similar, ongoing projec
designed to improve river flows in the Columbia River Basin.

B. HIGH Available Agricultural Potential @ 18% Loss (Allows10% Seep+Evap & 8% Leak+Spill Losses)

source: calculated = Step 2B * Step 8A. - Step 2B.*0.18 (HIGH Dist.) Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	1.2	8.5	11.1	13.0	13.2	13.6	10.3	2.2	---	---	73.0
2) Dry	---	---	2.0	10.6	9.7	14.0	16.5	16.9	10.9	1.8	---	---	82.5
3) B Norm	---	---	4.1	12.0	11.6	13.7	15.3	17.0	10.8	4.1	---	---	88.6
4) A Norm	---	---	4.3	13.2	11.3	14.0	15.8	16.7	11.2	0.7	---	---	87.2
5) Wet	---	---	6.5	14.7	12.9	13.6	15.4	15.5	9.3	2.3	---	---	90.1
Average	---	---	3.3	11.5	11.3	13.6	15.1	15.8	10.5	2.1	---	---	83.2

C. HIGH District Quantified Objective @ 18% Loss

source: calculated = minimum(Step 3A., Step 8A.) Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.0	8.5	11.1	13.0	13.2	13.6	10.1	2.2	---	---	71.6
2) Dry	---	---	0.0	0.0	0.0	1.3	16.5	16.9	5.4	1.8	---	---	42.0
3) B Norm	---	---	0.0	0.0	0.0	0.0	15.3	17.0	10.8	4.1	---	---	47.1
4) A Norm	---	---	0.0	0.0	0.0	0.0	15.8	16.7	11.2	0.7	---	---	44.4
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	---	---	15.4
Average	---	---	0.0	2.2	2.9	3.6	12.6	15.8	7.9	1.7	---	---	46.8

C. HIGH Additional Potential from Reservoir Repoeration Quantified Objective @ 18% Loss

source: calculated based on Step 3A., Step 8B. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	---	---	0.2
2) Dry	---	---	0.0	0.0	0.0	6.4	0.0	0.0	5.5	0.0	---	---	11.9
3) B Norm	---	---	0.0	0.0	0.0	6.9	0.0	0.0	0.0	0.0	---	---	6.9
4) A Norm	---	---	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	---	---	7.0
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	0.0
Average	---	---	0.0	0.0	0.0	3.9	0.0	0.0	1.2	0.0	---	---	5.1

D. VERY HIGH Available Agricultural Potential @ 8% Loss (Allows 4% Seep+Evap & 4% Leak+Spill Loss

source: calculated = Step 2B. * Step 8A. - Step 2B.*0.08 (VERY HIGH Dist.)Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	3.2	13.8	17.0	18.7	19.0	18.6	13.5	3.2	---	---	107.1
2) Dry	---	---	3.6	16.2	17.2	21.2	23.2	22.6	14.1	3.5	---	---	121.7
3) B Norm	---	---	5.7	16.7	18.6	21.2	22.5	23.6	15.1	5.5	---	---	128.9
4) A Norm	---	---	5.9	17.8	18.9	21.8	23.4	23.3	15.6	2.4	---	---	129.0
5) Wet	---	---	7.7	18.8	20.3	21.8	23.8	23.8	14.9	3.6	---	---	134.7
Average	---	---	5.0	16.4	18.2	20.8	22.1	22.1	14.6	3.5	---	---	122.7

E. VERY HIGH Additional Potential from Reservoir Repoeration Quantified Objective @ 8% Loss

source: calculated based on Step 3A., Step 8D. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.0	0.0	0.0	0.0	0.0	0.0	3.4	0.0	---	---	3.4
2) Dry	---	---	0.0	0.0	0.0	9.9	0.0	0.0	8.7	0.0	---	---	18.6
3) B Norm	---	---	0.0	0.0	0.0	10.6	0.0	0.0	0.0	0.0	---	---	10.6
4) A Norm	---	---	0.0	0.0	0.0	10.9	0.4	0.0	0.0	0.0	---	---	11.3
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	---	---	0.0
Average	---	---	0.0	0.0	0.0	6.1	0.1	0.0	2.7	0.0	---	---	8.8

Step 9. Combined Farm + District Quantifiable Objective

A. Improvement Level 1; EXISTING Farm + HIGH District

source: calculated = minimum(Step 3A, Step 8B.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Total
1) Critical	---	---	0.0	8.5	11.1	13.0	13.2	13.6	10.1	2.2	---	---	71.6
2) Dry	---	---	0.0	0.0	0.0	1.3	16.5	16.9	5.4	1.8	---	---	42.0
3) B Norm	---	---	0.0	0.0	0.0	0.0	15.3	17.0	10.8	4.1	---	---	47.1
4) A Norm	---	---	0.0	0.0	0.0	0.0	15.8	16.7	11.2	0.7	---	---	44.4
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	---	---	15.4
Average	---	---	0.0	2.2	2.9	3.6	12.6	15.8	7.9	1.7	---	---	46.8

B. Improvement Level 2; HIGH Farm + HIGH District

source: calculated = minimum(Step 3A,Step 7C. + Step 8B.)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Season Total
1) Critical	---	---	0.0	24.3	24.4	23.9	19.6	19.1	10.1	4.3	---	---	125.6
2) Dry	---	---	0.0	0.0	0.0	1.3	31.7	28.8	5.4	5.6	---	---	72.8
3) B Norm	---	---	0.0	0.0	0.0	0.0	32.7	32.5	14.4	7.9	---	---	87.4
4) A Norm	---	---	0.0	0.0	0.0	0.0	23.0	32.2	21.7	3.5	---	---	80.4
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	---	---	15.4
Average	---	---	0.0	6.3	6.4	6.8	24.1	28.4	11.2	4.3	---	---	87.4

C. Impovement Level 3; HIGH Farm + VERY HIGH District

source: calculated = minimum(Step 3A, Step 7C. + Step 8D.) Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.0	29.5	30.3	29.7	25.5	24.2	10.1	5.3	---	---	154.6
2) Dry	---	---	0.0	0.0	0.0	1.3	33.4	28.8	5.4	7.2	---	---	76.1
3) B Norm	---	---	0.0	0.0	0.0	0.0	39.9	39.0	14.4	9.3	---	---	102.6
4) A Norm	---	---	0.0	0.0	0.0	0.0	23.0	35.9	23.9	5.2	---	---	87.9
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	---	---	15.4
Average	---	---	0.0	7.7	7.9	8.3	29.3	32.1	11.2	5.5	---	---	101.9

D. Improvement Level 4; VERY HIGH Farm + VERY HIGH District

source: calculated = minimum(Step 3A., Step 7C. + Step 8D.) Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.0	43.1	38.3	32.0	31.3	29.2	10.1	6.5	---	---	190.7
2) Dry	---	---	0.0	0.0	0.0	1.3	33.4	28.8	5.4	9.2	---	---	78.1
3) B Norm	---	---	0.0	0.0	0.0	0.0	46.3	46.1	14.4	11.1	---	---	117.9
4) A Norm	---	---	0.0	0.0	0.0	0.0	23.0	35.9	23.9	7.5	---	---	90.3
5) Wet	---	---	0.0	0.0	0.0	0.0	0.0	15.4	0.0	0.0	---	---	15.4
Average	---	---	0.0	11.3	10.0	8.6	29.3	32.1	11.2	7.0	---	---	109.4

E. Summary of Annual Capital and O&M Costs

	Capital Cost	Total Annualized
	1999 Costs (million $)	
Improvement Level 1; EXISTING Farm + HIGH District	41.32	6.85
Improvement Level 2; HIGH Farm + HIGH District	77.37	13.38
Impovement Level 3; HIGH Farm + VERY HIGH District	110.4	19.30
Improvement Level 4; VERY HIGH Farm + VERY HIGH D	144.6	24.85

F. Summary of Combined Farm + District Quantifiable Objective

Improvement Level 1; EXISTING Farm + HIGH District

Year Type	Quantified Targeted Benefit Change	Agricultural Potential	Quantifiable Objective	Quantified Targeted Benefit Change Met
	Thousand Acre Feet			
1) Critical	239	73	72	30%
2) Dry	96	83	42	44%
3) B Norm	125	89	47	38%
4) A Norm	110	87	44	40%
5) Wet	15	90	15	100%
Average	128	83	47	37%
$/Acre Foot per year		$82	$120	

Improvement Level 2; HIGH Farm + HIGH District

Year Type	Quantified Targeted Benefit Change	Agricultural Potential	Quantifiable Objective	Quantified Targeted Benefit Change Met
	Thousand Acre Feet			
1) Critical	239	139	126	53%
2) Dry	96	177	73	76%
3) B Norm	125	187	87	70%
4) A Norm	110	180	80	73%
5) Wet	15	186	15	100%
Average	128	171	87	68%
$/Acre Foot per year		$73	$126	

Impovement Level 3; HIGH Farm + VERY HIGH District

Year Type	Quantified Targeted Benefit Change	Agricultural Potential	Quantifiable Objective	Quantified Targeted Benefit Change Met
	Thousand Acre Feet			
1) Critical	239	173	155	65%
2) Dry	96	188	76	79%
3) B Norm	125	195	103	82%
4) A Norm	110	195	88	80%
5) Wet	15	201	15	100%
Average	128	189	102	80%
$/Acre Foot per year		$87	$147	

Improvement Level 4; VERY HIGH Farm + VERY HIGH District

Year Type	Quantified Targeted Benefit Change	Agricultural Potential	Quantifiable Objective	Quantified Targeted Benefit Change Met
	Thousand Acre Feet			
1) Critical	239	222	191	80%
2) Dry	96	275	78	81%
3) B Norm	125	290	118	95%
4) A Norm	110	282	90	82%
5) Wet	15	297	15	100%
Average	128	268	109	85%
$/Acre Foot per year		$89	$157	

Detail 121, Water Quality Stanislaus River

Step 1. Quantified Targets

A. Constituent: Diazinon (insecticide)
Natural source: No
Application period: dormant orchards and growing season on other crops
Durability: 39 day half life. Microbiological (aerobic and anaerobic) degradation in the soil is a function of pesticide, soil, soil temperature, soil water content and the micro-organisms present (CIBA-GEIGY Corporation, 1989).
Application method: dormant and foliar spray
Transport mechanisn soluble, Surface or Ground Water Return

Crops	Affected	Existing acres	Assumed Affected
Pasture	No	56,500	---
Vineyard	No	11,000	---
Alfalfa	Yes	9,700	4,850
Sugar Beet	No	500	---
Field	No	20,900	---
Rice	No	4,700	---
Truck	No	6,200	---
Tomato	No	800	---
Orchard	Yes	81,100	40,550
Grains	No	2,000	---
Cotton	Yes	---	---
Citrus/Olives	Yes	---	---
Total		193,400	45,400

The Assumed Affected acreage is 50% of the applicable crop. vategory. The 50% represents an estimate of the acreage that flows back to the Stanislaus River.

B. Regulatory limit: 0.04 ug L-1 (RWQCB, 1998) this is the Target concentration all times all year types

Step 2. Reference Condition

A. Maximum Diazinon Concentration on the Stanislaus at Ripon

source: USGS Circular 1159 (1998) ug L^{-1}

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1) Critical	0.072	0.087	---	---	---	---	---	---	---	---	---	---

note: Diazinon data from the Merced River indicates that the concentration decreases to less than the regulatory limit after a peak in Feburary.

Merced (1993)	0.077	2.500	0.026	0.011	0.004	0.004	0.008	0.002	0.002	0.002	0.002	0.006

Step 3. Quantified Targeted Benefit Change

A. Quantified Targeted Benefit Change

source: calculated = Step 2A. - Step 1B. ug L-1

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1) Critical	0.031	0.046	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Dry	No Reference Data available for these year types											
3) B Norm												
4) A Norm												
5) Wet												

note: based on the concentration trend in the Merced (Step 2A.) we assume that the Quantified Targeted Benefit Change is 0 from Mar-Dec

Step 4. Area Affecting Targeted Benefit

A. Stanislaus:SubRegion 11 Streamflow Diversion Ratio

source: calculated from CVGSM Stanislaus Diversions/Total Diversions Sub-Region 11

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1) Critical	0.56	0.63	0.51	0.62	0.64	0.61	0.60	0.61	0.66	0.46	0.23	0.23	0.60
2) Dry	0.76	0.60	0.50	0.59	0.61	0.61	0.61	0.60	0.57	0.51	0.27	0.19	0.59
3) B Norm	0.47	0.78	0.49	0.57	0.58	0.59	0.60	0.61	0.60	0.72	0.39	0.27	0.59
4) A Norm	0.61	0.57	0.51	0.57	0.59	0.59	0.62	0.61	0.60	0.39	0.25	0.16	0.57
5) Wet	0.72	0.81	0.63	0.58	0.61	0.60	0.61	0.66	0.62	0.49	0.18	0.26	0.60
Average	0.62	0.66	0.52	0.59	0.61	0.60	0.61	0.61	0.61	0.50	0.26	0.22	0.59

B. Ratio of Affected Crops to Total Crops

source: calculated = Total Assumed Affected Crops/Total Crops

= 0.23

Step 5. Water Flow Path Elements

A. Farm Rain Sub-Region 11 * Step 4A. * Step 4B. (inflow) — Flow Path Not Affected

source: CVGSM SubRegion 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	3.7	3.0	2.0	1.7	1.0	0.3	0.0	0.1	0.4	0.7	0.8	1.2	14.8
2) Dry	4.5	3.6	3.5	1.6	1.1	0.1	0.0	0.0	0.6	1.4	1.2	1.0	18.6
3) B Norm	3.9	6.7	3.0	2.6	0.9	0.1	0.0	0.0	0.1	1.4	2.8	2.1	23.7
4) A Norm	5.1	4.9	4.3	2.6	0.4	0.1	0.1	0.2	0.3	1.2	1.6	1.6	22.5
5) Wet	9.2	8.6	6.9	4.8	0.8	0.2	0.2	0.0	1.1	1.5	1.3	3.0	37.6
Average	5.1	5.0	3.7	2.5	0.8	0.2	0.1	0.1	0.5	1.2	1.4	1.7	22.3

B. Ground Water Diversions Sub-Region 11 * Step 4A. * Step 4B. (inflow) — Flow Path Not Affected

source: CVGSM SubRegion 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.1	0.1	1.8	1.4	1.5	2.0	2.0	0.7	0.0	0.7	0.1	0.1	10.5
2) Dry	0.2	0.1	0.5	0.7	0.9	1.9	1.9	0.7	0.0	0.6	0.1	0.1	7.8
3) B Norm	0.1	0.1	0.4	0.6	0.8	1.8	1.9	0.7	0.0	0.9	0.1	0.1	7.7
4) A Norm	0.1	0.1	0.3	0.6	0.8	1.8	2.0	0.7	0.0	0.5	0.1	0.1	7.0
5) Wet	0.1	0.1	0.4	0.6	0.9	1.8	1.8	0.8	0.0	0.5	0.1	0.1	7.2
Average	0.1	0.1	0.8	0.8	1.0	1.9	1.9	0.7	0.0	0.6	0.1	0.1	8.2

C. ETAW Sub-Region 11 * Step 4A. * Step 4B. (outflow) — Flow Path Not Affected

source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.1	0.2	2.2	6.0	11.3	14.0	15.3	13.3	9.8	3.2	0.4	0.1	76.0
2) Dry	0.1	0.2	1.1	5.6	10.8	14.5	16.2	13.6	8.4	3.3	0.5	0.0	74.3
3) B Norm	0.0	0.1	1.4	4.7	10.4	14.0	16.0	13.9	9.1	4.8	0.5	0.1	75.0
4) A Norm	0.1	0.1	1.1	4.7	11.1	14.2	16.2	13.7	9.0	2.3	0.2	0.0	72.8
5) Wet	0.0	0.1	1.3	3.4	11.2	14.2	15.9	14.8	8.6	2.9	0.1	0.0	72.4
Average	0.1	0.2	1.5	5.0	11.0	14.2	15.9	13.8	9.1	3.2	0.3	0.1	74.2

