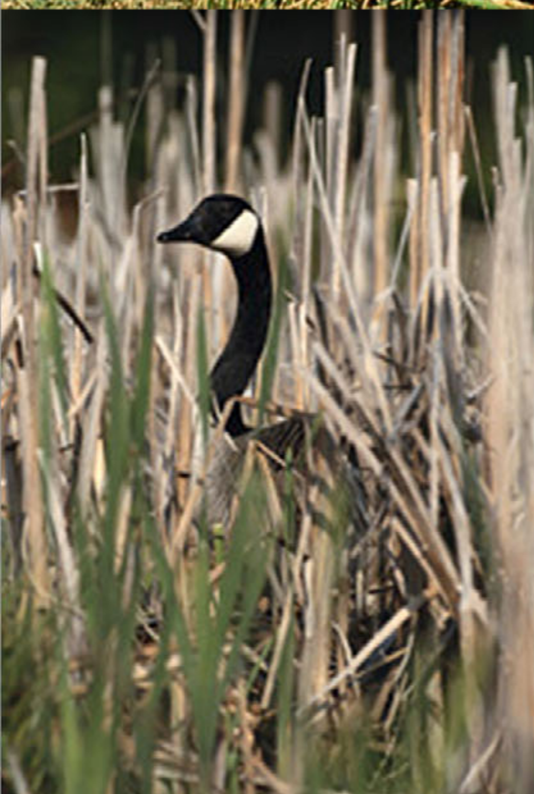

FINAL

Sacramento Valley

REGIONAL

Water Management Plan

Prepared by

Sacramento River Settlement Contractors
in cooperation with
U.S. Bureau of Reclamation

CH2MHILL

in association with

MBK ENGINEERS

January 2006

Preface

This Regional Water Management Plan (Regional Plan) was prepared by the Sacramento River Settlement Contractors in cooperation with the U.S. Bureau of Reclamation, in accordance with the *Regional Criteria for Evaluating Water Management Plans for the Sacramento River Contractors* (Regional Criteria). This document was developed as an outgrowth of the Basinwide Water Management Plan (BWMP), which was prepared to meet the requirements of a January 1997 "Memorandum of Understanding between the Settlement Contractors and the United States of America for the Preparation of Data in Aid of the Renewal of Settlement Contracts" (Contract Renewal MOU). The intent of the BWMP planning effort was as follows:

- To address specific issues outlined in the Contract Renewal MOU
- To provide a common set of data to serve as the basis for contract renewal negotiations
- To document district, sub-basin, and basinwide irrigation-season water requirements and available supplies
- To identify management tools and potential approaches to match supply and water requirements while identifying opportunities for environmental enhancement

Study participants and/or sponsors that were signatories to the Contract Renewal MOU and are participants in this RWMP include the following:

- Anderson-Cottonwood Irrigation District
- Glenn-Colusa Irrigation District
- Provident Irrigation District
- Princeton-Codora-Glenn Irrigation District
- Reclamation District No. 108
- Reclamation District No. 1004
- Meridian Farms Water Company
- Sutter Mutual Water Company
- Pelger Mutual Water Company
- Natomas Central Mutual Water Company

Participating agencies in the BWMP and signatories to the Contract Renewal MOU for the federal and state government were the U.S. Bureau of Reclamation and California Department of Water Resources, respectively.

The BWMP, which was finalized in 2004, identified potential water management improvements, including sub-basin-level management actions and system improvement (water use efficiency) projects. This planning process was a large step forward toward increasing cross-district communication and recognizing the potential for mutually beneficial projects and/or operations. The partnerships, cooperation, and ideas developed as part of the initial phases of the BWMP were a primary catalyst for the Sacramento Valley Water Management Agreement and the Sacramento Valley Water Management Program. A number of recommendations made in the BWMP (including potential inter-and intra-district projects and policy actions) were identified and summarized in Chapter 8 of the BWMP Plan Summary, included in Appendix D of this Regional Plan.

Regional Water Management Plan Format

This Regional Plan contains the following sections, in response to the Regional Criteria:

- 1.0 – Regional Description and Resources
- 2.0 – Sub-basin Water Use, Supply and District Descriptions
- 3.0 – Regional Water Measurement Program
- 4.0 – Analysis of Sub-region Water Management Quantifiable Objectives
- 5.0 – Identification of Actions to Implement and Achieve Proposed Quantifiable Objectives
- 6.0 – Establishment of Monitoring Program
- 7.0 – Proposed Budget and Allocation of Regional Costs
- 8.0 – Regional Plan Coordination

This Regional Plan is organized to provide regional, sub-basin, and district specific water use, supply, and facilities information to support improved water management. Section 3.0, Regional Water Measurement Program, contains a summary of the continued cooperative effort between the Sacramento River Settlement Contractors and Reclamation to evaluate current water measurement practices being implemented by the Sacramento River Settlement Contractors and develop recommendations for future practices. Sections 4.0 and 5.0 evaluate current targeted benefits for the study area, and propose quantifiable objectives based on potential feasible projects. Some of these projects have recently received partial CALFED Water Use Efficiency funding, and others will be submitted for consideration in upcoming funding rounds.

In addition, each participating district or company continues to encourage and implement smaller-scale, local water management activities and improvements, as also discussed in Sections 4.0 and 5.0. Regional Plan participants will continue to evaluate and pursue additional regional cooperation and inter-district management opportunities if mutual benefits can be identified and funding sources secured. Additional information can be found in the documents referenced in Section 9.0.

It is hoped that the data and relation ships developed in the preparation of this Regional Plan will continue to foster improved water management across the Sacramento Valley.

Index of U.S. Bureau of Reclamation Standard Criteria

Index of U.S. Bureau of Reclamation Standard Criteria
Sacramento Valley Regional Water Management Plan

Section	Regional	GCID	RD 108	PCGID	PID	RD 1004	PMWC	ACID	SMWC	MFWC	NCMWC
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Natural and Cultural Resources	1-19 through 1-24										
Operating Rules and Regulations	1-24 through 1-30	2-57 through 2-58	2-119 through 2-120	2-98 through 2-99	2-78 through 2-79	2-150 through 2-151	2-225	2-23 through 2-24	2-203 through 2-204	2-181 through 2-182	2-260 through 2-261
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Water Uses within the Region for the Representative Year(s)		---	---	---	---	---	---	---	---	---	---
Agriculture		2-35 through 2-36, 2-51 through 2-52	2-35 through 2-36, 2-114 through 2-115	2-35 through 2-36, 2-94 through 2-95	2-35 through 2-36, 2-74 through 2-75	2-133, 2-146 through 2-147	2-163 through 2-164, 2-220 through 2-221	2-4, 2-19 through 2-20	2-163 through 2-164, 2-199 through 2-200	2-163 through 2-164, 2-178 through 2-179	2-239 through 2-240, 2-255 through 2-256
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Identify Actions to Implement and Achieve Proposed Quantifiable Objectives	5-1 through 5-2	5-6 through 5-10	5-10 through 5-11	5-11 through 5-12	5-13 through 5-14	5-14 through 5-16	5-20 through 5-21	5-2 through 5-6	5-17 through 5-20	5-16 through 5-17	5-22
Establish Monitoring Program	6-3 through 6-11	6-1	6-2	6-2	6-2	6-2	6-2 through 6-3	6-1	6-2	6-2	6-3
Budget and Allocation of Regional Costs	7-1 through 7-3										
Regional Plan Coordination	8-1										