D. Farm Surface Water Return Sub-Region 11 * Step 4A. * Step 4B. (outflow, recoverable)

source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.0	0.0	0.8	2.1	2.6	2.9	2.9	2.5	1.9	0.7	0.1	0.1	16.7
2) Dry	0.0	0.0	0.6	2.2	2.7	3.2	3.4	2.8	1.9	0.8	0.2	0.1	17.8
3) B Norm	0.0	0.0	0.6	2.2	2.6	3.1	3.4	3.0	2.0	1.0	0.2	0.1	18.3
4) A Norm	0.0	0.0	0.6	2.2	2.7	3.1	3.5	3.0	2.1	0.6	0.2	0.1	17.9
5) Wet	0.0	0.0	0.7	2.2	2.8	3.2	3.4	3.2	2.1	0.7	0.1	0.1	18.5
Average	0.0	0.0	0.7	2.2	2.7	3.1	3.3	2.9	2.0	0.7	0.2	0.1	17.7

E. Farm Runoff from Rain Sub-Region 11 * Step 4A. * Step 4B. (outflow, irrecoverable)

source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
2) Dry	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3) B Norm	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.4
4) A Norm	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
5) Wet	0.4	0.4	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	1.3
Average	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4

F. Farm Ground Water Flow Sub-Region 11 * Step 4A. * Step 4B. (outflow, recoverable)

source: calculated — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	2.5	1.4	2.9	6.5	3.6	2.2	1.3	1.1	1.1	0.4	0.5	1.1	24.5
2) Dry	3.0	1.9	3.2	6.9	4.6	3.7	3.1	2.9	2.5	0.9	0.9	1.0	34.6
3) B Norm	2.8	4.7	2.9	8.2	4.7	4.1	3.5	3.5	2.6	0.7	2.2	2.1	42.0
4) A Norm	3.8	3.2	4.0	8.2	4.3	4.2	3.8	3.7	2.8	0.8	1.5	1.6	41.9
5) Wet	7.4	6.2	6.3	10.3	4.8	4.2	3.8	3.8	3.5	1.0	1.1	3.0	55.5
Average	3.7	3.2	3.8	7.8	4.3	3.5	3.0	2.8	2.4	0.7	1.2	1.6	38.1

G. Surface Water Diversions Sub-Region 11 * Step 4A. * Step 4B. (inflow) — Flow Path Not Affected

source: CVGSM SubRegion 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.3	0.3	3.8	13.0	16.0	17.1	17.5	16.1	12.0	3.5	0.7	0.6	100.9
2) Dry	0.4	0.4	3.5	13.9	17.1	19.5	20.7	18.7	12.0	4.0	0.9	0.5	111.7
3) B Norm	0.2	0.5	3.7	14.0	16.9	19.4	21.1	19.7	13.1	5.5	1.3	0.7	116.1
4) A Norm	0.3	0.4	3.8	14.1	17.3	19.7	21.6	19.7	13.2	3.1	0.9	0.5	114.6
5) Wet	0.4	0.5	4.7	14.3	17.9	19.8	21.4	21.0	13.5	3.8	0.6	0.7	118.7
Average	0.3	0.4	3.8	13.8	17.0	19.0	20.2	18.8	12.7	3.9	0.9	0.6	111.3

Step 6. Idealized Agricultural Potential (Farm)

A. Idealized Agricultural Potential (Farm)

source: calculated = Step 5D. + Step 5F. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	1.4	0.9	1.9	5.3	4.0	3.1	2.5	2.2	2.0	0.5	0.2	0.3	24.1
2) Dry	2.3	1.1	1.9	5.3	4.4	4.2	3.9	3.5	2.5	0.8	0.3	0.2	30.5
3) B Norm	1.3	3.7	1.7	5.9	4.3	4.2	4.2	4.0	2.8	1.2	1.0	0.6	34.8
4) A Norm	2.3	1.8	2.3	5.9	4.2	4.3	4.5	4.1	2.9	0.5	0.4	0.3	33.6
5) Wet	5.3	5.0	4.5	7.2	4.6	4.4	4.4	4.6	3.5	0.8	0.2	0.8	45.3
Average	2.3	2.1	2.3	5.8	4.3	4.0	3.8	3.5	2.7	0.7	0.3	0.4	32.3

B. Additional Agricultural Potential (rain runoff management)

source: calculated = Step 5E. Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2) Dry	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
3) B Norm	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3
4) A Norm	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
5) Wet	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Average	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3

Step 7. Farm Quantifiable Objective Component

The half-life of Diazinon is short enough that we assumed that it would not occur in the Ground Water Return flow path (except for fields directly linked to the Stanislaus). The only flow path of concern during Jan and Feb is Direct Runoff from Rain (Step 5E.). Eliminating this flow path during Jan-Feb should substantially reduce the Diazinon concentration in the Stanislaus River.

Possible actions that may achieve this Quantifiable Objective include tailwater retention ponds, furrow dikes, cover cropping and reduction in late season (Oct-Nov) irrigations.

Costs to be considered include cultural operations, risk associated with reducing late season irrigations and potential changes in district delivery policies.

Step 8. District Quantifiable Objective Component

There is no District Quantifiable Objective for this Targeted Benefit

Step 9. Combined Farm + District Quantifiable Objective

The combined Quantifiable Objective is the Farm Component (Step 7)

Detail 127, Decrease Nonproductive ET to Increase Water Supply for Beneficial Uses

Step 1. Quantified Targets

A. Acreage Assumed for Reduction of Nonproductive ET
source: CVGSM Sub-Region 11

Crop	Potential for ET Red	Existing (acres)	Assumed for ET Reduction* (acres)
Pasture	No	56,500	---
Vineyard	Yes	11,000	2,147
Alfalfa	No	9,700	---
Sugar Beet	No	500	---
Field	No	20,900	---
Rice	No	4,700	---
Truck	Yes	6,200	1,210
Tomato	Yes	800	156
Orchard	Yes	81,100	15,827
Grains	No	2,000	---
Cotton	No	---	---
Citrus/Olives	Yes	---	---
Total		193,400	19,340

*The Assumed Acreage is 10% of the Total Acreage in the SubRegion. The Assumed Acreage is then proportionally split among the crops that have potential for ET reduction.

B. Existing ET
source: CVGSM

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Inches Total
Vineyard	0.0	0.0	0.0	1.1	3.7	5.8	6.6	5.5	3.5	1.3	0.0	0.0	27.5
Truck	0.0	0.0	0.0	1.4	2.2	3.9	3.7	2.7	1.8	1.2	0.0	0.0	16.9
Tomato	0.0	0.0	0.0	1.1	2.6	6.0	8.1	7.2	4.6	2.0	0.0	0.0	31.5
Orchard	0.9	1.7	1.8	3.0	5.2	6.4	7.1	6.1	4.0	2.3	1.0	0.7	40.2
Citrus/Olive	0.0	0.0	1.9	2.7	4.2	4.8	5.0	4.2	2.8	2.0	0.0	0.0	27.6
Average	0.7	1.4	1.5	2.7	4.8	6.2	6.8	5.8	3.8	2.1	0.8	0.6	37.3

C. ET from Rain for SubRegion 11
source: CVGSM

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Inches Total
1) Critical	0.7	0.8	0.7	0.6	0.5	0.4	0.4	0.2	0.1	0.5	0.5	0.3	5.7
2) Dry	0.6	0.8	1.3	0.6	0.5	0.2	0.2	0.0	0.1	0.6	0.4	0.5	6.0
3) B Norm	0.7	0.9	1.1	1.0	0.5	0.2	0.2	0.0	0.0	0.5	0.6	0.4	6.1
4) A Norm	0.7	0.8	1.3	1.0	0.2	0.2	0.2	0.1	0.0	0.7	0.7	0.5	6.5
5) Wet	0.7	0.9	1.4	1.7	0.4	0.2	0.3	0.0	0.3	0.7	0.8	0.5	7.7
Average	0.7	0.8	1.1	0.9	0.4	0.3	0.3	0.1	0.1	0.6	0.6	0.4	6.3

D. Existing ETAW
source: calculated = Step 1B.(Average Total) - Step 1A,

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Inches Total
1) Critical	0.1	0.6	0.7	2.1	4.3	5.8	6.4	5.7	3.8	1.7	0.4	0.2	31.5
2) Dry	0.1	0.6	0.2	2.0	4.3	6.0	6.6	5.8	3.7	1.5	0.4	0.1	31.3
3) B Norm	0.1	0.5	0.3	1.7	4.4	6.0	6.6	5.8	3.8	1.6	0.3	0.1	31.2
4) A Norm	0.1	0.5	0.1	1.7	4.6	6.0	6.6	5.8	3.8	1.4	0.1	0.1	30.8
5) Wet	0.0	0.5	0.1	1.0	4.5	6.0	6.6	5.8	3.5	1.4	0.1	0.1	29.5
Average	0.1	0.6	0.3	1.7	4.4	5.9	6.6	5.8	3.7	1.5	0.2	0.1	30.9

E. Target ETAW

source: calculated = Step 1D. * 90% — Inches

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.1	0.5	0.7	1.8	3.9	5.2	5.8	5.1	3.4	1.5	0.3	0.2	28.4
2) Dry	0.1	0.5	0.1	1.8	3.9	5.4	6.0	5.2	3.3	1.4	0.3	0.1	28.1
3) B Norm	0.1	0.5	0.3	1.5	3.9	5.4	6.0	5.2	3.5	1.4	0.2	0.1	28.1
4) A Norm	0.1	0.5	0.1	1.5	4.1	5.4	5.9	5.2	3.4	1.3	0.1	0.1	27.7
5) Wet	0.0	0.5	0.1	0.9	4.0	5.4	5.9	5.2	3.2	1.3	0.1	0.1	26.6
Average	0.1	0.5	0.3	1.6	4.0	5.3	5.9	5.2	3.3	1.4	0.2	0.1	27.9

Step 2. Reference Condition

For ET Reduction the Reference Condition is the existing Crop ET, Step 1B.

Step 3. Quantified Targeted Benefit Change

A. Quantified Targeted Benefit Change

source: = Quantified Targeted Benefit — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	---	---	0.1	0.3	0.7	0.9	1.0	0.9	0.6	0.3	---	---	4.9
2) Dry	---	---	0.0	0.3	0.7	1.0	1.1	0.9	0.6	0.2	---	---	4.9
3) B Norm	---	---	0.1	0.3	0.7	1.0	1.1	0.9	0.6	0.3	---	---	4.9
4) A Norm	---	---	0.0	0.3	0.7	1.0	1.1	0.9	0.6	0.2	---	---	4.8
5) Wet	---	---	0.0	0.2	0.7	1.0	1.1	0.9	0.6	0.2	---	---	4.6
Average	---	---	0.1	0.3	0.7	1.0	1.1	0.9	0.6	0.2	---	---	4.8

Step 4. Streamflow Data Conversion

This section is not applicable to this Targeted Benefit

Step 5. Water Flow Path Elements

A. Farm Rain Sub-Region 11 (inflow) — Flow Path Not Affected

source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	28.1	20.4	16.4	11.7	6.5	2.2	0.0	0.9	2.5	6.4	14.5	21.2	131.0
2) Dry	25.2	25.6	29.8	11.6	7.4	0.8	0.1	0.3	4.6	11.4	18.3	22.4	157.6
3) B Norm	35.7	36.8	26.4	19.5	6.7	0.9	0.0	0.3	0.6	8.1	30.6	33.0	198.5
4) A Norm	35.9	36.6	36.1	19.8	2.7	1.1	1.0	1.4	1.9	13.6	26.6	43.6	220.4
5) Wet	54.8	45.6	46.3	35.0	5.3	1.2	1.3	0.3	7.3	13.5	29.7	49.2	289.5
Average	34.7	31.6	29.8	18.4	5.7	1.3	0.4	0.7	3.3	10.4	22.9	32.7	191.9

B. Surface Water Diversions Sub-Region 11 (inflow) — Flow Path Not Affected

source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	2.1	2.2	31.8	89.9	106.1	119.6	124.8	113.3	77.5	32.5	13.2	10.2	723.1
2) Dry	2.2	2.7	29.8	101.1	119.6	136.4	144.5	132.7	89.9	33.2	15.1	11.4	818.5
3) B Norm	2.2	2.7	32.6	104.8	124.0	140.8	148.8	137.1	93.3	32.6	13.8	10.8	843.5
4) A Norm	2.4	2.6	31.5	105.6	124.7	141.7	149.8	137.1	93.4	33.8	15.5	12.4	850.4
5) Wet	2.6	2.5	31.4	105.3	124.7	141.6	150.1	136.6	93.2	33.5	14.5	12.1	848.2
Average	2.3	2.5	31.4	100.4	118.7	134.7	142.1	129.9	88.5	33.1	14.4	11.3	809.3

C. Ground Water Diversions Sub-Region 11 (inflow) — Flow Path Not Affected
source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	1.1	1.0	15.2	9.7	10.1	13.7	13.9	5.3	0.0	6.3	1.5	1.5	79.2
2) Dry	1.0	0.5	4.6	5.0	6.4	13.4	13.4	5.1	0.0	5.3	1.4	2.0	58.2
3) B Norm	1.0	0.6	3.4	4.8	6.1	13.2	13.7	5.0	0.0	5.2	1.4	1.7	56.1
4) A Norm	0.9	0.6	2.4	4.6	6.1	13.0	13.6	4.9	0.0	5.1	1.4	1.5	54.0
5) Wet	0.6	0.7	2.4	4.6	6.0	13.0	12.9	4.9	0.0	4.8	1.5	1.2	52.6
Average	0.9	0.7	6.4	6.0	7.2	13.3	13.5	5.1	0.0	5.4	1.4	1.6	61.6

D. ETAW Sub-Region 11 (outflow)
source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.5	1.4	18.6	41.5	75.1	98.2	108.9	93.9	63.5	29.6	7.0	2.5	540.9
2) Dry	0.8	1.3	9.4	41.1	75.6	101.3	112.8	96.6	62.5	27.3	7.4	0.1	536.2
3) B Norm	0.3	0.7	12.2	35.2	76.5	101.5	112.8	96.6	64.9	28.3	5.4	1.0	535.4
4) A Norm	0.5	0.9	8.9	35.1	80.2	102.1	112.1	95.5	63.8	25.5	3.2	0.4	528.2
5) Wet	0.0	0.6	8.5	24.8	77.8	101.2	111.8	96.4	59.6	25.3	2.3	0.0	508.4
Average	0.5	1.0	12.0	36.4	77.0	100.7	111.5	95.6	63.0	27.4	5.3	0.9	531.1

E. Farm Surface Water Return Sub-Region 11 (outflow, recoverable) — Flow Path Not Affected
source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.0	0.0	7.0	14.8	17.3	20.1	20.8	17.8	12.5	6.1	2.4	1.6	120.4
2) Dry	0.0	0.0	5.2	15.7	18.6	22.4	23.5	20.3	14.4	6.2	2.9	1.6	130.8
3) B Norm	0.0	0.0	5.3	16.1	19.3	22.6	24.2	21.0	14.5	6.0	2.5	1.6	133.0
4) A Norm	0.0	0.0	4.8	16.1	19.3	22.6	24.2	21.0	14.5	6.3	3.0	1.6	133.4
5) Wet	0.0	0.0	4.8	16.1	19.3	22.6	24.2	21.0	14.5	5.9	2.6	1.6	132.6
Average	0.0	0.0	5.5	15.7	18.7	21.9	23.1	20.0	14.0	6.1	2.7	1.6	129.3

F. Farm Runoff from Rain Sub-Region 11 (outflow, irrecoverable) — Flow Path Not Affected
source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.5
2) Dry	0.3	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	1.3
3) B Norm	1.2	0.7	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.6	3.5
4) A Norm	0.8	0.9	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	1.1	3.9
5) Wet	2.2	2.1	2.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.8	9.4
Average	0.8	0.8	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.7	3.3

G. Farm Ground Water Flow Sub-Region 11 (outflow, recoverable) — Flow Path Not Affected
source: CVGSM Sub-Region 11 — Thousand Acre Feet

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1) Critical	18.8	9.8	24.5	44.9	23.6	15.1	9.2	7.9	6.9	3.8	9.8	19.3	193.6
2) Dry	16.8	13.5	27.6	50.1	32.0	26.0	21.3	20.7	18.9	7.3	14.2	22.8	271.1
3) B Norm	25.6	25.8	25.3	61.1	34.4	29.6	25.1	24.3	18.2	4.2	24.3	32.7	330.7
4) A Norm	26.4	24.1	33.5	61.7	31.3	29.9	26.4	25.5	19.8	9.2	24.9	43.7	356.4
5) Wet	43.7	32.8	42.8	75.7	33.6	30.0	26.4	24.5	24.3	8.9	26.8	49.4	418.9
Average	25.1	19.9	30.2	57.1	30.3	25.2	20.7	19.6	16.7	6.6	19.0	32.3	302.5

Step 6. Idealized Agricultural Potential (Farm)

Additional ET research is required to determine this component.

Step 7. Farm Quantifiable Objective Component

For ET Reduction the Farm Component is the same as the Quantified Targeted Benefit Change (Step 3A

Step 8. District Quantifiable Objective Component

There is no District Quantifiable Objective Component for this Targeted Benefit

Step 9. Farm Quantifiable Objective

For ET Reduction the Farm Quantifiable Objective is the same as Quantified Targeted Benefit Change (Step 3A).

A. ET Reduction Cost Summary

System	Capital	Annualized Capital	O&M	Total Annualized
	1999 Costs (million $)			
On-Farm Irrigation Systems	15.91	2.37	0.23	2.59
Drip Irigation Water Management Support	0.00	0.00	0.97	0.97
Total	15.91	2.37	1.20	3.56

Total Annualized per Acre Foot per year (based on 4.8 TAF) $742

IV. Complete List of Targeted Benefits

The following tables (and associated map/dividers) provide a complete listing of all 199 Targeted Benefits categorized by Sub-Region. For a description of the columns of these tables, please refer to Section III, Explanation and Examples of Quantifiable Objectives, Table 11.1.

Sub-Region 1, Redding Basin

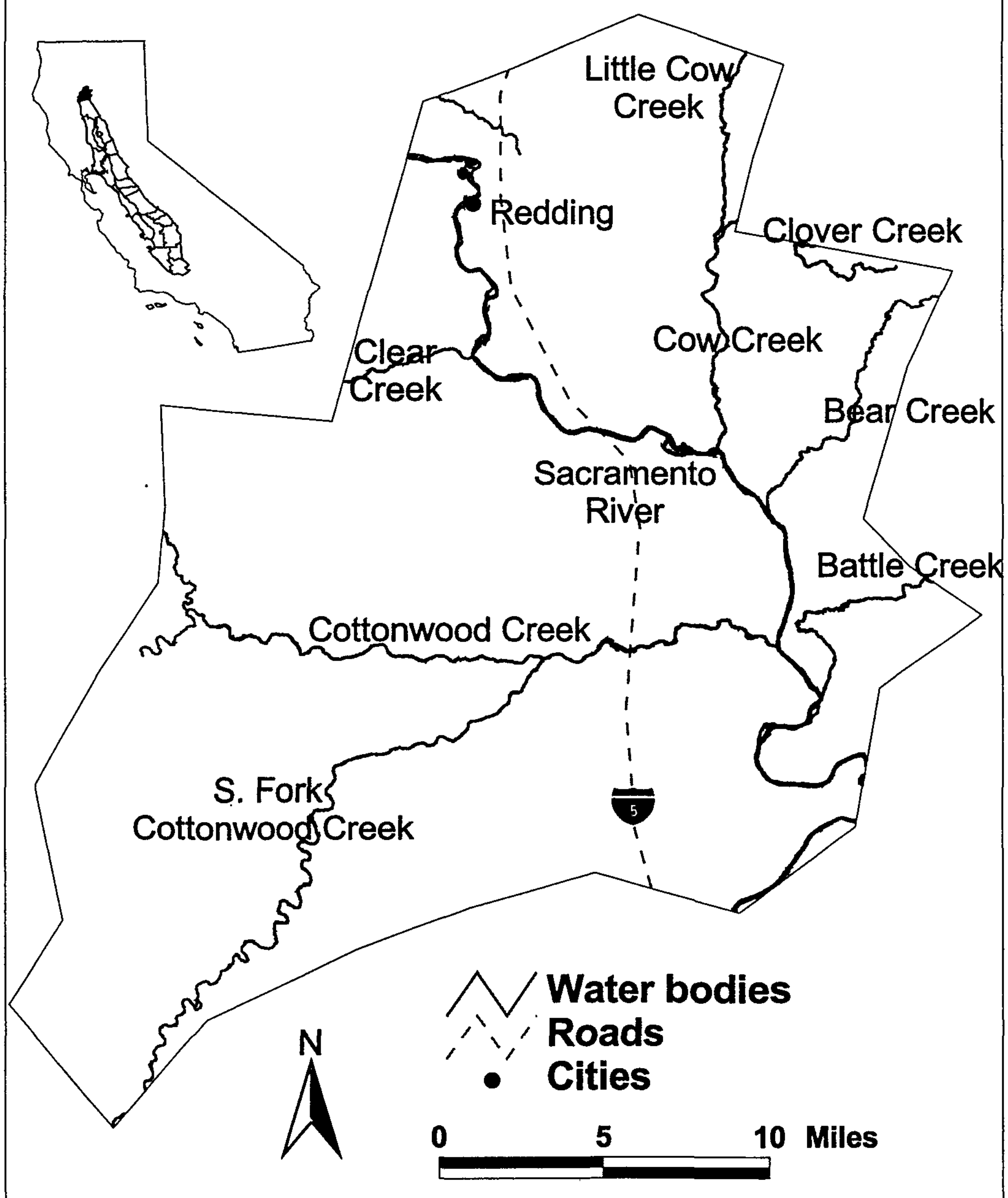


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Table 1.1. Descriptive List of Targeted Benefits, Sub-Region 1, Redding Basin					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
1	Battle Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	TBD	Incomplete
2	Bear Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	TBD	Indefined
3	Clear Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
4	Cottonwood Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Summer & fall	Undefined
5	Cow Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	October	Incomplete
6 [13, 20 30, 57, 75]	Sacramento River below Keswick	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Undefined
7	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
8	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete

Sub-Region 2, Sacramento Valley, Chico Landing to Red Bluff

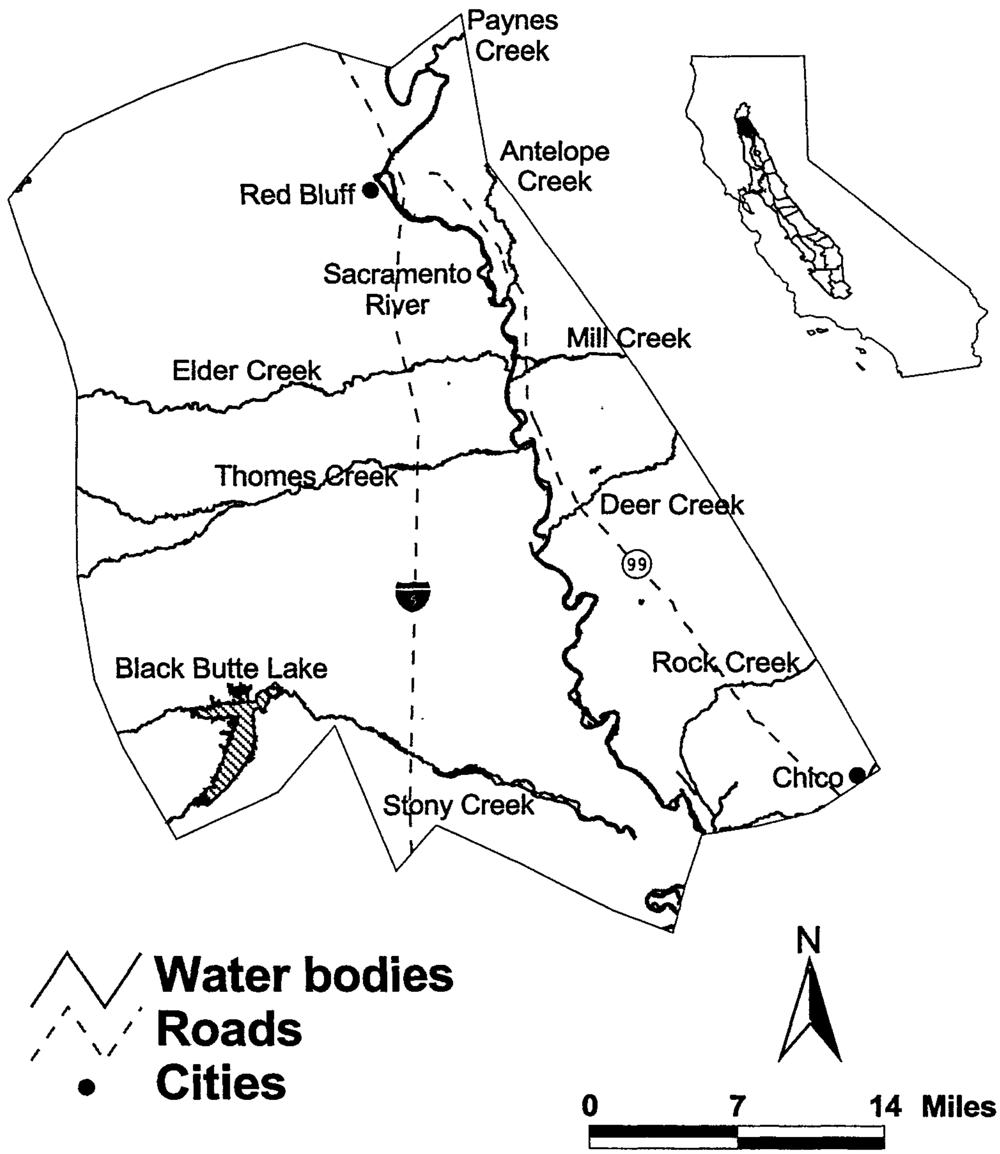


Table 2.1. Descriptive List of Targeted Benefits, Sub-Region 2, Sacramento Valley, Chico Landing to Red Bluff					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
9	Antelope Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - summer	Incomplete
10	Deer Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	TBD	Undefined
11	Mill Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	TBD	Undefined
12	Paynes Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall & spring	Undefined
13 [6, 20 30, 57, 75]	Sacramento River below Keswick	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Undefined
14	Elder Creek	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
15 [23, 31, 52, 59]	Sacramento River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
16	Deer Creek	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Complete
17	Mill Creek	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Complete
18	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
19	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete

Sub-Region 3, Sacramento Valley, Colusa Basin

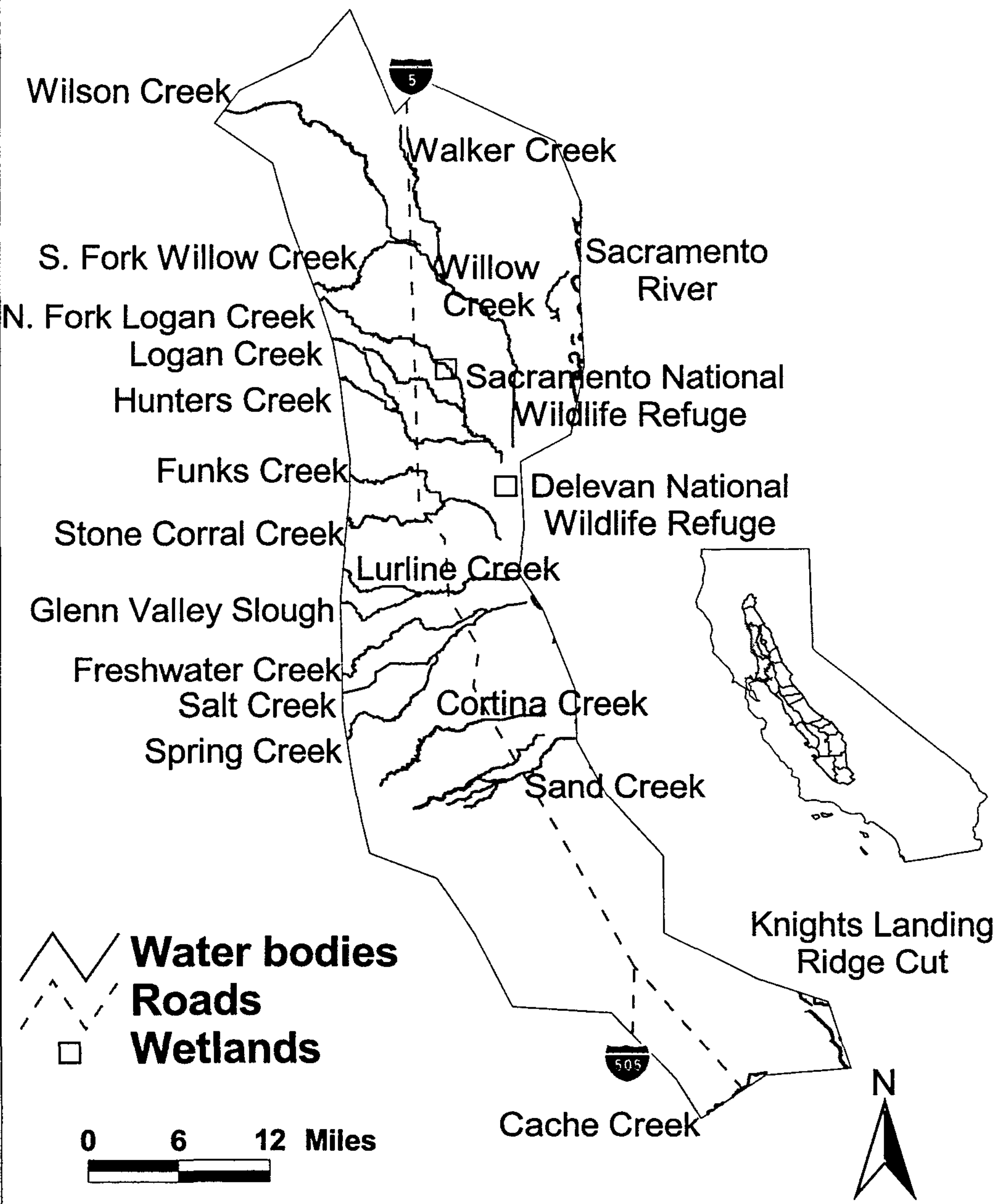


Table 3.1. Descriptive List of Targeted Benefits, Sub-Region 3, Sacramento Valley, Colusa Trough					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
20 [6, 13, 30, 57, 75]	Sacramento River below Keswick	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Undefined
21	Colusa Drain	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
22	Colusa Drain	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
23 [15, 31, 52, 59]	Sacramento River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
24	Colusa Drain	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Ag, M&I	Year round	Complete
25	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
26	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
27 [35, 48, 54, 65, 73]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete
28	Sacramento & Delevan National Wildlife Refuge	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable (mostly winter)	Incomplete
29	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Incomplete