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Acronyms and Abbreviations

1995 WQCP	1995 Water Quality Control Plan for the San Francisco Bay/ Sacramento-San Joaquin River Delta Estuary
AB 3030 Plan	Assembly Bill 3030 Groundwater Management Plan
AB	Assembly Bill
ac-ft	acre-feet
ac-ft/yr	acre-feet per year
ACID	Anderson-Cottonwood Irrigation District
Ag WUE	Agricultural Water Use Efficiency Element
Bay-Delta	San Francisco Bay/Sacramento-San Joaquin River Delta
bgs	below ground surface
BWMP	Sacramento River Basinwide Water Management Plan
CALFED	CALFED Bay-Delta Authority
cfs	cubic feet per second
Coalition	Sacramento Valley Water Quality Coalition
Cooperative Study	Cooperative Water Measurement Study
CVP	Central Valley Project
Delta	Sacramento-San Joaquin River Delta
Department	California Department of Water Resources
ESA	Endangered Species Act
ET	evapotranspiration
GCID	Glenn-Colusa Irrigation District
M&I	municipal and industrial
maf	million acre-feet
MFWC	Meridian Farms Water Company
mg/L	milligrams per liter
MID	Maxwell Irrigation District
MRPP	Monitoring and Reporting Program Plan

msl	mean sea level
NCMWC	Natomas Central Mutual Water Company
NRCS	U.S. Department of Agriculture, Natural Resources Conservation Service
O&M	operation and maintenance
PCGID	Princeton-Codora-Glenn Irrigation District
Phase 8 Settlement	California Bay-Delta Phase 8 Settlement
PID	Provident Irrigation District
PMWC	Pelger Mutual Water Company
QO	quantifiable objective
RD	Reclamation District
Reclamation	U.S. Bureau of Reclamation
Regional Criteria	Regional Criteria for Evaluating Water Management Plans for the Sacramento River Contractors
Regional Plan	Sacramento Valley Regional Water Management Plan
SMWC	Sutter Mutual Water Company
SRSC	Sacramento River Settlement Contractor
SVWMP	Sacramento Valley Water Management Program
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf/yr	thousand acre-feet per year
TB	targeted benefit
TCCA	Tehama-Colusa Canal Authority
TIDC	Tisdale Irrigation and Drainage Company
TM	technical memorandum
TMDL	Total Maximum Daily Load
USFWS	U.S. Fish and Wildlife Service
Water Board	Central Valley Regional Water Quality Control Board

SECTION 1.0

Regional Description and Resources

The geographic boundary of the area covered by the Sacramento Valley Regional Water Management Plan (Regional Plan) and served by the participating Sacramento River Settlement Contractors (SRSC) is the portion of the Sacramento River Basin from Shasta Dam to the Sacramento metropolitan area. Figure 1-1 depicts the study area, which includes five generally hydrologic sub-basins identified as part of the Sacramento River Basinwide Water Management Plan (BWMP) and SRSC service area boundaries. The study area encompasses about 3,500 square miles, about 20 percent of which is included within the SRSC service area boundaries.

For this report, the downstream terminus of the Sacramento River basin is the confluence of the Sacramento and American Rivers. The American River is included in the Regional Plan only to the extent of its contribution as a major tributary to the Sacramento River at the downstream terminus of the Sacramento Basin. Ongoing water resources planning activities on the American River are included in the Regional Plan to the extent that they provide additional opportunities to optimize overall water resources management activities in the Sacramento Basin.

Similarly, the Feather River and its major tributaries are included in the Regional Plan only to the extent of their contribution as major tributaries to the Sacramento River. Requirements and water management considerations within the Feather River basin are not directly addressed in the Regional Plan.

1.1 History and Sub-basin Description

The history involving the development of water resource management along the Sacramento River, including water rights and Central Valley Project (CVP) water service contracts is covered in the attached BWMP.

Five unique sub-basins were identified to assess current and future water requirements, water supplies, and possible options to maximize management activities. The boundaries of each sub-basin were derived from existing California Department of Water Resources (Department) study boundaries where appropriate, accounting for the boundaries of each of the participating SRSC districts. In general, the sub-basin boundaries were developed according to the following considerations:

- Encompass participating SRSC boundaries
- Possess common hydrologic, land, and water use characteristics
- Consistency with Department planning boundaries, particularly the detailed analysis units and planning sub-area units

The five sub-basins identified as part of this process include the following:

- Redding Sub-basin
- Colusa Sub-basin
- Butte Sub-basin
- Sutter Sub-basin
- American Sub-basin

The Colusa, Butte, and Sutter Sub-basins are dominated by agricultural uses; municipal and industrial (M&I) uses are generally insignificant. The vast majority of total water requirements in the Sacramento Basin come from the agricultural sector. The Redding and American Sub-basins have extensive agricultural requirements as well as substantial M&I requirements related to the Redding and Sacramento urban areas, respectively. Environmental uses within the sub-basins include wildlife refuges, native vegetation and associated wildlife use, streams and the Sacramento River and associated aquatic and wildlife use, wetlands, duck clubs, mitigation lands, and habitat incidental to agricultural production (e.g., rice fields) and water conveyance (e.g., drain canals).

The majority of the districts, other than the most northerly Anderson-Cottonwood Irrigation District (ACID) and southerly Natomas Central Mutual Water Company (NCMWC) are generally rural and are surrounded by agricultural uses. Urban development has become an increasingly important factor for ACID, as Redding continues to encroach upon ACID from the north, and for NCMWC as Sacramento grows northward. Rice is the predominant crop for most of the districts given the clay soils that are prevalent; many of the growers within those districts have acquired equipment and expertise specific to rice. Other key crops include tomatoes, vine seed, corn, pasture, alfalfa, and orchard crops where suitable soils are present. The following provides a brief summary of the location and general characteristics of each sub-basin. Additional details are provided in Section 2.

1.1.1 Redding Sub-basin

The Redding Sub-basin is located at the northern extent of the Sacramento Valley. The sub-basin encompasses the Sacramento River from Shasta Dam to north of Red Bluff and consists of significant urban areas, including the cities of Redding, Anderson, Shasta Lake, and the community of Cottonwood. ACID is the participating SRSC within the Redding Sub-basin.

Relative to the sub-basins in the central and southern end of the study area, the Redding Sub-basin receives approximately twice as much rainfall annually; the rainy season may extend further into the spring months and delay the demand for irrigation water. Inflows to the sub-basin are dominated by natural runoff from tributaries to the Sacramento River and regulated Sacramento River flows released from Shasta Dam. Water is also imported from the Trinity River Basin. Outflows from the basin consist primarily of the Sacramento River flows.

Numerous water users along the Sacramento River divert water for agricultural and municipal uses. Many diversions are controlled by contracts with the U.S. Bureau of Reclamation (Reclamation) between April 1 and October 31. There are also numerous water