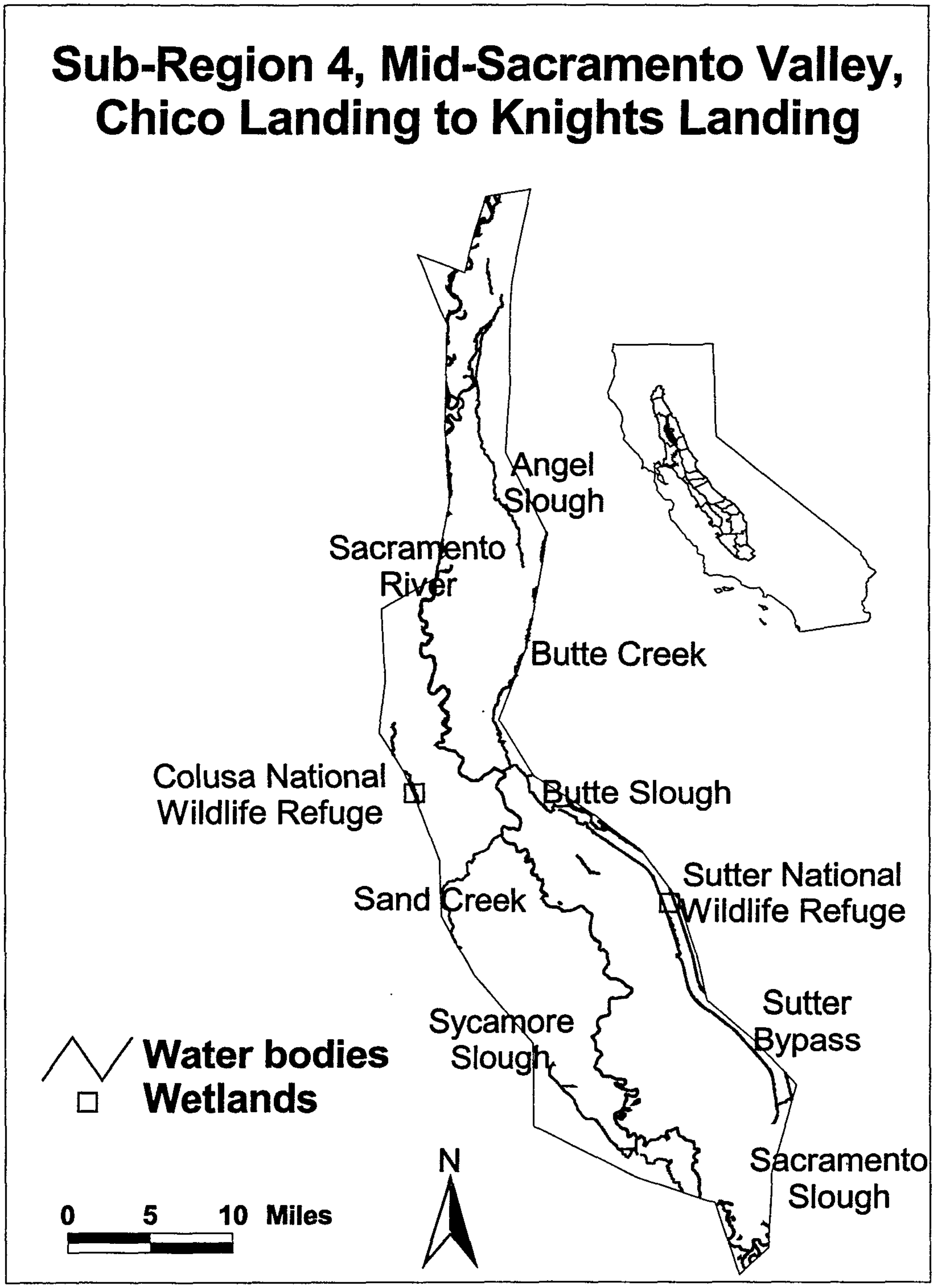

Sub-Region 4, Mid-Sacramento Valley, Chico Landing to Knights Landing
Angel Slough
Sacramento River
Butte Creek
Colusa National Wildlife Refuge
Butte Slough
Sutter National Wildlife Refuge
Sand Creek
Sutter Bypass
Sycamore Slough
Water bodies
Wetlands
N
0 5 10 Miles
Sacramento Slough

Table 4.1. Descriptive List of Targeted Benefits, Sub-Region 4, Mid-Sacramento Valley, Chico Landing to Knight's Landing					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Beneficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
30 [6, 13, 20, 57, 75]	Sacramento River below Keswick	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Undefined
31 [15, 23, 52, 59]	Sacramento River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
83	Sacramento Slough	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
32		omitted			
33	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
34	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
35 [27, 48, 54, 65, 73]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete
36	Colusa & Sutter National Wildlife Refuge	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable (mostly winter)	Incomplete

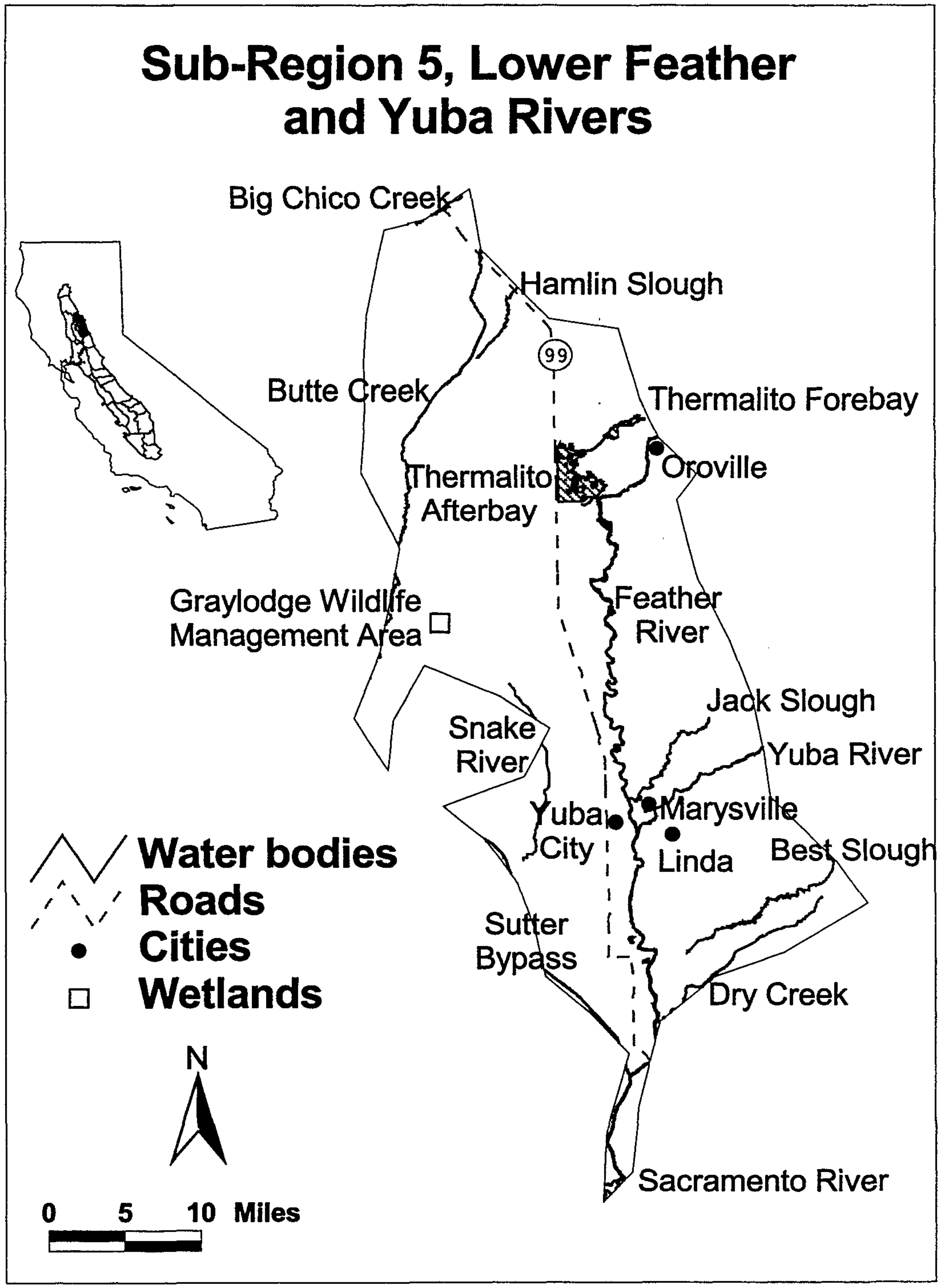

Sub-Region 5, Lower Feather and Yuba Rivers
Big Chico Creek
Hamlin Slough
99
Butte Creek
Thermalito Forebay
Oroville
Thermalito Afterbay
Graylodge Wildlife Management Area
Feather River
Jack Slough
Snake River
Yuba River
Yuba City
Marysville
Linda
Best Slough
Water bodies
Roads
Cities
Wetlands
Sutter Bypass
Dry Creek
N
Sacramento River
0 5 10 Miles

Table 5.1. Descriptive List of Targeted Benefits, Sub-Region 5, Lower Feather River and Yuba River					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
37	Butte Creek	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
38	Feather River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
39	Yuba River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
40	Feather River	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
41	Feather River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
42	Sacramento Slough	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Ag, M&I	Year round	Complete
43	Butte Creek	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
44	Feather River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
45	Yuba River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
46	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
47	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
48 [27, 35, 54, 65, 73]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete
49	Graylodge Wildlife Mgmt Area	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable (mostly winter)	Incomplete

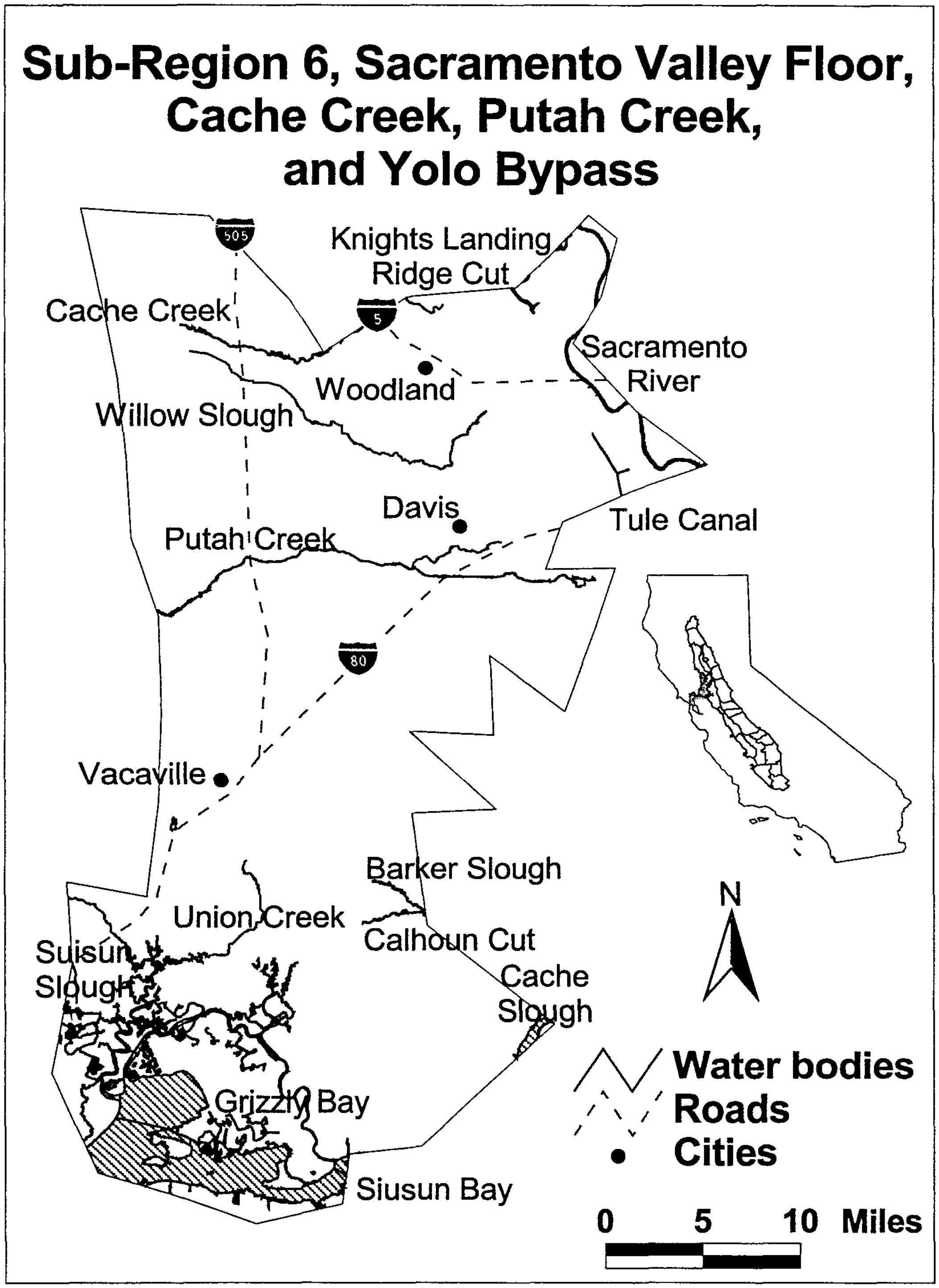
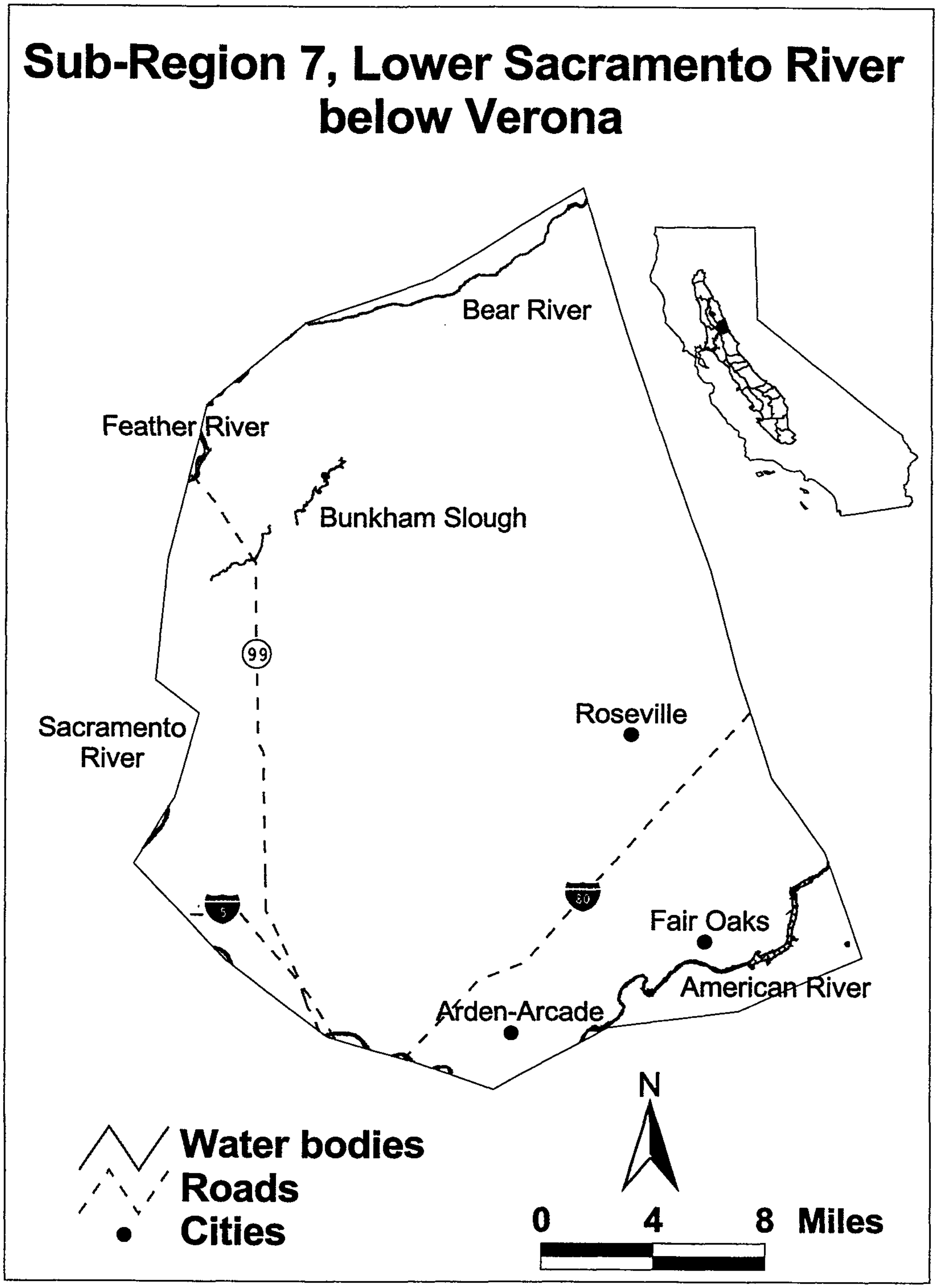
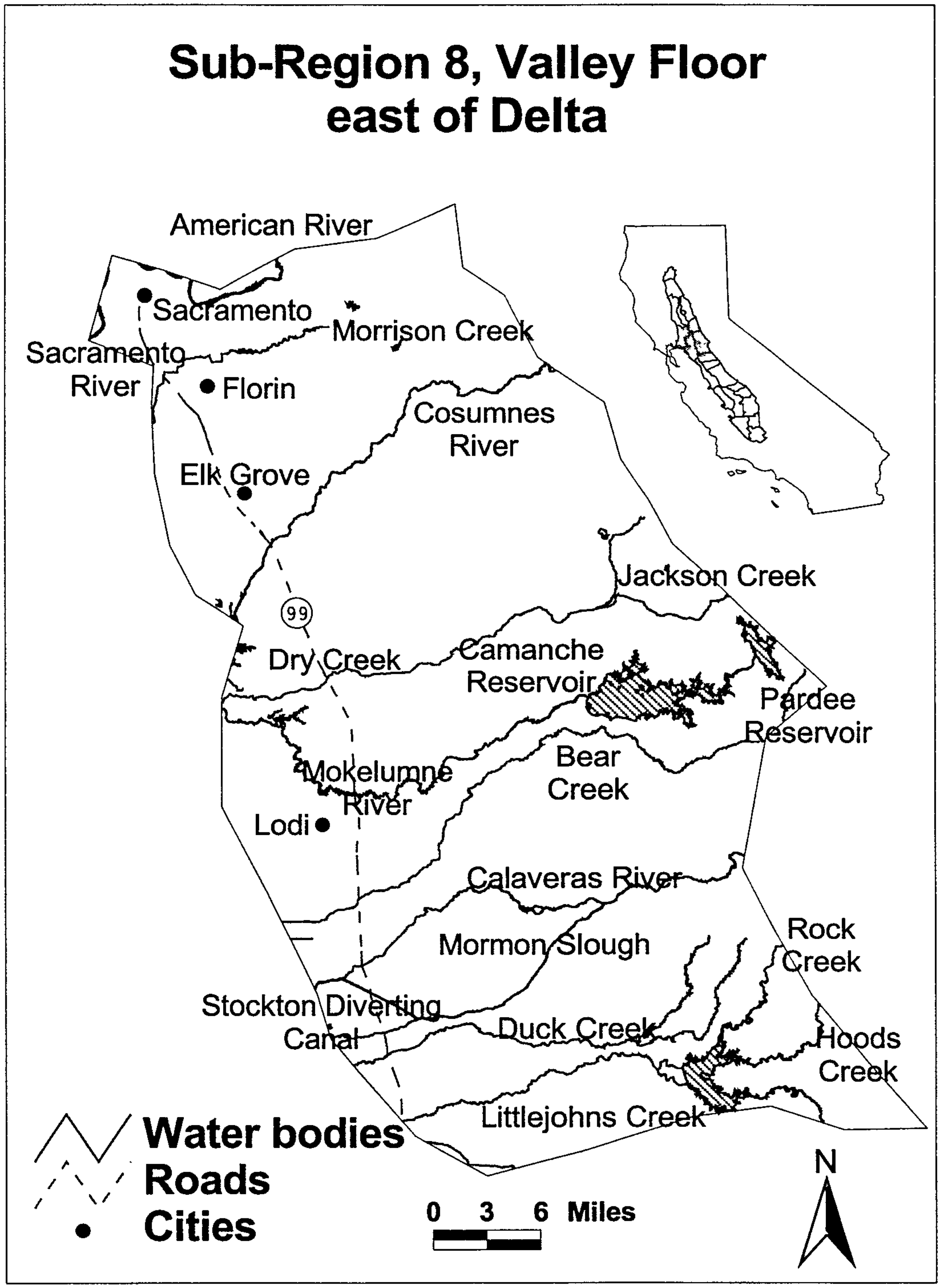