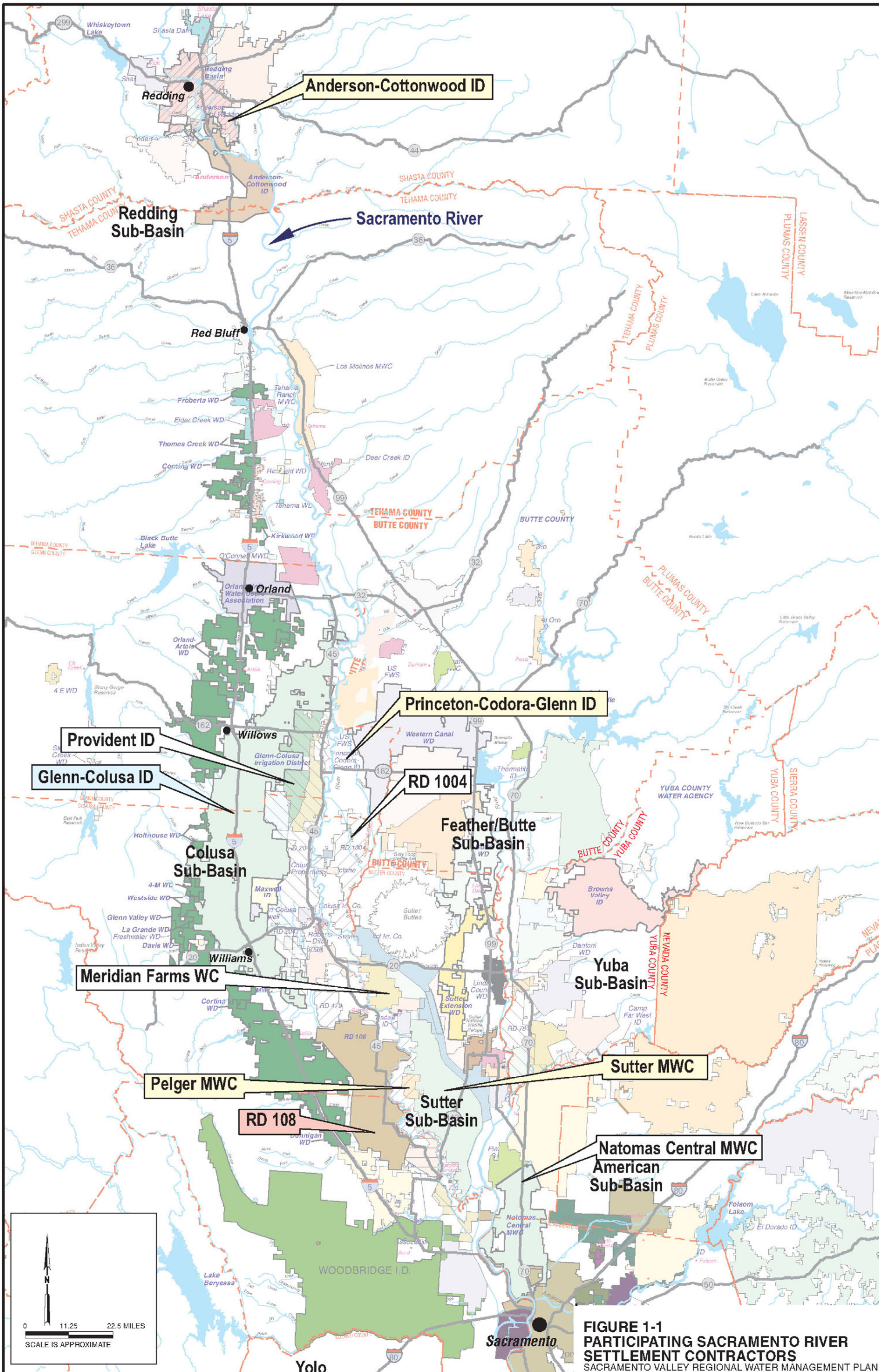

FIGURE 1-1
PARTICIPATING SACRAMENTO RIVER SETTLEMENT CONTRACTORS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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users with riparian and appropriative rights to Sacramento River water and associated tributaries in the sub-basin.

No California State Water Project (SWP) contractors are located in the sub-basin. A portion of most diversions returns to the sub-basin as a result of system leakage or deep percolation, which enters the groundwater system. In the groundwater system, a portion of this water remains in storage, and the remainder becomes subsurface flow to the Sacramento River or another part of the surface water system. A small percentage of these flows may be rediverted for irrigation purposes before reaching the river.

1.1.2 Colusa Sub-basin

The Colusa Sub-basin drains a portion of the west side of the Sacramento Valley and is bounded on the west by the Coast Ranges, on the north by Stony Creek, on the east by the Sacramento River (from the Glenn-Colusa Irrigation District [GCID] diversion facility to the Knights Landing outfall gates), and on the south by Cache Creek. Participating SRSCs within this sub-basin include the following:

- GCID
- Provident Irrigation District (PID)
- Princeton-Codora-Glenn Irrigation District (PCGID)
- Maxwell Irrigation District (MID)
- Reclamation District (RD) No. 108

Water users in the basin include other CVP contractors, such as the Tehama-Colusa Canal Authority (TCCA), Sacramento River riparian diverters, and groundwater users. There are no SWP contractors in the sub-basin.

Inflows to the sub-basin include diversions from the west bank of the Sacramento River and imports through the Tehama-Colusa Canal. Outflows occur either through the Colusa Basin Drain to the Sacramento River, the Knights Landing ridge cut to the Yolo Bypass, or the RD 108 pumping plant to the Sacramento River. Surplus water from precipitation and return flows from irrigation typically flow to the Colusa Basin Drain. This surplus water is rediverted (several times in some cases) for irrigation before leaving the basin as outflow.

Rice is the predominant crop grown by irrigators in the sub-basin. For example, irrigated lands in GCID, the largest water purveyor in the area, typically consists of over 75 percent rice. This percentage is generally less towards the southern end of the sub-basin.

1.1.3 Butte Sub-basin

The Butte Sub-basin is located on the east side of the Sacramento Valley and is bounded on the west by the Sacramento River, on the north by Big Chico Creek, on the east by Butte Creek and Butte Slough, and the south by the Sacramento River and Butte Slough. The participating SRSC within this sub-basin is RD 1004.

Inflows to the sub-basin include diversions from the east bank of the Sacramento River, Butte Creek, and Big Chico Creek. Outflows occur either through Butte Slough to Sutter Bypass or through RD 1004 pumping plants to the Sacramento River. Surplus water from precipitation and return flows from irrigation flow to Butte Slough. This surplus water can be rediverted for irrigation before leaving the basin as outflow.

Other water users in the sub-basin include the SRSCs Lewis Ranch and M&T Ranch. Western Canal Water District, which is a State Water Contractor, is located adjacent to the sub-basin.

1.1.4 Sutter Sub-basin

The Sutter Sub-basin is south of Butte Sub-basin and is located on the east side of the Sacramento Valley. This sub-basin is bounded on the west and south by the Sacramento River, on the north and northeast by Butte Creek and Butte Slough, and on the east by the Sutter Bypass west levee. Participating SRSCs within this sub-basin include the following:

- Meridian Farms Water Company (MFWC)
- Tisdale Irrigation and Drainage Company (TIDC)
- Sutter Mutual Water Company (SMWC)
- Pelger Mutual Water Company (PMWC)

Inflows to the sub-basin include diversions from the east bank of the Sacramento River, Butte Slough, and Sutter Bypass West Borrow Channel. Outflows occur through pumping plants operated by RD 70, RD 1500, and RD 1660. Surplus water from precipitation and return flows from irrigation are rediverted in portions of the sub-basin for crop irrigation. In particular, drain flows from landowners located outside water company boundaries (rim landers), along the western edge of the southern portion of the sub-basin, are reused by adjacent companies before being pumped out of the sub-basin.

In addition to the participating SRSCs, there are numerous short-form SRSCs, riparian diverters, groundwater users, and other irrigation companies with water rights on Butte Creek and Butte Slough. There are no SWP contractors in the sub-basin.

1.1.5 American Sub-basin

The American Sub-basin is bounded on the west by the Sacramento and Feather Rivers, on the north by the Bear River, and on the south and southeast by the American River. The eastern boundary is defined as the edge of the Sacramento Valley floor. Like the Redding Sub-basin, this sub-basin is unique in that a large proportion of municipal users are present throughout the area, including parts of the City and County of Sacramento and urban centers in Placer County, such as the City of Roseville. Most of the area is served with surface water or a combination of surface water and groundwater.

The NCMWC is the only SRSC in the American Sub-basin that is participating in this Regional Plan. Nonparticipating SRSCs include Pleasant Grove-Verona Mutual Water Company and numerous short-form SRSCs. Other major water users in the sub-basin include various CVP contractors associated with the American River; South Sutter Water District; Nevada Irrigation District; riparian diverters associated with the Sacramento, American, Feather, and Bear Rivers; and groundwater users. There are no SWP contractors in the sub-basin.

Inflows to the sub-basin include diversions from the Sacramento, Feather, Bear, and American Rivers and imported water from canals and tributaries originating in the foothills to the east. Outflows occur through four RD 1000 pumping plants to the Sacramento River, and through an RD 1001 pumping plant to the Natomas Cross Canal. Surplus precipitation and return flows from irrigators is rediverted in portions of the sub-basin for further crop irrigation.

1.1.6 Colusa Drain Mutual Water Company

The Colusa Drain Mutual Water District, located in the Colusa Sub-basin, holds a contract with Reclamation that has no provisions for a physical supply of water. The company pays Reclamation for project releases, which are required to offset the impacts to senior water rights holders downstream of the water company diverters, caused by calculated consumptive use within the company's service area. The company has historically required approximately 25,000 to 30,000 acre-feet (ac-ft) of replacement water that has been met with Project Supply provided under its contract with Reclamation or has been met with water transfers from SRSCs.