Sub-Region 6, Sacramento Valley Floor,
Cache Creek, Putah Creek,
and Yolo Bypass
505
Knights Landing
Ridge Cut
Cache Creek
5
Sacramento
River
Woodland
Willow Slough
Davis
Tule Canal
Putah Creek
80
Vacaville
Barker Slough
N
Union Creek
Calhoun Cut
Suisun
Slough
Cache
Slough
Water bodies
Roads
Cities
Grizzly Bay
Siusun Bay
0
5
10
Miles

Table 6.1. Descriptive List of Targeted Benefits, Sub-Region 6, Sacramento Valley Floor, Cache Creek and Putah Creek and Yolo Bypass					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
50	Cache & Putah Creeks	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
51	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
52 [15, 23, 31, 59]	Sacramento River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
53	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
54 [27, 35, 48, 65, 73]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete



Sub-Region 7, Lower Sacramento River below Verona
Bear River
Feather River
Bunkham Slough
99
Sacramento River
Roseville
5
80
Fair Oaks
American River
Arden-Arcade
N
Water bodies
Roads
Cities
0
4
8
Miles

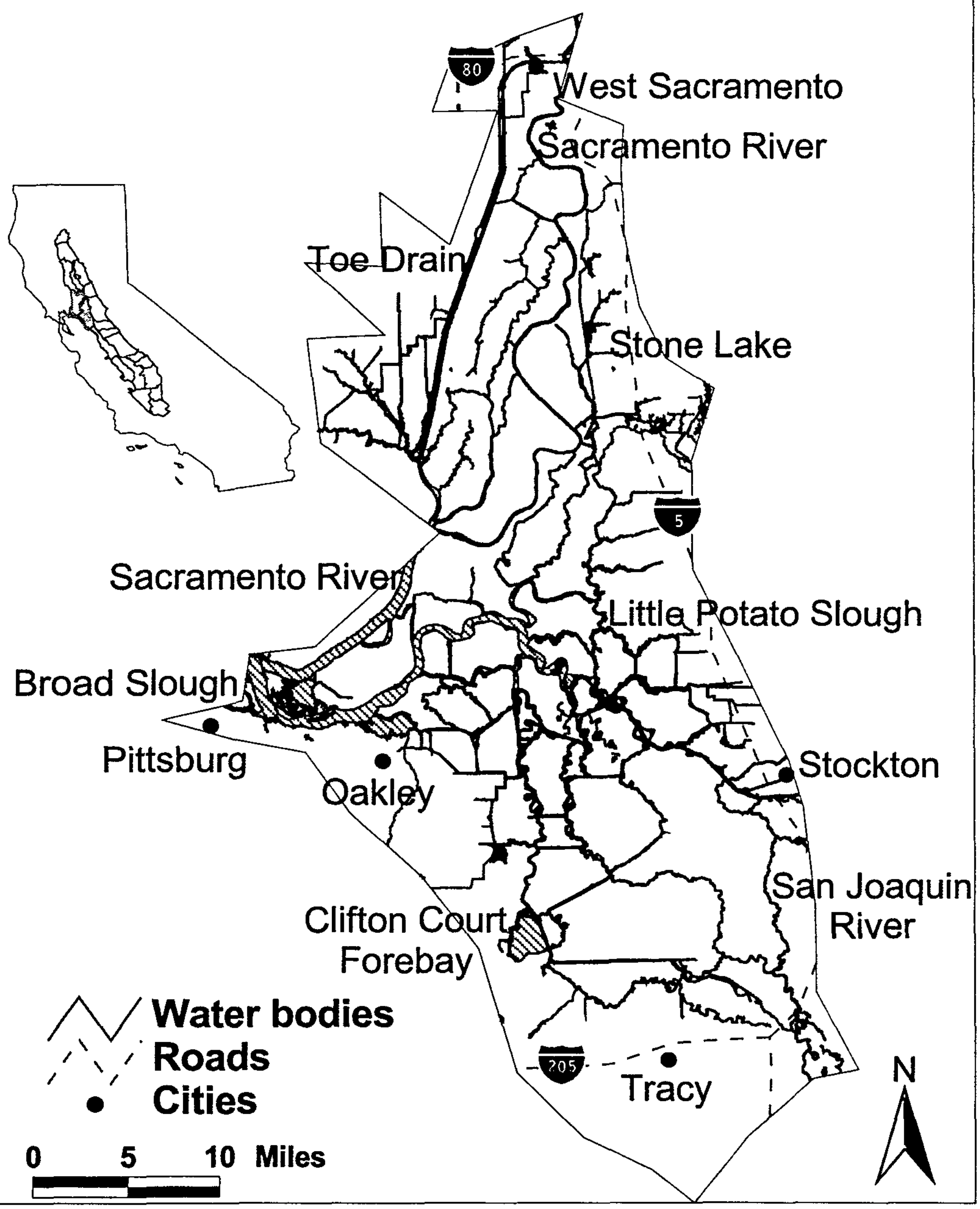
Table 7.1. Descriptive List of Targeted Benefits, Sub-Region 7, Lower Sacramento River below Verona					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
55	American River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
56	Bear River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
57 [6, 13, 20, 30, 75]	Sacramento River below Keswick	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Undefined
58	Natomas East Main Drain	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
59 [15, 23, 31, 52]	Sacramento River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
60	Natomas Drain	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Ag or M&I	TBD	Complete
61	American River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
62	Bear River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	TBD	Incomplete
63	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
64	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
65 [27, 35, 48, 54, 73]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete


Sub-Region 8, Valley Floor
east of Delta
American River
Sacramento
Morrison Creek
Sacramento
River
Florin
Cosumnes
River
Elk Grove
Jackson Creek
99
Dry Creek
Camanche
Reservoir
Pardee
Reservoir
Bear
Creek
Mokelumne
River
Lodi
Calaveras River
Rock
Creek
Mormon Slough
Stockton Diverting
Canal
Duck Creek
Hoods
Creek
Littlejohns Creek
Water bodies
Roads
Cities
0 3 6 Miles
N

C —0 2 6 5 7 1

Table 8.1. Descriptive List of Targeted Benefits, Sub-Region 8, Valley Floor east of Delta					
TB # (1) [duplicate]	Location (2)	Category of Targeted Benefit (3)	Beneficiary (4)	General Time-Frame (5)	Conceptual Completeness (6)
66	Calavaras River	Flow: Provide flow to improve aquatic ecosystem conditions		Fall - spring	Undefined
67	Cosumnes River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Undefined
68	Mokelumne River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Spring - summer	Incomplete
69	Calavaras River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
70	Mokelumne River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
71	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
72	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
73 [27, 35, 48, 54, 65]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete

Sub-Region 9, Sacramento - San Joaquin Delta



C —0 2 6 5 7 3

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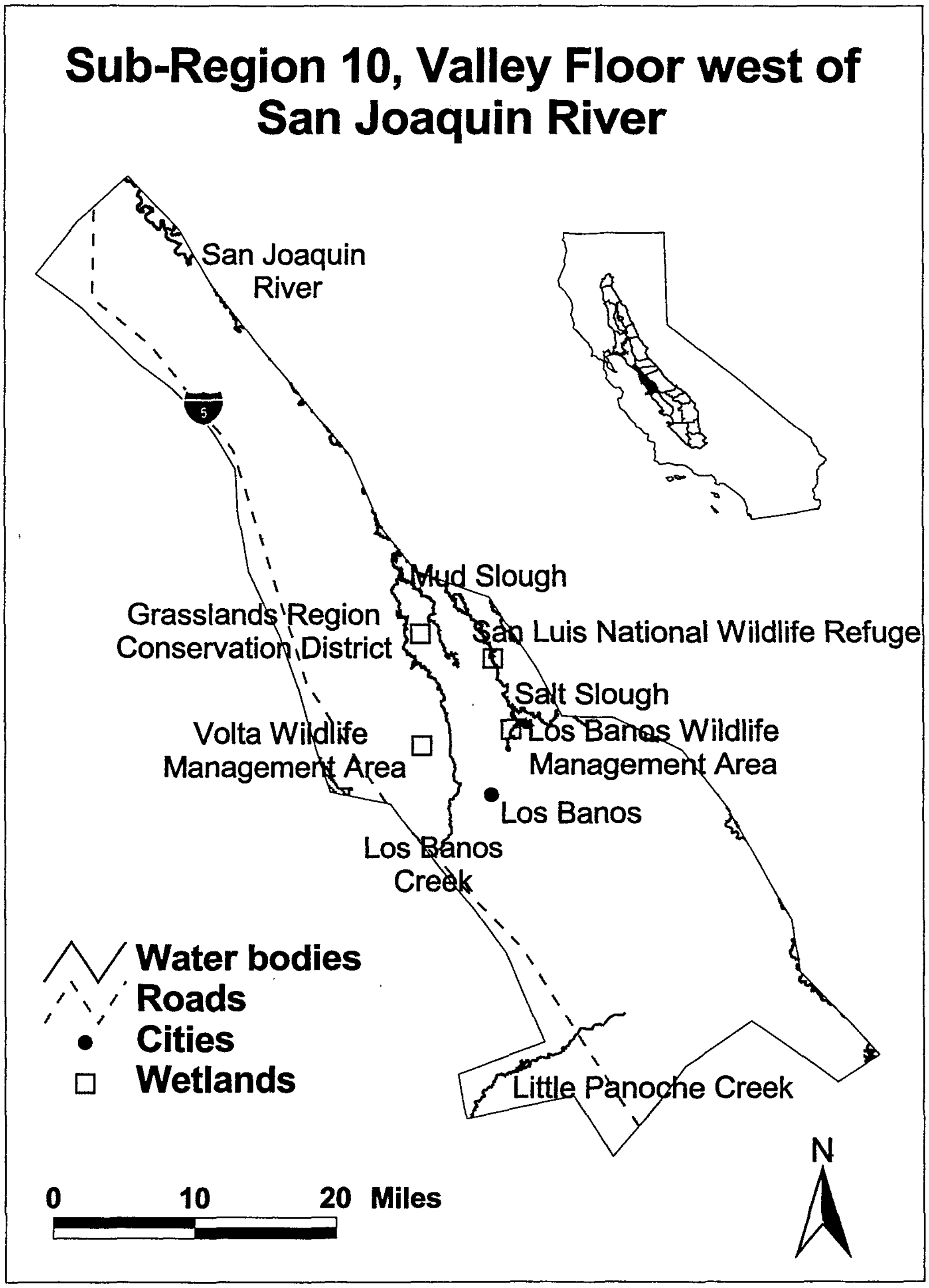
Table 9.1. Descriptive List of Targeted Benefits, Sub-Region 9, Sacramento-San Joaquin Delta					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
74	Delta	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Spring - summer	Undefined
75 [6, 13, 20, 30, 57]	Sacramento River below Keswick	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Undefined
76	Western Delta	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Spring - fall	Incomplete
77	Delta	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
78	Delta	Quality: Reduce native constituents to enhance and maintain beneficial	M&I	Irrigation season	Complete
79 [98]	San Joaquin River	Quality: Reduce native constituents to enhance and maintain beneficial	Eco or M&I	TBD	Complete
80	Delta	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
81	Delta Waterways	Quality: Reduce nutrients to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
82 [101, 120, 137, 152, 173]	San Joaquin River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
83	Sacramento Slough	TB Moved to Subregion 4			
162	Five Mile Slough	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
84	Delta	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
85	Sacramento River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
86	Delta channels	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Fall and Spring	Undefined
87	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for	Eco, Ag or M&I	Irrigation season	Complete
88	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
89	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable (mostly winter)	Incomplete
90	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete
91	All suitable lands	Quantity: Provide short-term diversion flexibility to make water available to the Environmental Water Acct.	Eco, Ag or M&I	Irrigation season	Undefined


Sub-Region 10, Valley Floor west of San Joaquin River
San Joaquin River
Mud Slough
Grasslands Region Conservation District
San Luis National Wildlife Refuge
Salt Slough
Volta Wildlife Management Area
Los Banos Wildlife Management Area
Los Banos
Los Banos Creek
Little Panoche Creek
Water bodies
Roads
Cities
Wetlands
0
10
20
Miles
N
5

C —0 2 6 5 7 5

Table 10.1. Descriptive List of Targeted Benefits, Sub-Region 10, Valley Floor west of San Joaquin River					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
92	West San Joaquin Tributaries	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Spring	Undefined
93 [115, 134, 150, 172]	San Joaquin River	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
94	Panoche Crk.	TB Moved to Subregion 14			
95	Grassland Marshes	Quality: Reduce native constituents to enhance and maintain beneficial	Eco or M&I	TBD	Complete
96	Mud and Salt Slough	Quality: Reduce native constituents to enhance and maintain beneficial	Eco or M&I	TBD	Complete
97	Mud Slough	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
98 [79]	San Joaquin River	Quality: Reduce native constituents to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
99	Salt Slough	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
100	Orestimba Creek	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
101 [82, 120, 137, 152, 173]	San Joaquin River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
102	Grassland Marshes	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco	TBD	Complete
103	Mud and Salt Slough	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
104 [123, 140, 154, 174]	San Joaquin River at Vernalis	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
105	Panoche Creek	TB Moved to Subregion 14			
106	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for	Eco, Ag or M&I	Irrigation season	Complete
107	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial	Eco, Ag or M&I	Year round	Complete
108	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
109	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete
110 [129, 146, 160]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete
111	Specific managed wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete

Sub-Region 11, Eastern San Joaquin Valley above Tuolumne River

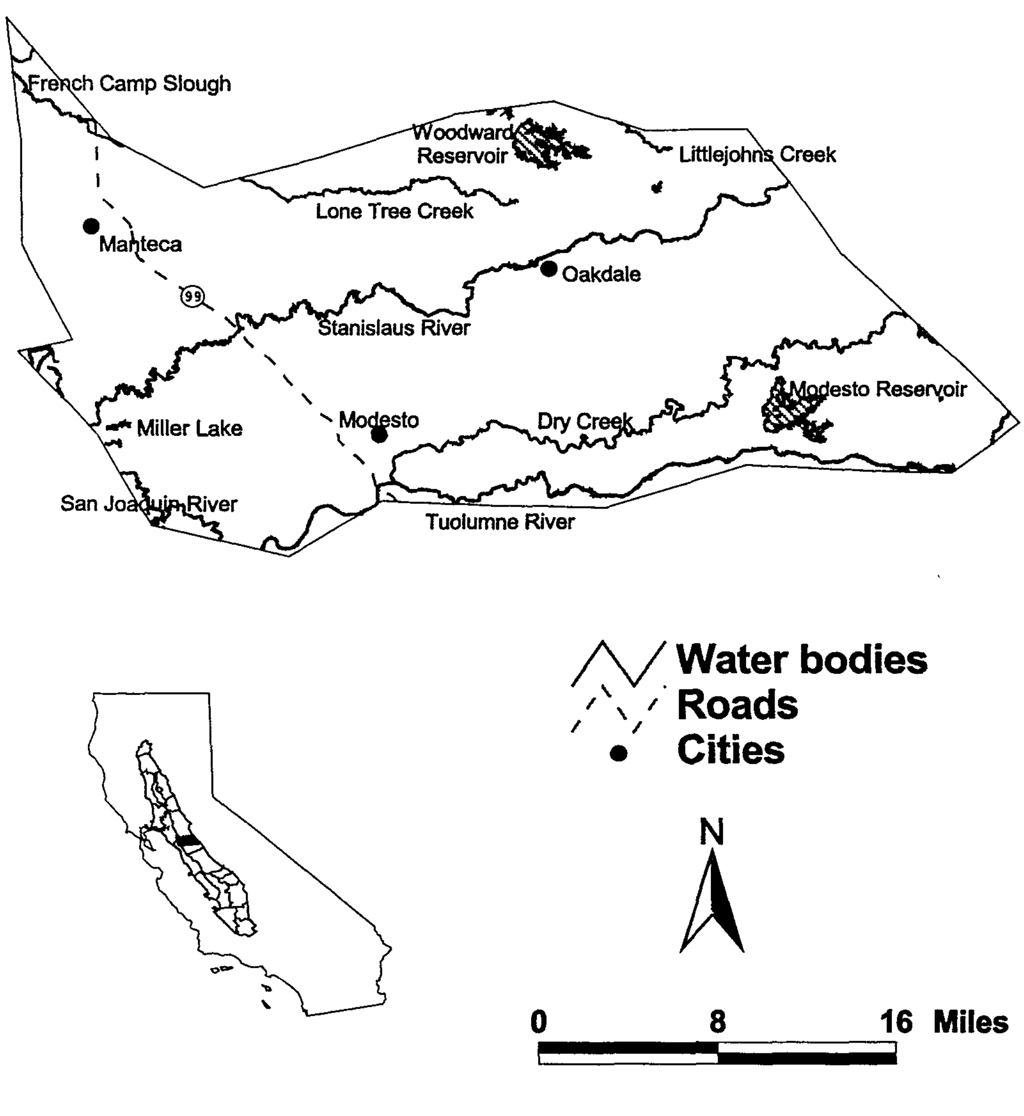


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Table 11.1. Descriptive List of Targeted Benefits, Sub-Region 11, Eastern San Joaquin Valley above Tuolumne River					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Beneficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
112 [131, 148, 171]	San Joaquin River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall	Incomplete
113	Stanislaus River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
114 [132]	Tuolumne River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Incomplete
115 [93, 134, 150, 172]	San Joaquin River	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
116	Stanislaus River	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
117 [135]	Tuolomne River	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
118	Harding Drain	TB Moved to Subregion 12			
119	Harding Drain	TB Moved to Subregion 12			
120 [82, 101, 137, 152, 173]	San Joaquin River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
121	Stanislaus River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
122 [138]	Tuolomne River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
123 [104, 140, 154, 174]	San Joaquin River at Vernalis	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
124 [143, 157, 175]	San Joaquin River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	TBD	Incomplete
125	Stanislaus River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
126 [143]	Tuolomne River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
127	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
128	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
129 [110, 146, 160]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water	Eco	Variable	Incomplete

Sub-Region 12, Eastern Valley Floor between Merced and Tuolumne Rivers

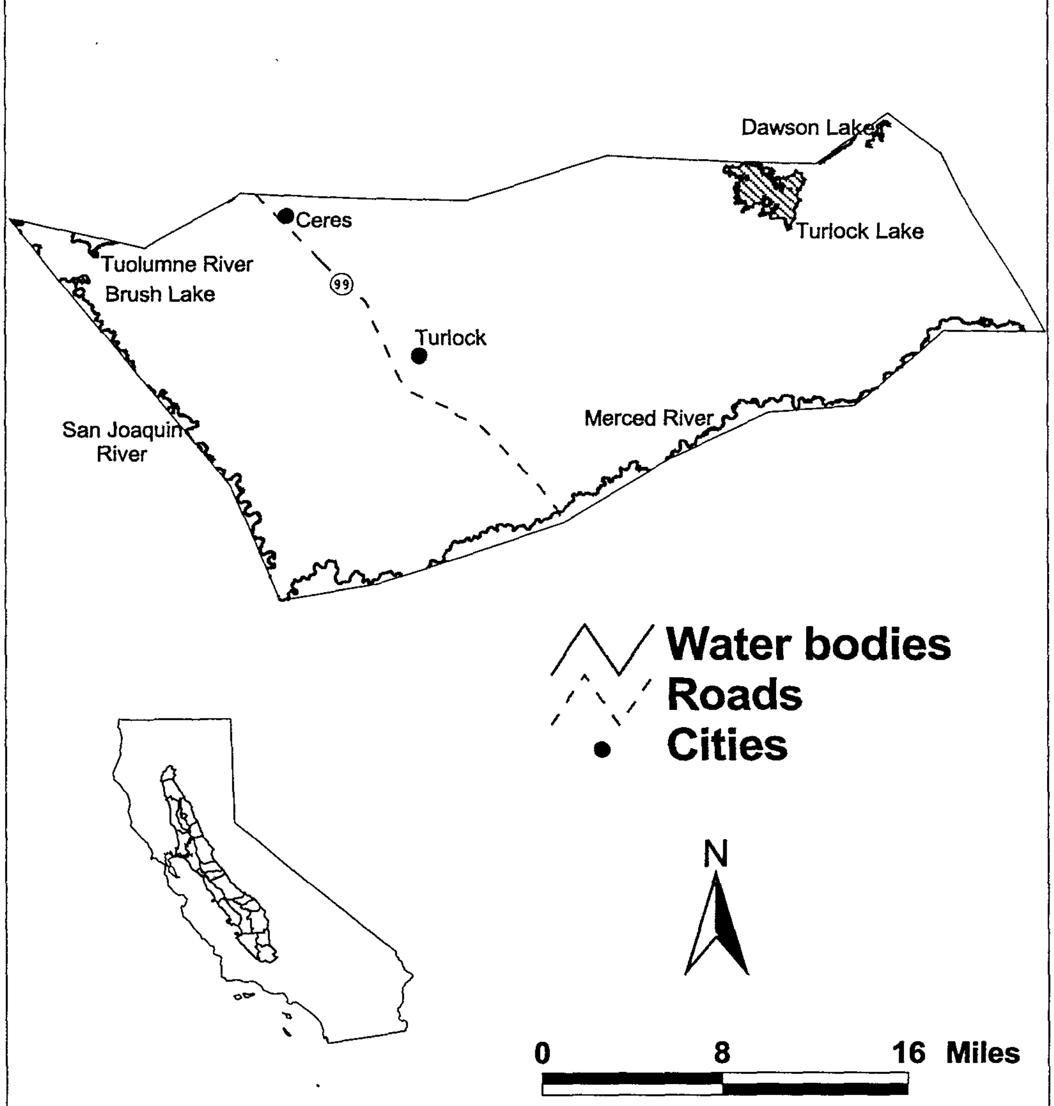
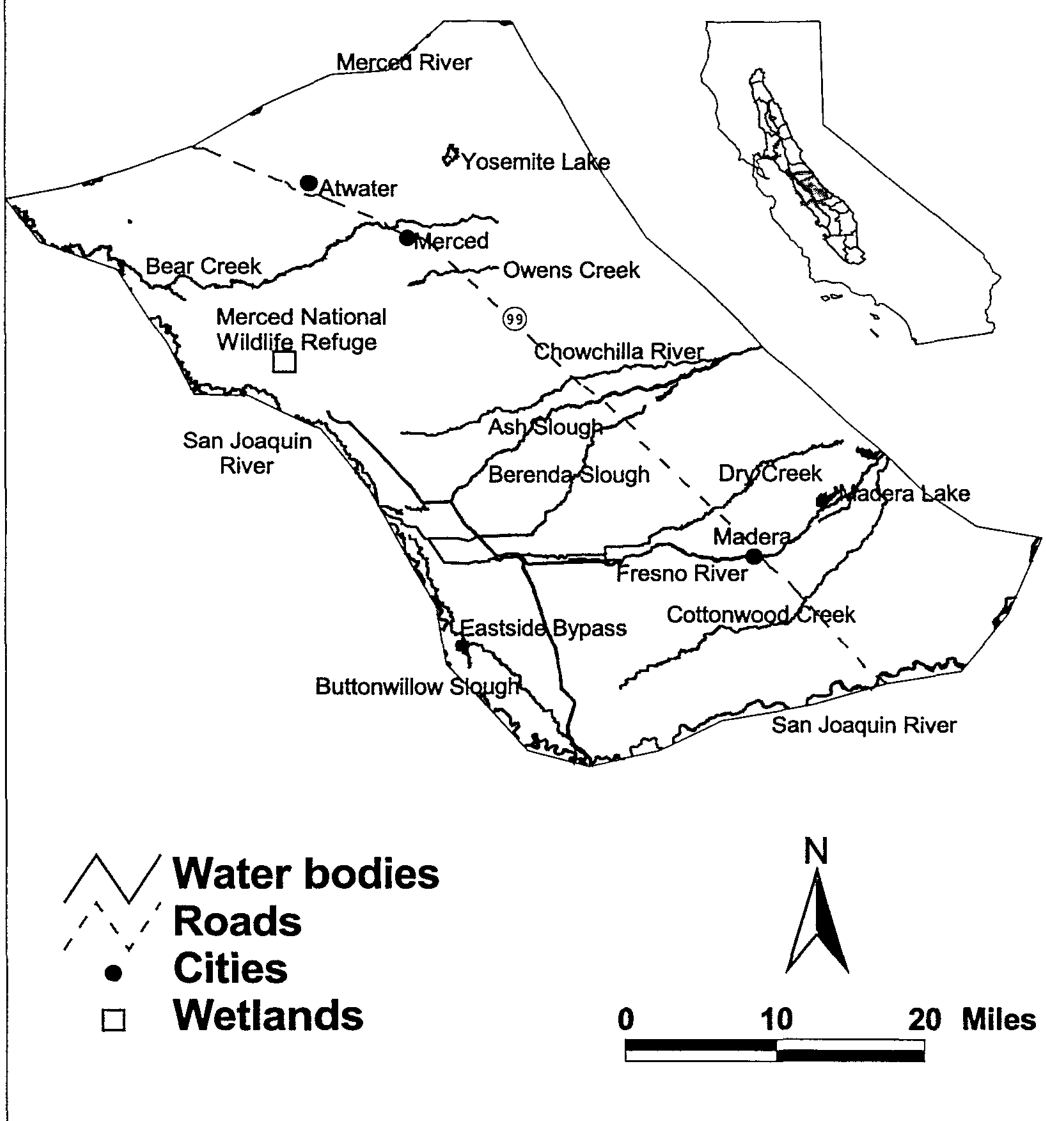


Table 12.1. Descriptive List of Targeted Benefits, Sub-Region 12, Eastern Valley Floor between Merced River and Tuolumne River					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
130 [147]	Merced River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
131 [112, 148, 170]	San Joaquin River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall	Incomplete
132 [114]	Tuolumne River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall - spring	Incomplete
133 [149]	Merced River	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
134 [93, 115, 150, 172]	San Joaquin River	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
135 [117]	Tuolomne River	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
118	Harding Drain	Quality: Reduce nutrients to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
119	Harding Drain	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
136 [151]	Merced River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
137 [82, 101, 120, 152, 173]	San Joaquin River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
138 [122]	Tuolomne River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
139 [153]		omitted			
140 [104, 123, 154, 174]	San Joaquin River at Vernalis	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
141 [155]	Merced River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
142 [124, 156, 175]	San Joaquin River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	TBD	Incomplete
143 [126]	Tuolomne River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
144	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial	Eco, Ag or M&I	Year round	Complete
145	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
146 [110, 129, 160]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water	Eco	Variable	Incomplete

Sub-Region 13, Eastern Valley Floor between San Joaquin and Merced River



C—026581

Table 13.1. Descriptive List of Targeted Benefits, Sub-Region 13, Eastern Valley Floor between San Joaquin River and Merced River					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
147 [130]	Merced River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Year round	Incomplete
148 [112, 131, 169]	San Joaquin River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall	Incomplete
149 [133]	Merced River	Quality: Reduce group A pesticides to enhance and maintain beneficial	Eco or M&I	TBD	Complete
150 [93, 115, 134, 172]	San Joaquin River	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
151 [136]	Merced River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
152 [82, 101, 120, 137, 173]	San Joaquin River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
153 [139]		omitted			
154 [104, 123, 140, 174]	San Joaquin River at Vernalis	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
155 [141]	Merced River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	Year round	Incomplete
156 [124, 142, 175]	San Joaquin River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	TBD	Incomplete
157	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial	Eco, Ag or M&I	Year round	Complete
158	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
159	Merced National Wildlife Refuge	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable (mostly winter)	Incomplete
160 [110, 129, 146]	Wetlands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable	Incomplete
161	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

Sub-Region 14, Westlands Area

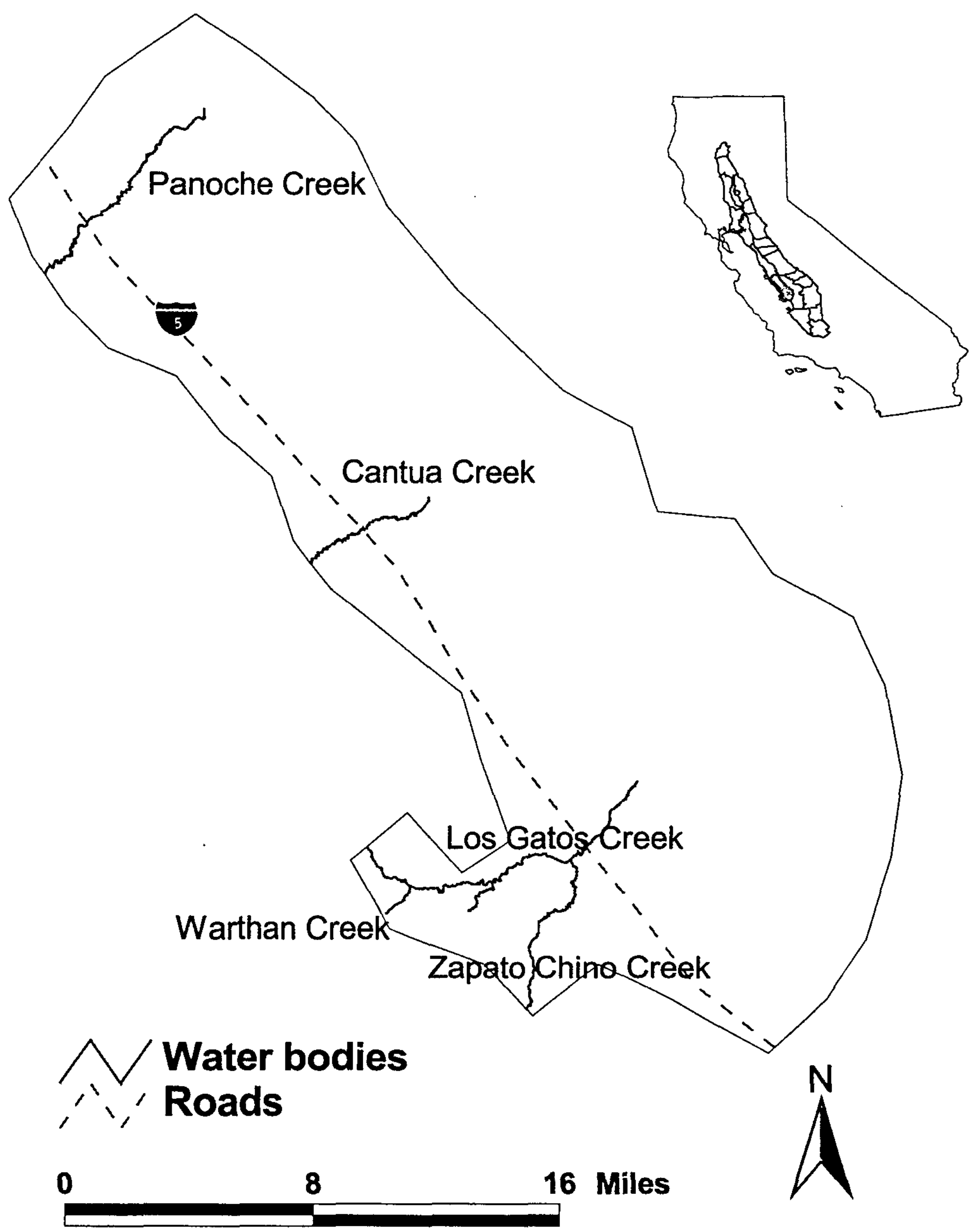
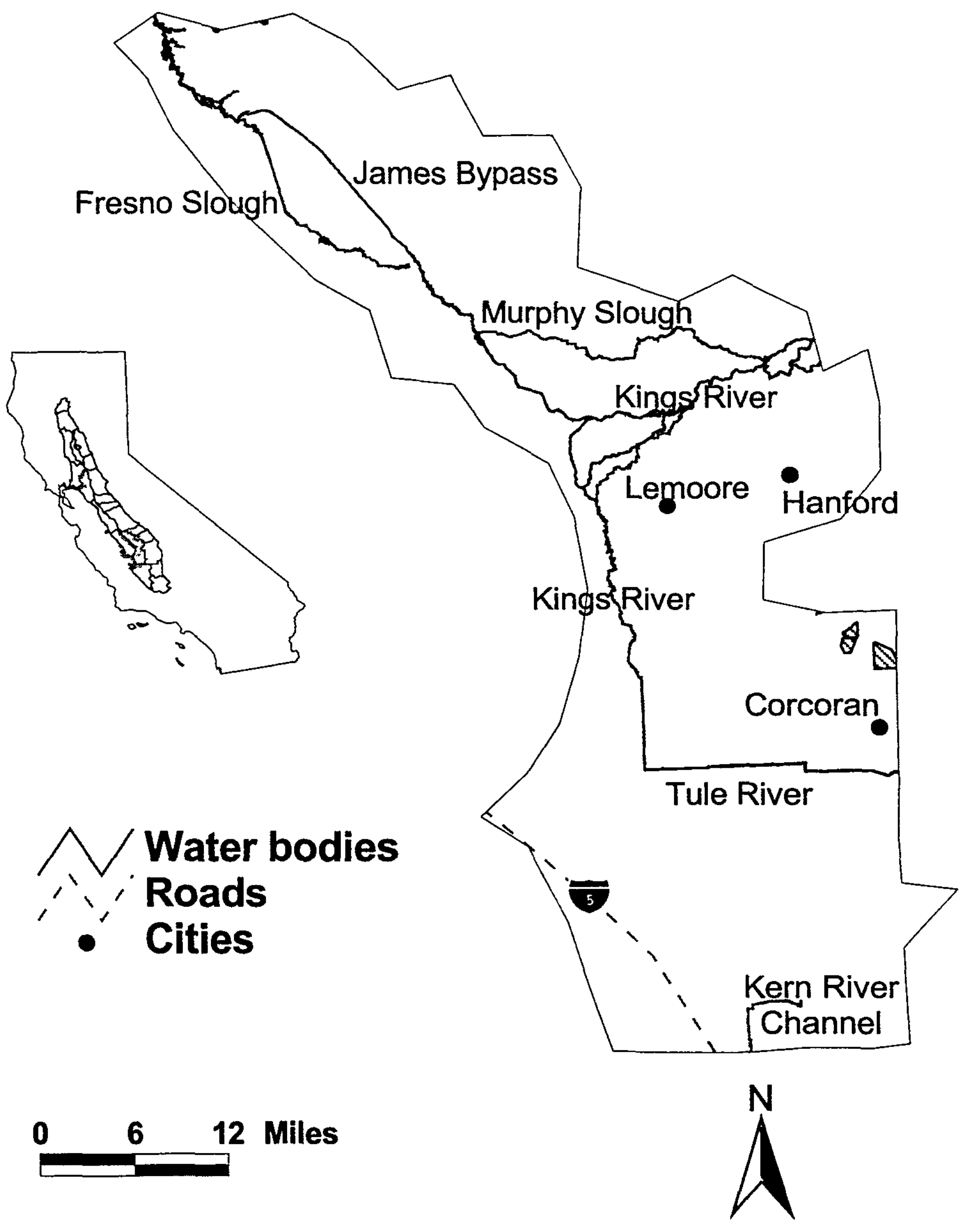


Table 14.1. Descriptive List of Targeted Benefits, Sub-Region 14, Westland Area					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
94	Panoche Creek	Quality: Reduce native constituents to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
105	Panoche Creek	Quality: Reduce sediments to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
162	Five Mile Slough	TB Moved to Subregion 9			
163	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for beneficial uses	Eco, Ag or M&I	Irrigation season	Complete
164	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
165	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
166	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

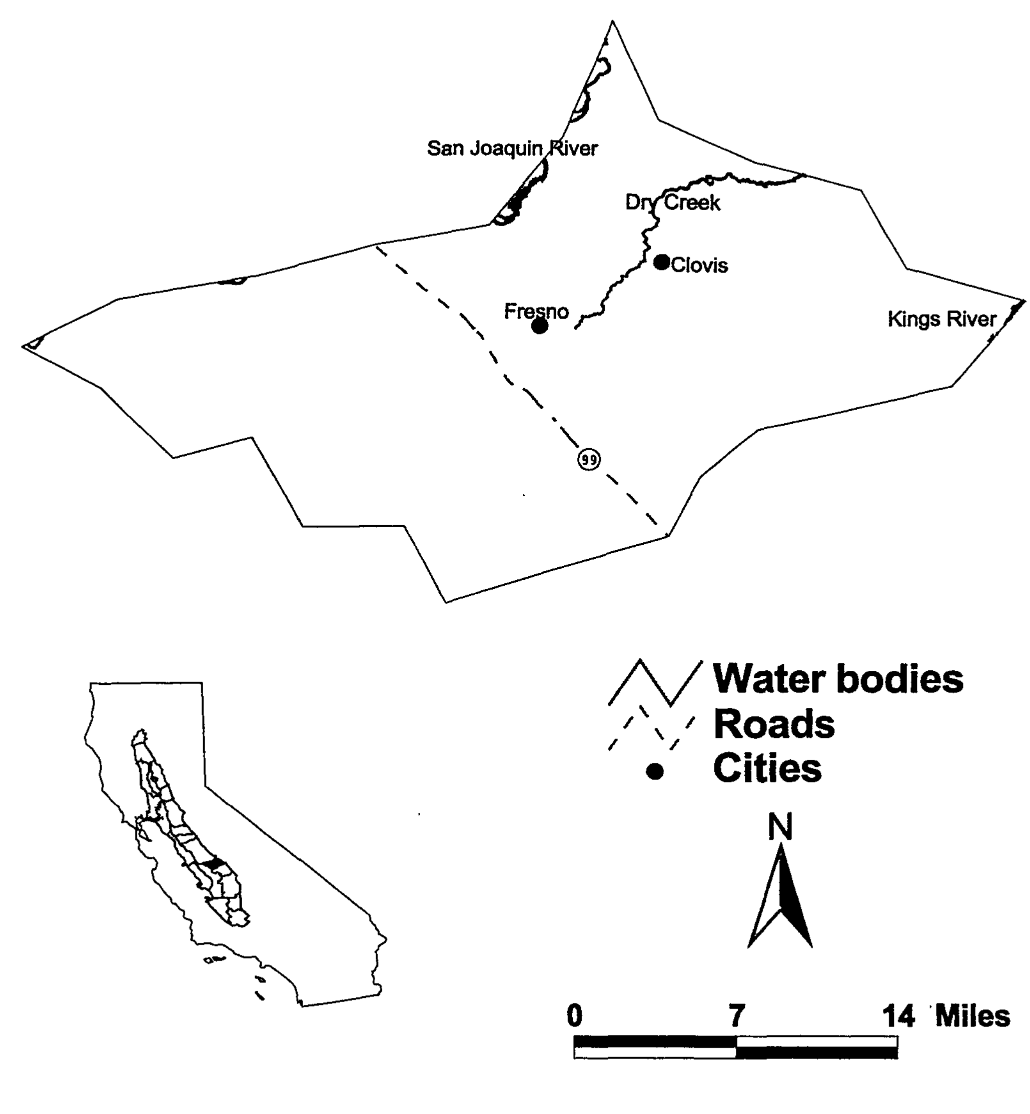
Sub-Region 15, Mid-Valley Area



C—026585

Table 15.1. Descriptive List of Targeted Benefits, Sub-Region 15, Mid-Valley Area					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Beneficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
167	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for beneficial uses	Eco, Ag or M&I	Irrigation season	Complete
168	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
169	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
170	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

Sub-Region 16, Fresno Area



C-026587

Table 16.1. Descriptive List of Targeted Benefits, Sub-Region 16, Fresno Area					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
171 [112, 131, 148]	San Joaquin River	Flow: Provide flow to improve aquatic ecosystem conditions	Eco	Fall	Incomplete
172 [93, 115, 134, 150]	San Joaquin River	Quality: Reduce group A pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
173 [82, 101, 120, 137, 152]	San Joaquin River	Quality: Reduce pesticides to enhance and maintain beneficial uses of water	Eco or M&I	TBD	Complete
174 [104, 123, 140, 154]	San Joaquin River at Vernalis	Quality: Reduce salinity to enhance and maintain beneficial uses of water	Eco, Ag or M&I	TBD	Complete
175 [124, 142, 156]	San Joaquin River	Quality: Reduce temperatures to enhance and maintain aquatic species populations	Eco	TBD	Incomplete
176	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
177	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
178	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

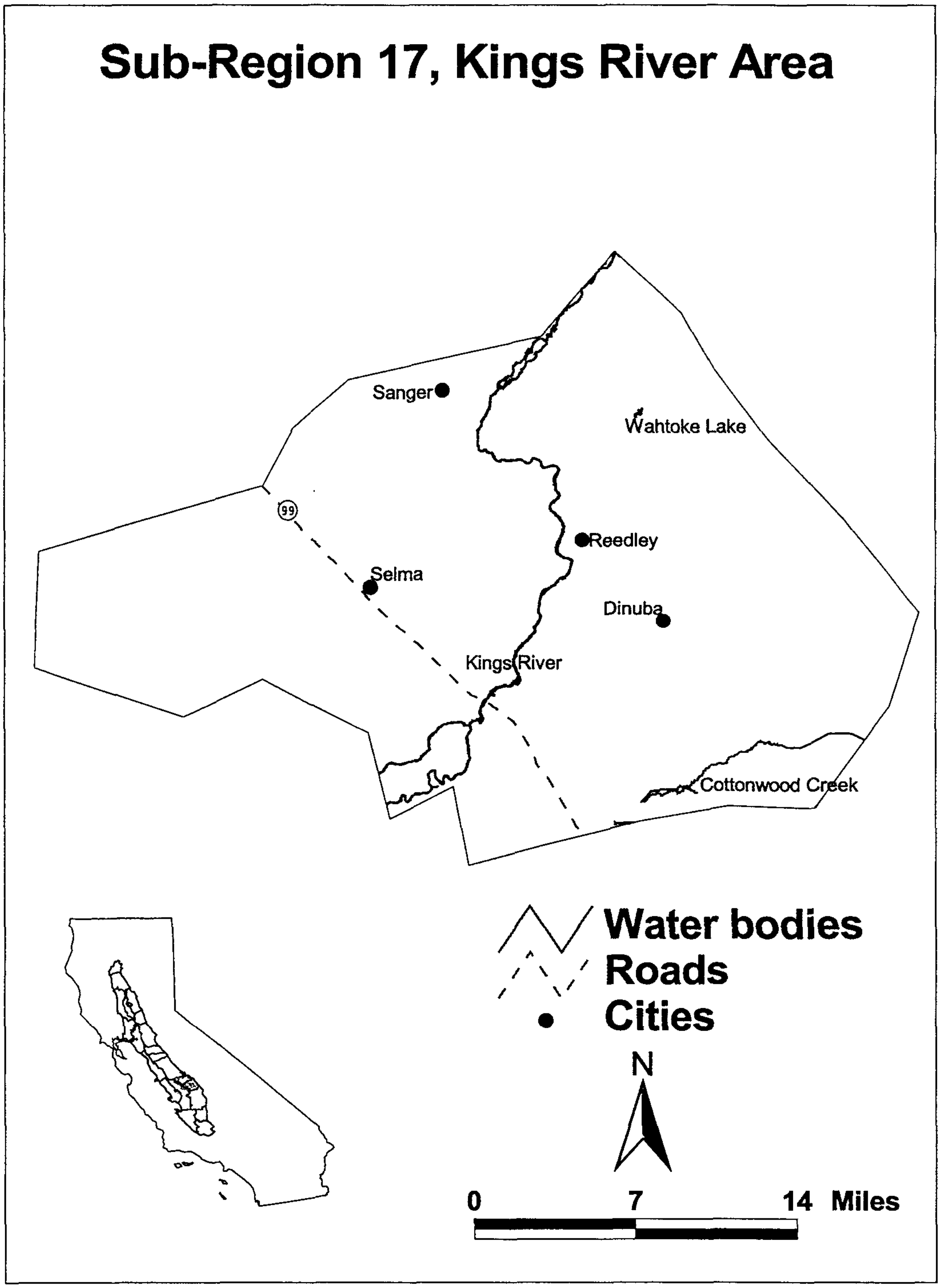

Sub-Region 17, Kings River Area
Sanger
Wahtoke Lake
99
Reedley
Selma
Dinuba
Kings River
Cottonwood Creek
Water bodies
Roads
Cities
N
0
7
14 Miles

Table 17.1. Descriptive List of Targeted Benefits, Sub-Region 17, Kings River Area					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
179	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for beneficial uses	Eco, Ag or M&I	Irrigation season	Incomplete
180	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
181	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
182	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