1.2 Surface Water and Groundwater Resources

1.2.1 Surface Water Resources

Water supply facilities that affect flow conditions on the upper Sacramento River above Red Bluff include CVP and local irrigation district facilities. The most significant feature is Shasta Dam, which was completed in 1944 and created the largest reservoir in the CVP. Shasta Dam provides a storage capacity of 4,552,000 ac-ft. Keswick Dam, completed in 1950 as part of the CVP, provides a storage capacity of 23,800 ac-ft and serves as an afterbay for Shasta Dam.

Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through CVP facilities. Historically, an average annual quantity of 1,269,000 ac-ft of water has been exported. This annual quantity is approximately 17 percent of the flows measured in the Sacramento River at Keswick.

Figure 1-2 shows the annual flows in the Sacramento River at Keswick from 1926 to 1997 and the average monthly flows for the following three periods:

1. Prior to the completion of Shasta Dam
2. Following the completion of Shasta Dam and prior to the completion of the Trinity River Division
3. Following the completion of the Trinity River Division

Prior to the construction of Shasta Dam, monthly flows reflected the runoff patterns associated with winter precipitation and spring snow melt. Peak flows generally occurred during the months of February, March, and April. Following the construction of Shasta Dam, average monthly flows during March and April were reduced, and average monthly flows during the summer irrigation months were increased. Following the construction of the Trinity River Division of the CVP in 1964, exports from the Trinity River Basin to the Sacramento River Basin increased the average annual releases from Keswick Dam.

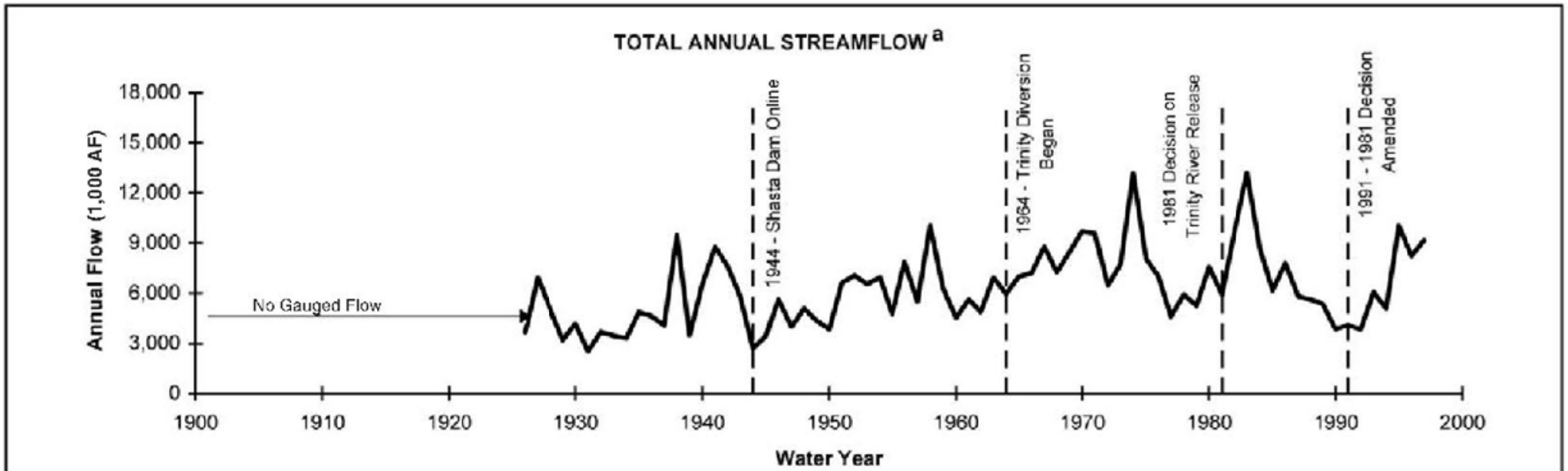
The portion of the upper Sacramento River between Keswick Dam and Knights Landing (upstream of the confluence with the Feather River) is fed by several tributaries that drain the west slope of the Sierra Nevada Mountains and the east slope of the Coast Range. The lower Sacramento River extends from Knights Landing, above the confluence with the Feather River, to Freeport, below the point where the Sacramento River crosses the Sacramento-San Joaquin River Delta (Delta) boundary (defined by the Delta Protection Act and Section 12220 of the California Water Code). The flows in this portion of the Sacramento River are increased primarily by the addition of the Feather and American River flows (BWMP; see Appendix D)

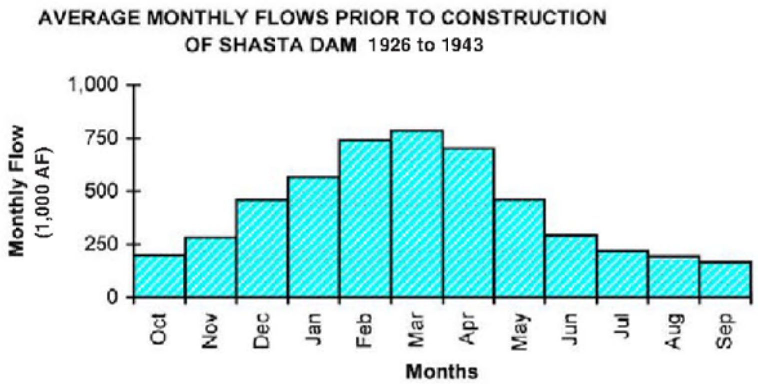
1.2.2 Groundwater Resources

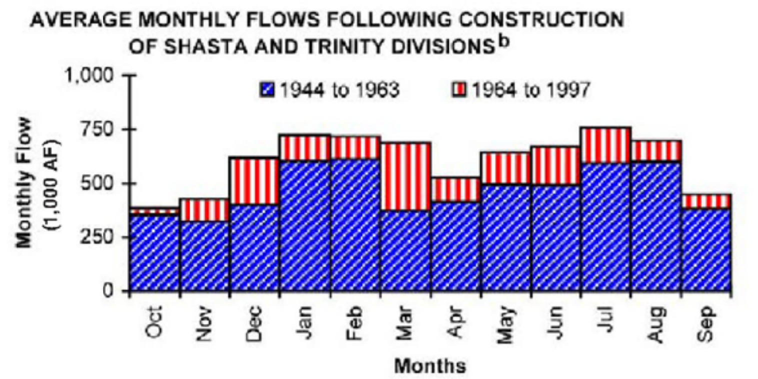
The northern third of the Central Valley regional aquifer system is located in the Sacramento Valley (see Figure 1-3). The Department identifies this portion of the Central Valley aquifer as the Sacramento Valley and Redding Basins, which cover over 5,500 square miles (Department, 1978). Most of the Redding Basin is underlain by several hundred feet of water-bearing materials, and groundwater characteristics are governed by unconfined conditions. A majority of the groundwater development in the Redding Basin has occurred south of the City of Redding. Irrigation wells typically range between 100 and 500 feet deep, although in some places the static groundwater level may be within 10 feet of the ground surface (Department, 1978). To date, an estimate of sustainable groundwater yield has not been determined for the Sacramento River Basin except in some specific areas.

Large amounts of groundwater are stored in thick sedimentary deposits in the Sacramento Valley Basin, ranging from several hundred feet thick in the northern portion of the basin, to 3,000 feet deep in the southern portion. Groundwater is used intensively in some areas but only slightly in areas where surface water supplies are abundant. Groundwater occurs in various degrees of confinement in the basin. Typically unconfined conditions occur in the alluvial deposits and partially confined to confined conditions occur at greater depths. Irrigation wells typically range from 100 to 600 feet deep; however, wells at depths greater than 1,000 feet exist in the southern portion of the basin. Groundwater levels associated with the Sacramento Valley Basin have historically declined moderately during extended droughts, generally recovering to predrought levels because of subsequent wetter periods. Groundwater levels can be within 10 feet of the ground surface in low-lying portions of the basin, and can increase to a depth of more than 100 feet toward the basin margins. Figure 1-4 illustrates recent groundwater level trends across the Sacramento Valley.

Groundwater in both the Sacramento and Redding Basins is typically replenished through deep percolation of streamflow, precipitation, and applied irrigation water; recharge by subsurface inflow is relatively small in proportion. A majority of streambeds are in contact with the underlying aquifer, making the systems hydraulically connected. Many streams have historically been gaining streams, a condition where groundwater is discharged into the stream. For conceptual model development and numerical modeling purposes, the system would be considered hydraulically disconnected only when the aquifer water levels fall below the elevation of the streambed. Typically, the Sacramento River is a gaining stream between Redding and Grimes, and a losing stream south of Grimes to south of Sacramento (Department, 1978).







NOTE:
a First full year of streamflow data for station 11370500 was 1939. Data for 1926 to 1963 are from Station 1136950 (Sacramento River at Kennet); data for 1964 to 1997 from USGS Station 11370500 (National Stream Quality Network Station).
b Following the construction of the Trinity River Diversion of the CVP in 1964, exports from the Trinity River Basin to the Sacramento River Basin increased average releases from Keswick Dam on an annual basis.

FIGURE 1-2
HISTORICAL STREAMFLOW IN THE SACRAMENTO RIVER BELOW KESWICK DAM
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_130 (6/13/05)

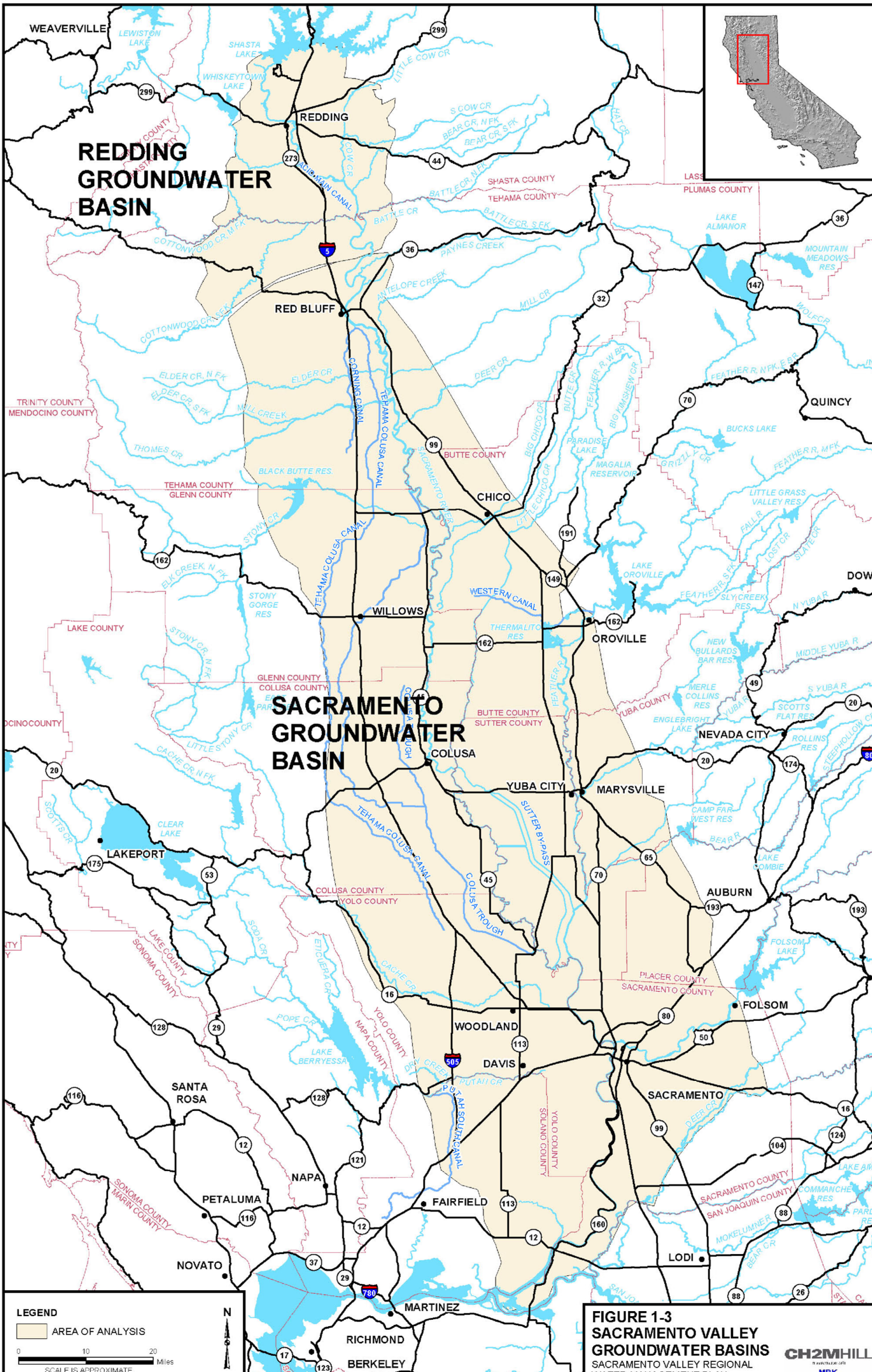


FIGURE 1-3
SACRAMENTO VALLEY GROUNDWATER BASINS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

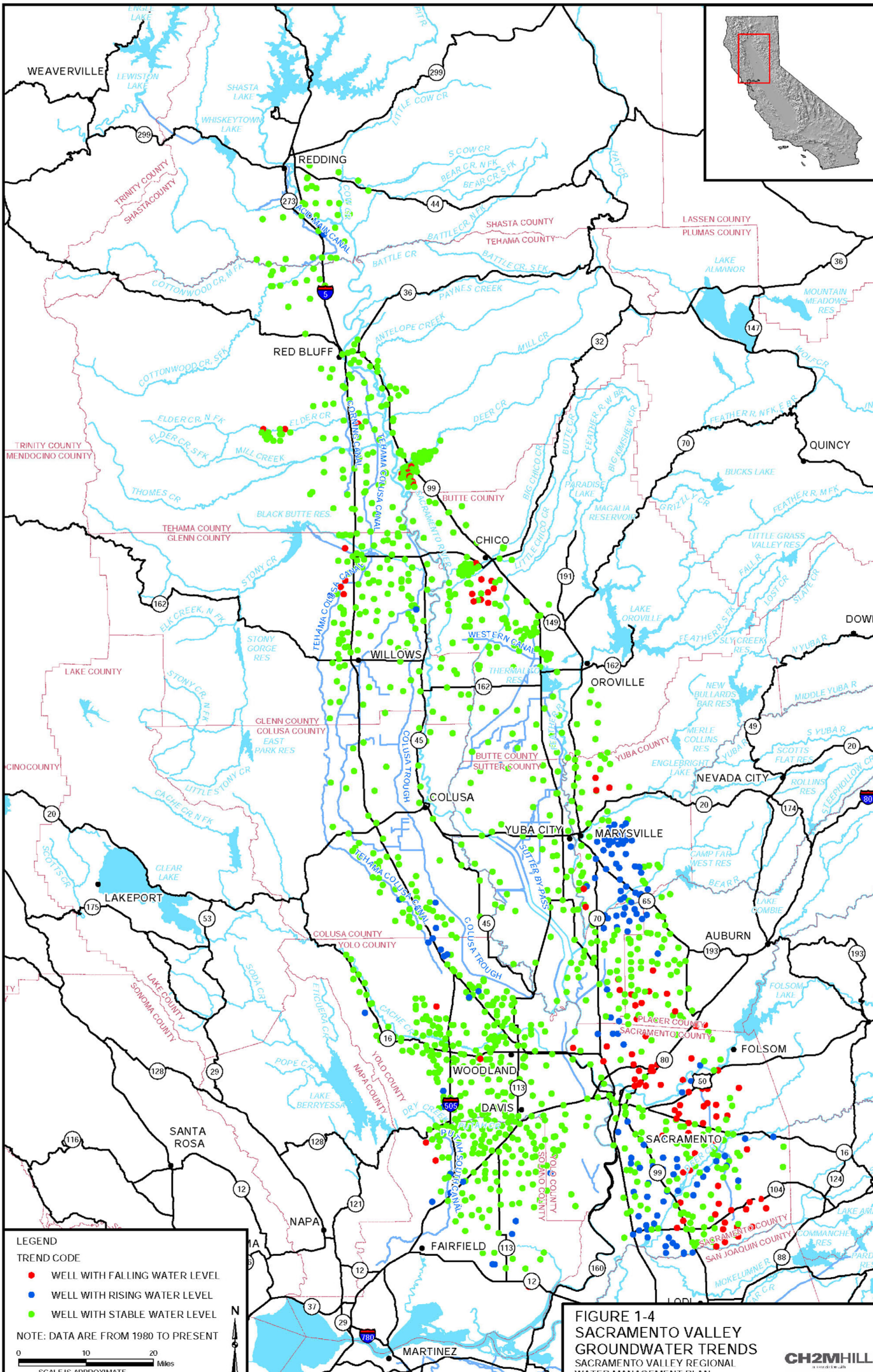


FIGURE 1-4
SACRAMENTO VALLEY
GROUNDWATER TRENDS
SACRAMENTO VALLEY REGIONAL
WATER MANAGEMENT PLAN

Attempts have been made to estimate sustainable yields for different regions of the basin; however, these estimates can vary significantly depending upon the methodology, water management, and land use assumptions. Discussion of these estimates is beyond the scope of this document; additional information is available in Department Bulletins 118, 118-6, 118-80, 160-93, and U.S. Geological Survey Water Resources Investigation 1401-A. The Department Bulletin 118-6 identifies three areas of greatest concern (areas where discharge has historically exceeded recharge), including the following: Placer and Sacramento Counties, northern Yolo and southern Colusa Counties, and Glenn County, west of Interstate 5. With the exception of Sacramento County, these areas have stabilized and groundwater levels are not declining because, on average, discharge no longer exceeds recharge as a result of importing surface water.

1.3 Typical District Facilities

Water diversion and conveyance facilities used by the participating SRSCs are generally similar in nature. Typical facilities are in-river diversion facilities, including pumps to lift water into conveyance canals and fish screens to ensure minimal impacts to the fishery. The diversion facilities also include measuring devices to track total diversion quantities.

In general, the majority of district canals move water via gravity flow, although some districts pump water where necessary to make deliveries. Some canals are lined, but the majority of canals in the valley are unlined. Unlined canals are inevitably susceptible to leaking as water slowly passes through the porous soil underlying the canal. While this water recharges the groundwater and is available later for use elsewhere, control of the leaked water is lost, and additional water must be diverted to compensate for water that has seeped from canals. To reduce this seepage, some districts have lined their canals with concrete or other relatively impermeable material. In many areas, canal lining has been determined to be infeasible where losses are relatively small. The seepage quickly returns to the river or can be recovered from the groundwater. Some districts have also elected not to line canals due to concerns related to the removal of wildlife habitat in areas where such vegetation has been allowed to grow, as well as due to relatively high capital costs.

The degree of system automation varies by district and is influenced by such factors as topography and the size of a particular district. Distribution of water supplies to a given field or set of fields is accomplished via smaller lateral canals which are designed wherever possible to allow for gravity flow. Pumping of water is limited to those areas where required.

Districts also maintain a series of tailwater drains to carry water away from fields, providing soil drainage and allowing productive use of the agricultural lands to continue. As much of this water is reused as possible, while some water is allowed to eventually return to the Sacramento River, seep to the groundwater table, or be pumped out and reused locally or by other downstream users. Many SRSCs, and other agricultural users in the Sacramento Basin incorporate reuse of this water into their overall water management plans, thereby decreasing their surface water diversions from the Sacramento River. In addition, reuse provides additional operational flexibility for water managers. Reliability, cost, and increasing soil salinity implications affect the level of reuse that may be effectively implemented at a sustainable level.