Sub-Region 18, Kaweah River and Tule River Area

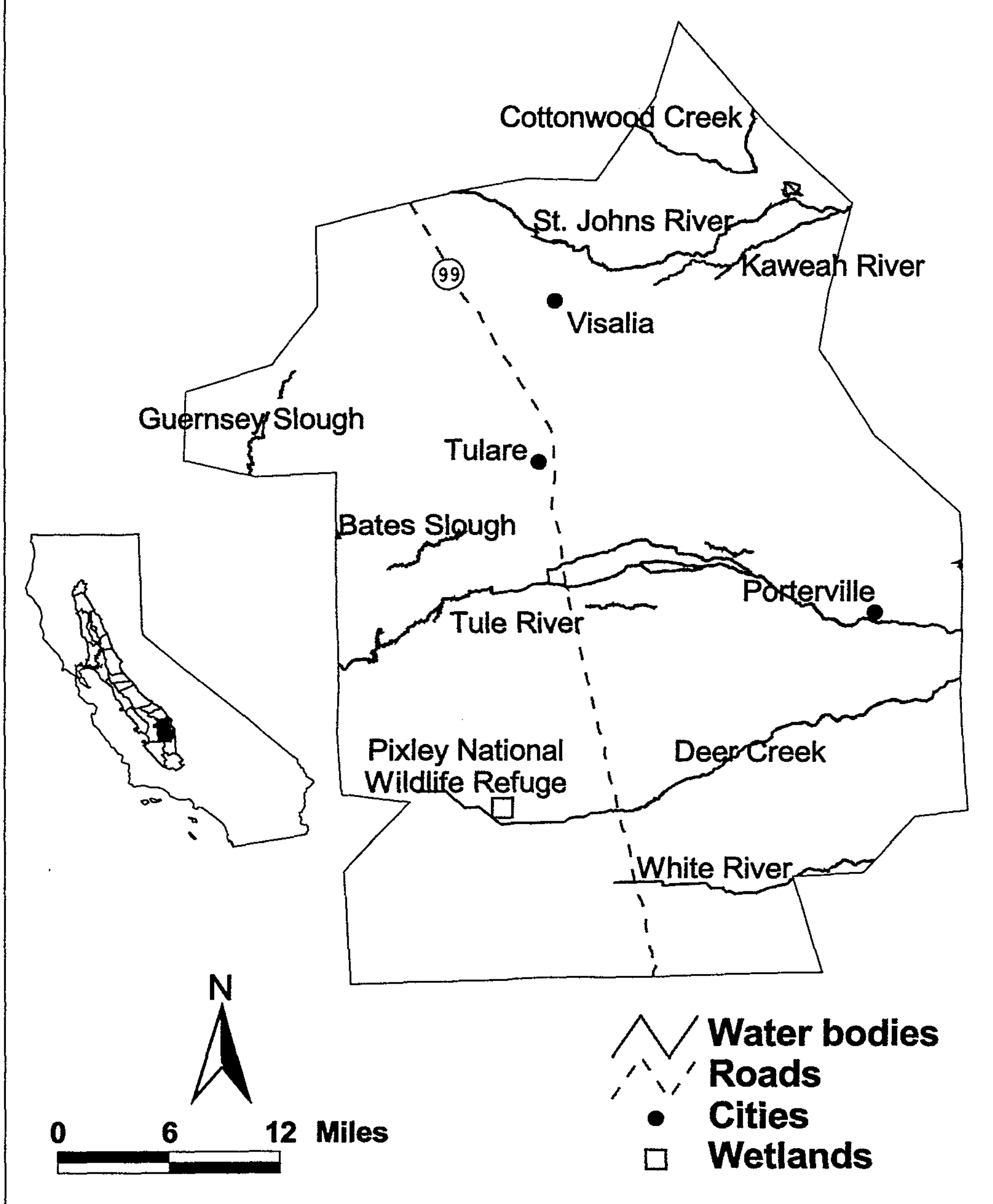
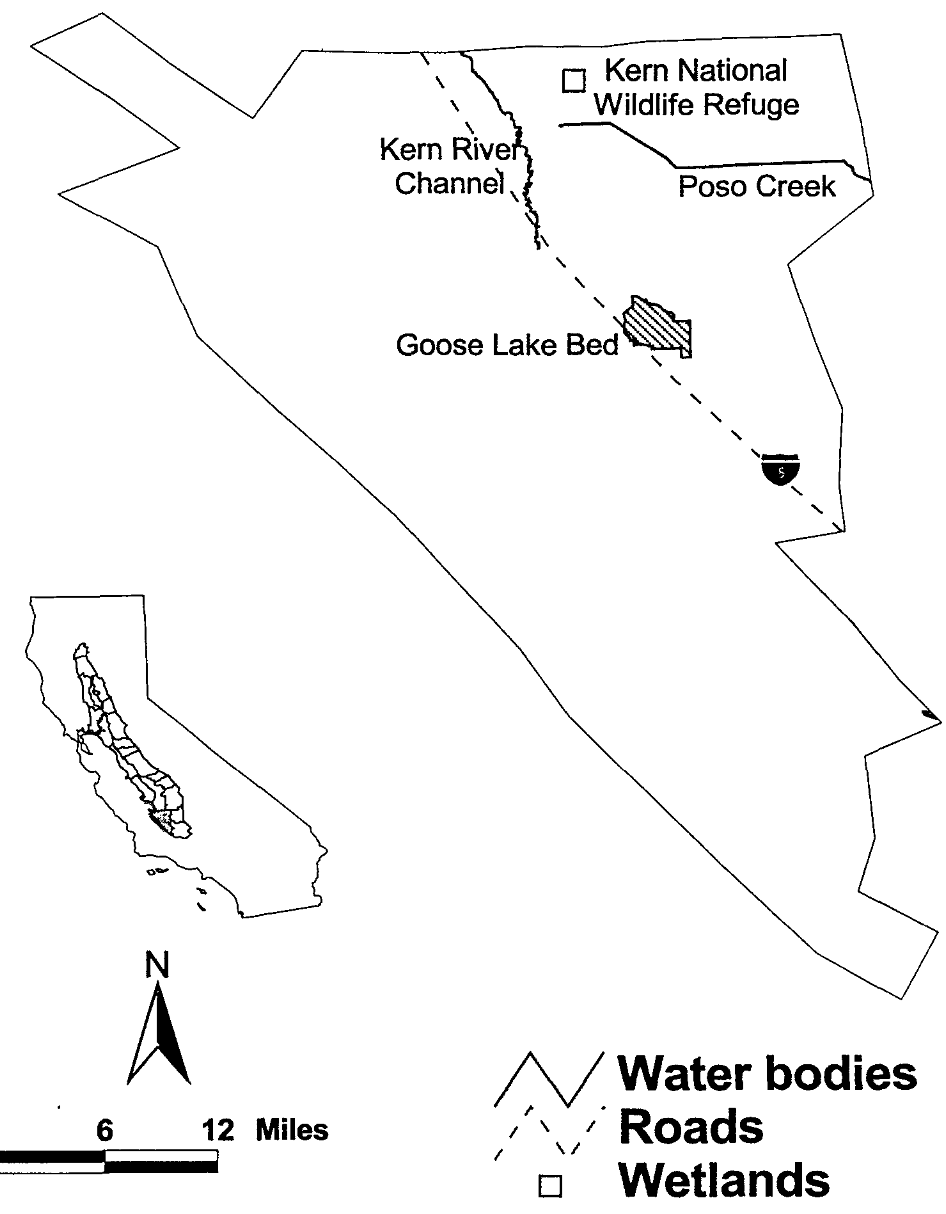


Table 18.1. Descriptive List of Targeted Benefits, Sub-Region 18, Kaweah River and Tule River Area					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Beneficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
183	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for beneficial uses	Eco, Ag or M&I	Irrigation season	Incomplete
184	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
185	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
186	Pixley National Wildlife Refuge	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable (mostly winter)	Incomplete
187	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

Sub-Region 19, Western Kern County



C—026593

Table 19.1. Descriptive List of Targeted Benefits, Sub-Region 19, Western Kern County					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Beneficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
188	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for beneficial uses	Eco, Ag or M&I	Irrigation season	Incomplete
189	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
190	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
191	Kern National Wildlife Refuge	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco	Variable (mostly winter)	Incomplete
192	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Incomplete

Sub-Region 20, Eastern Kern County

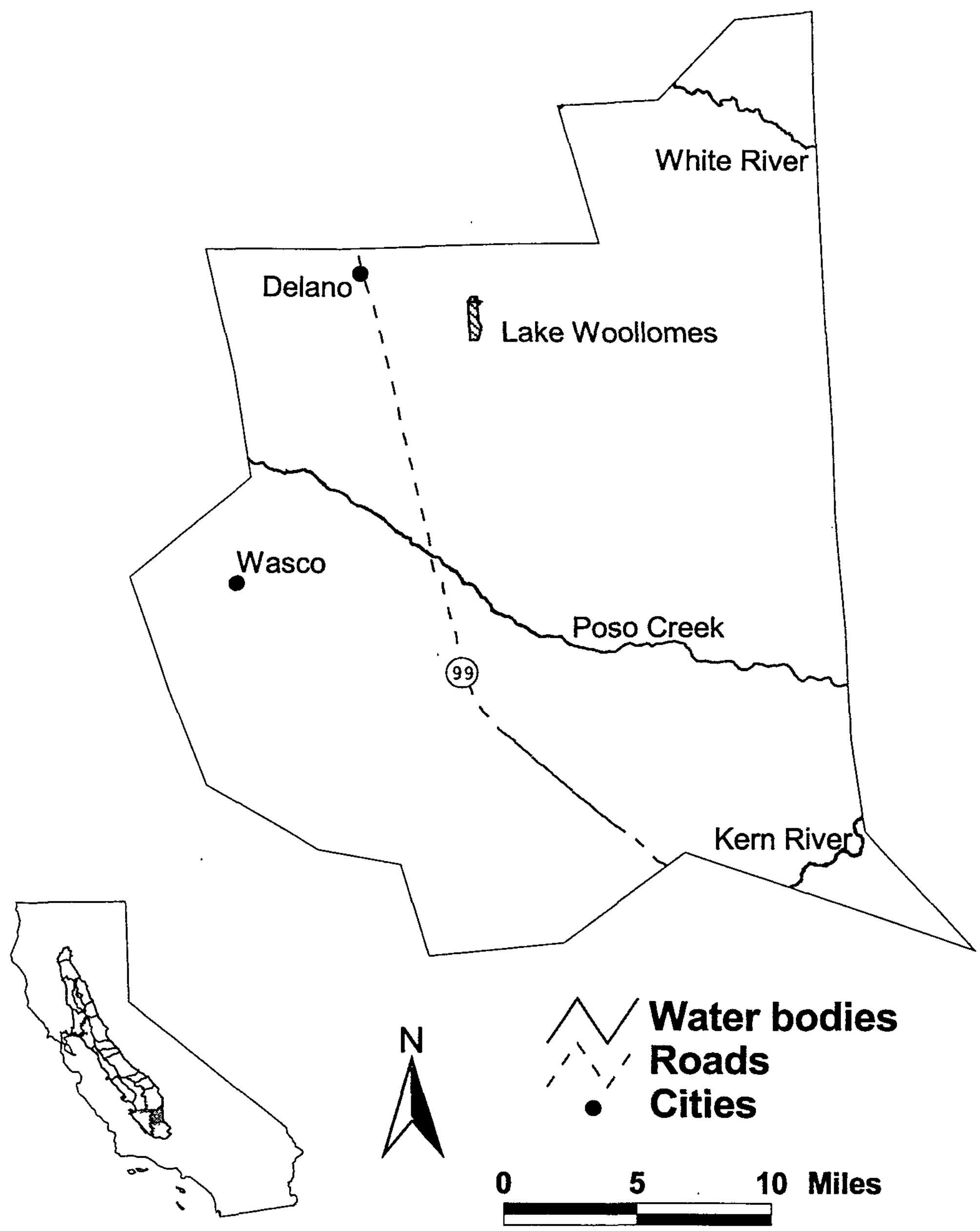


Table 20.1. Descriptive List of Targeted Benefits, Sub-Region 20, Eastern Kern County					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Beneficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
193	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
194	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
195	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

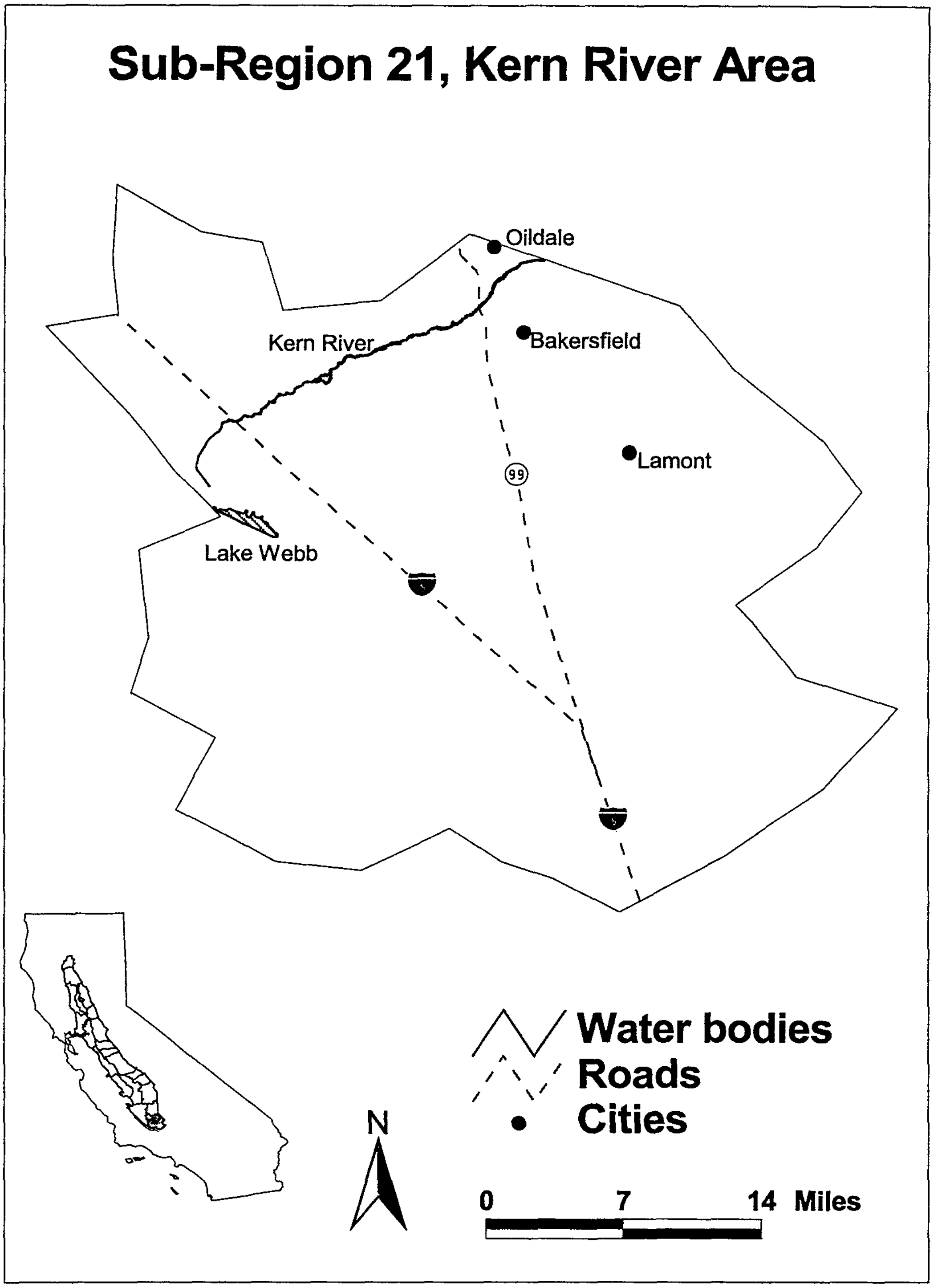

Sub-Region 21, Kern River Area
Oildale
Bakersfield
Kern River
Lamont
99
Lake Webb
Water bodies
Roads
Cities
N
0
7
14 Miles

Table 21.1. Descriptive List of Targeted Benefits, Sub-Region 21, Kern River Area					
TB # (1) [duplicate]	**Location (2)**	**Category of Targeted Benefit (3)**	**Bene-ficiary (4)**	**General Time-Frame (5)**	**Conceptual Completeness (6)**
196	All affected lands	Quantity: Decrease flows to salt sinks to increase the water supply for beneficial uses	Eco, Ag or M&I	Irrigation season	Incomplete
197	All affected lands	Quantity: Decrease nonproductive ET to increase water supply for beneficial uses	Eco, Ag or M&I	Year round	Complete
198	All suitable lands	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Eco, Ag or M&I	TBD	Incomplete
199	Salt affected soils	Quantity: Provide long-term diversion flexibility to increase the water supply for beneficial uses	Ag	Irrigation season	Complete

V. List of Abbreviations and Acronyms

303(d)	List of Impaired Water Bodies, State Water Resources Control Board
AAP	Available agriculture potential
Ag	Agriculture
AWMC	Agricultural Water Management Council
cfs	cubic feet per second
CVGSM	Central Valley Ground and Surface Water Model
CVHJVIP	Central Valley Habitat Joint Venture Implementation Plan
CVPIA	Central Valley Project Improvement Act
DAU	Detailed Analysis Unit
DWR	Department of Water Resources
Eco	the ecosystem
ERPP	Draft Ecosystem Restoration Program Plan
ETAW	evapotranspiration of applied water
M & I	municipal and industrial users
QO	Quantifiable Objective
QTBC	Quantified Targeted Benefit Change
RWQCB	Regional Water Quality Control Board
RWS (ICP)	Refuge Water Supply Interagency Cooperative Program
TAF	thousand acre feet
TB	Targeted Benefit
TBD	To be determined
USBR	United States Bureau of Reclamation
USGS	United States Geological Survey
WUE	Water Use Efficiency