The Sacramento River Basin is unique because water is reused extensively both within and between districts. Accordingly, some typical management measures can adversely impact downstream users. The SRSCs are currently participating in a joint effort with Reclamation to investigate current and potential measurement approaches to identify what changes might be appropriate.

Greater detail on district-specific facilities and operations is provided in Section 2.

1.4 Topography and Soils

The SRSCs are situated within the Sacramento River Basin, within the Sacramento River watershed (see Figure 1-1). The basin is located in the northern portion of the Central Valley. Drainage is provided by the Sacramento River, which flows generally from north to south from its source near Mount Shasta to the Delta, and receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin.

1.4.1 Topography

The Sacramento River Basin's principal geographic features include the Sacramento Valley, which is bounded on the northwest by the Klamath Mountains, the west by the Coast Range, the northeast by the southern extent of the Cascade Mountains, and the southeast by the northern extent of the Sierra Nevada Mountains. Elevations in the northern portion of the Sacramento River Basin range from approximately 3,600 feet above mean sea level (msl) in the headwaters of the Sacramento River in the City of Mount Shasta, to approximately 1,100 feet msl at Shasta Lake. The mountainous areas that border the valley reach elevations higher than 5,000 feet msl.

The floor of the Sacramento Valley, where the various districts are located, is relatively flat, with elevations ranging from approximately 60 to 300 feet msl. The topography of the basin lends itself to district water operations and management. The surface water supply naturally flows in a southerly direction to where the majority of the agricultural users are located. Even with this relatively flat topography, there is typically enough variation within the basin to allow for gravity/surface irrigation. The water can also be easily pressurized into sprinkler or micro-irrigation systems. The topography also forms a natural drain in the lower portion of the valley at the Yolo Bypass.

The west side of the Sacramento Valley contains a number of reservoirs, including Black Butte, Stony Gorge, East Park, and Indian Valley Reservoirs. From the east side of the valley come various tributary rivers and creeks, including Big Chico Creek, Butte Creek, and the Feather River. The Sacramento Valley also contains the "world's smallest mountain range," the Sutter Buttes, located approximately 6 miles northwest of Yuba City; it is circular with a 10-mile diameter and covers an area of only 75 square miles.

1.4.2 Soils

The majority of the Sacramento Valley consists of soil that is fine textured with high clay content, mostly suitable for rice, tomatoes, and some cotton. Adjacent to the Sacramento River and the associated tributaries are coarser textured soils suitable for a wide variety of crops.

The soil associations found within the Sacramento Valley are identified below. The descriptions include soil associations that are dominant in their respective region of the Sacramento Basin – northern, central, and southern. Complete descriptions of the soil associations and the corresponding acreage of each association in the valley are provided in the soil surveys for Shasta, Tehama, Butte, Glenn, Colusa, Sutter, Yuba, and Yolo Counties prepared by U.S. Department of Agriculture/Soil Conservation Service (now the Natural Resources Conservation Service [NRCS]).

1.4.2.1 Northern Region

Dominant soil associations in the northern region, represented by Tehama County include the following (U.S. Department of Agriculture/Soil Conservation Service, 1967):

- Toomes-Guenoc: Shallow or moderately deep, rocky, gently sloping to steep soils, underlain by volcanic rock. Toomes soils are loams that are very rocky. Guenoc soils have a surface layer of loam and a subsoil of clay loam or clay.
- Newville-Dibble: Shallow to deep, moderately steep or steep, medium- to fine-textured soils underlain by soft sedimentary rock. Newville soils have a surface layer of gravelly loam and a subsoil of gravelly clay. Dibble soils consist of layers of silt loam or silty clay loam over dense compact siltstone.
- Maywood-Tehama: Very deep to moderately deep, nearly level to very gently sloping loams on floodplains and terraces along tributaries of the Sacramento River.

1.4.2.2 Central Region

Dominant soil associations in the central region, represented by Butte County are as follows:

- Stockton-Sacramento: Very deep, nearly level, moderately well-drained to poorly-drained soils occurring in nearly-level basins or floodplains in the Sacramento Valley. Stockton soils have granular clay surface layers and massive clay subsoils. Sacramento soils have granular to blocky clay surface layers and hard, blocky clay subsoils.
- Aiken-Cohassett: Moderately deep to very deep, gently sloping to steep, well-drained soils. Aiken soils have soft, granular loam surface layers, and slightly hard, massive clay subsoils over weathered rock. Cohasset soils are soft, granular, cobbly, loam surface layers and hard, blocky clay loam subsoils resting on weathered basalt rock.
- Goulding-Auburn: Shallow to very shallow, gently sloping to very steep, well drained soils. Goulding have soft, gravelly loam surface layers, and slightly hard, granular, very gravelly loam subsoils. Auburn soils have slightly hard, massive, cobbly, silt loam surface and hard, massive, silt loam subsurface layers that rest on metamorphic rock (U.S. Department of Agriculture/Soil Conservation Service, 1967).

1.4.2.3 Southern Region

Dominant soil associations in the southern region, represented by Colusa County are as follows (Haradine, 1948):

- Willows: Nearly level, fine-textured soils with moderately dense subsoils. Willows soils are clays with sedimentary alluvium rock as the parent material.
- Attamont-Contra Costa: Steep, shallow, medium-textured soils. Attamont-Contra Costa soils are clay loams with sedimentary rock as the parent material.

Soil profile characteristics in the southern region represented by Colusa County are as follows:

- Older alluvial fans, alluvial plains, or terraces having moderately developed profiles with moderately dense subsoils.
- Soils of upland areas formed in place from underlying consolidated sedimentary bedrock.

Soils in Shasta, Tehama, Butte, Glenn, Colusa, Sutter, Yuba, and Yolo Counties are currently classified according to profile characteristics. Soil profile characteristics for these counties will be updated and grouped into soil association descriptions after publication of the new NRCS county soil surveys. Identification of the limitations on the participating SRSCs' agriculture resulting from soil problems is not applicable to the *Bureau of Reclamation, Mid-Pacific Region, Regional Criteria for Evaluating Water Management Plans for the Sacramento River Contractors* (Regional Criteria). Specific data regarding soil problems and related impacts to agriculture are available through the districts or individual farmers in the districts.

1.5 Climate

The total annual precipitation in the headwaters area of the Sacramento River averages between 60 and 70 inches per year. The Sierra Nevada and Cascade Mountains receive as much as 95 inches annual precipitation. Snow is prevalent in the mountains bordering the Sacramento Valley, and areas above 5,000 feet receive an average of 42 inches of precipitation per year.

The Sacramento Valley is characterized by hot, dry summers and cool, wet winters (see Table 1-1). Most of the precipitation in the valley occurs during November through April. During the period between 1961 and 1999, the average annual rainfall in the area of the valley from Sacramento to Red Bluff was 19.52 inches, and ranged from a low of 15.82 inches to a high of 22.62 inches. During that same period, the average annual rainfall in the Redding area was 40.94 inches. Snowfall in the Sacramento Valley is rare, with the highest annual average of 4.8 inches measured in Redding.

Winds in the Sacramento Valley blow predominantly from the north and south because of the mountains bordering the valley. Annual average wind velocities range from 3.5 miles per hour in Mount Shasta to 8.2 miles per hour in Marysville. The average annual wind velocity for the valley is 6.6 miles per hour (Western Regional Climate Center, 2005).

TABLE 1-1
Average Temperature Range in the Sacramento Valley
Sacramento Valley Regional Water Management Plan

Parameter[a]	Temperature in °F
Annual Average Maximum Temperature	74.9
Annual Average Minimum Temperature	48.7
Average High Temperature in January	54.3
Average Low Temperature in January	37.0
Average High Temperature in July	95.4
Average Low Temperature in July	61.1

[a]Averages derived from five selected areas within Sacramento Valley (Orland, Colusa, Red Bluff, Sacramento, and Marysville).

Note:

°F = degrees Fahrenheit

Source:

Meteorological data were obtained from NOAA Fisheries.

1.6 Natural and Cultural Resources

1.6.1 Natural Resources

Historically, the Sacramento Valley contained a mosaic of riverine, wetland, and riparian habitat with surrounding terrestrial habitats consisting of perennial grassland and oak woodland. With settlement of the Sacramento Valley, agricultural and urban development converted land from native habitats to cultivated fields, pastures, residences, water impoundments, flood control structures, and other developments. The primary areas of concern are the Sacramento Valley portions of Shasta, Glenn, Colusa, Yolo, Solano, Butte, Sutter, Yuba, Nevada, Placer, and Sacramento Counties. Land uses in the Sacramento Valley are variable, and include developed areas ranging in character from downtown Sacramento to smaller communities such as Willows and Colusa. Most of the valley, however, is rural in character and developed for agricultural use. As a result, native habitats generally are restricted in their distribution and size and are highly fragmented.

The Sacramento Valley supports the following seven primary vegetation and wildlife communities:

- Seasonally flooded agricultural land
- Orchard and vineyard
- Wetlands
- Valley foothill riparian forest
- Foothill pine-oak woodland
- Blue oak woodland
- Non-native grassland

A few other habitats (e.g., mixed conifer, montane hardwood, and chaparral) occur in higher elevation areas.

Non-native grassland dominates the valley floor where there is no cultivation; otherwise, row and field crops and general agricultural land predominate, with rice, pasture, wheat, safflower, tomatoes, corn, and fruit and nut trees accounting for most of the crops. Rice fields are flooded in fall for rice stubble decomposition and the creation of wintertime waterfowl habitat. Agricultural drains and canals support wetland vegetation in some areas and provide habitat for wetland species; more extensive areas of freshwater marsh habitat are provided in several national wildlife refuges. Some vernal pool complexes persist in areas of non-native grassland, particularly in portions of Tehama and Butte Counties. The area within Butte and Sutter Counties is a relatively flat area with several trapped depressions that result in large hydrologic sinks that have no outlets. These sinks support a large amount of freshwater marsh habitat.

Special-status species are federal or state species of concern, species of local concern[1], species classified as candidates for future federal listing, California fully protected species, and plant species assigned special status by the California Native Plant Society. Table 1-2 lists the special-status species that might occur in the Sacramento Valley.

TABLE 1-2
Potential Federal and State Listed and Proposed Species in the Sacramento Valley Area
Sacramento Valley Regional Water Management Plan

Common Name	Scientific Name	Status
Wildlife		
American peregrine falcon	*Falco peregrinus anatum*	Federal – None State – E, FP
Bald eagle	*Haliaeetus leucocephalu*	Federal – T State – E, FP
Bank swallow	*Riparia riparia*	Federal – SC State – T
California black rail	*Laterallus jamaicensis coturniculus*	Federal – SC State – T
California clapper rail	*Rallus longirostris obsoletus*	Federal – E State – E
California freshwater shrimp	*Syncaris pacifica*	Federal – E State – E
California least tern	*Sterna antillarum browni*	Federal – E State – E
California red-legged frog	*Rana aurora draytonii*	Federal – T State – CSC
Conservancy fairy shrimp	*Branchinecta conservation*	Federal – E State – None
Delta green ground beetle	*Elaphrus viridis*	Federal – E State – None
Giant garter snake	*Thamnophis gigas*	Federal – T State – T
Greater sandhill crane	*Grus canadensis tabida*	Federal – None State – T, FP
Little willow flycatcher	*Empidonax traillii brewsteri*	Federal – SC State – E

[1]Any species of local or regional concern or conservation significance that might become vulnerable to extinction on a national level from declining population trends, limited range, and/or continuing threats.

TABLE 1-2
Potential Federal and State Listed and Proposed Species in the Sacramento Valley Area
Sacramento Valley Regional Water Management Plan

Common Name	Scientific Name	Status
Northern spotted owl	*Strix occidentalis caurina*	Federal – T State – None
Riparian brush rabbit	*Sylvilagus bachmani riparius*	Federal – E State – E
Riparian woodrat	*Neotoma fuscipes riparia*	Federal – E State – CSC
Salt marsh harvest mouse	*Reithrodontomys raviventris*	Federal – E State – E
Shasta salamander	*Hydromantes shastae*	Federal – SC State – T
Swainson's hawk	*Buteo swainsoni*	Federal – SC State – T
Valley elderberry longhorn beetle	*Desmocerus californicus dimorphus*	Federal – T State – None
Vernal pool fairy shrimp	*Branchinecta lynchi*	Federal – T State – None
Western snowy plover	*Charadrius alexandrinus nivosus*	Federal – T State – CSC
Western yellow-billed cuckoo	*Coccyzus americanus occidentalis*	Federal – C State – E
Vernal pool tadpole shrimp	*Lepidurus packardi*	Federal – E State – None
Plants		
Boggs Lake hedge-hyssop	*Gratiola heterosepala*	Federal – None State – E
Colusa grass	*Neostapfia colusana*	Federal – T State – E
Contra Costa goldfields	*Lasthenia conjugens*	Federal – E State – None
El Dorado bedstraw	*Galium californicum* ssp. *Sierrae*	Federal – E State – Rare
Few-flowered navarretia	*Navarretia leucocephala* ssp. *pauciflora*	Federal – E State – T
Greene's tuctoria	*Tuctoria greenei*	Federal – E State – E
Hartweg's golden sunburst	*Pseudobahia bahiifolia*	Federal – E State – E
Hairy Orcutt grass	*Orcuttia pilosa*	Federal – E State – E
Hoover's spurge	*Chamaesyce hooveri*	Federal – T State – None
Indian Valley brodiaea	*Brodiaea coronaria* ssp. *Rosea*	Federal – None State – E
Layne's ragwort	*Senecio layneae*	Federal – T State – Rare
Milo Baker's lupine	*Lupinus milo-bakeri*	Federal – None State – T
Palmate-bracted bird's beak	*Cordylanthus palmatus*	Federal – E State – E

TABLE 1-2
Potential Federal and State Listed and Proposed Species in the Sacramento Valley Area
Sacramento Valley Regional Water Management Plan

Common Name	Scientific Name	Status
Pine Hill ceanothus	*Ceanothus roderickii*	Federal – E State – Rare
Pine Hill flannelbush	*Fremontodendron decumbens* ssp. *Californicum*	Federal – E State – Rare
Sacramento Orcutt grass	*Orcuttia viscida*	Federal – E State – E
Scadden Flat checkerbloom	*Sidalcea stipularis*	Federal – None State – E
Showy Indian clover	*Trifolium amoenum*	Federal – E State – None
Slender Orcutt grass	*Orcuttia tenuis*	Federal – T State – E
Solano grass	*Tuctoria mucronata*	Federal – E State – E
Stebbin's morning-glory	*Calystegia stebbinsii*	Federal – E State – E

Notes:
E = Endangered under either the federal Endangered Species Act (ESA) or the California ESA
T = Threatened under either the federal ESA or California ESA
SC = U.S. Fish and Wildlife Service (USFWS) species of concern
CSC = California species of special concern
Rare = Classified as rare under Native Plant Protection Act
FP = California fully protected species

The Central Valley provides habitat for several species of native anadromous fish, including freshwater stages of Chinook salmon and steelhead. The Sacramento River provides a corridor to the ocean for anadromous salmonids that are spawned and reared in Central Valley rivers, streams, and hatcheries.

The Sacramento River is the largest river system in California and, along with the hatcheries on its tributaries, produces more than 90 percent of the Central Valley salmon and steelhead. The Sacramento River supports four runs of Chinook salmon – fall, late fall, winter, and spring – with fall Chinook being the most abundant. Most of the Central Valley fall steelhead are also found in the Sacramento River Basin. Native non-salmonid anadromous fish in the Central Valley include green sturgeon, white sturgeon, and Pacific lamprey.

Table 1-3 presents the special-status fish species that could occur in the Sacramento Valley, the regulatory status of each, and the water body where each species is anticipated to occur.

1.6.2 Cultural Resources

Archaeological evidence of human occupation in the Sacramento Valley and nearby areas extends back several thousand years. The Sacramento Valley was home to several Native American groups, including the Wintu, Yana, Nomlaki, Konkow, Nisenan, Patwin, By Miwok, and Plains Miwok.

TABLE 1-3
Special-status Fish Species within the Sacramento Valley
Sacramento Valley Regional Water Management Plan

Common Name	Scientific Name	Status	Location
Central Valley fall-run/late fall-run Chinook salmon	*Oncorhynchus tshawytscha*	C, CSC	Sacramento, Feather, Yuba, and lower American Rivers and the Delta
Central Valley spring-run Chinook salmon	*Oncorhynchus tshawytscha*	T, ST	Sacramento, Feather, and Yuba Rivers and the Delta
Central Valley winter-run Chinook salmon	*Oncorhynchus tshawytscha*	E	Sacramento River and the Delta
Central Valley steelhead	*Oncorhynchus mykiss*	T	Sacramento, Feather, Yuba, and lower American Rivers and the Delta
Delta smelt	*Hypomesus transpacificus*	T	Delta
Green sturgeon	*Acipenser medirostris*	C, CSC	Sacramento and Feather Rivers and the Delta
Hardhead	*Mylopharodon conocephalus*	CSC	Sacramento and Feather Rivers
Longfin smelt	*Spirinchus thaleichthys*	CSC	Delta
River lamprey	*Lampetra ayresi*	CSC	Sacramento River and the Delta
Sacramento perch	*Archoplites interruptus*	CSC	Sacramento River and the Delta
Sacramento splittail	*Pogonichthys macrolepidotus*	CSC	Sacramento, Feather, and lower American Rivers and the Delta
San Joaquin roach	*Lavinia symmetricus* ssp.	CSC	Sacramento River

Notes:

E	=	Endangered	Federally listed as being in danger.
T	=	Threatened	Federally listed as likely to become endangered within the foreseeable future.
P	=	Proposed	Officially proposed for listing as endangered or threatened.
C	=	Candidate	Candidate to become a proposed species.
ST	=	State Threatened	State listed as likely to become endangered.
CSC	=	California Species of Special Concern	Species of special concern to the California Department of Fish and Game.

The northern Sacramento Valley saw the majority of white settlement following the California Gold Rush. Settlement was further stimulated by the 1862 Homestead Act and construction of railroads. Settlements included the establishment of farms, ranches, gold mines, and lumber and other extractive industries.

Through the late nineteenth and twentieth centuries, the expansion of riverboat and ferry transportation and later railroad and highway transportation infrastructure increased access to more distant markets. The northern end of the Sacramento Valley developed a growing population sustained by a mix of mineral and timber extraction industries and farm and ranch operations. Large-scale irrigation of farms and ranches was made possible in the mid-twentieth century by completion of Shasta Dam and other large water reservoirs and aqueduct projects. In recent decades, recreation and tourism have emerged as important components of the local economy.

Following the California Gold Rush, white settlers developed the farmland in the region and made use of its abundant water. Several agricultural developments were introduced. Today, the Sacramento Valley enjoys a diverse population and industry with vast stretches of rich farmland.

The southern region of the Sacramento Valley includes portions of Yolo, Glenn, Solano, and Colusa Counties. After the California Gold Rush, many miners became permanent settlers who raised cattle, sheep, wheat, and barley. Initially, the location of towns and settlements was influenced by access to water and water transportation routes. In the late nineteenth century, emphasis shifted from livestock grazing to growing grain and orchard crops.

In the 1870s, the railroad progressed northward and brought settlers who established towns such as Arbuckle, Williams, Maxwell, Willows, and Orland. With the advent of large-scale flood control and irrigation projects, the Colusa Sub-basin has become noted for growing rice and tomatoes. Large-scale, diversified farming was introduced as new lands were irrigated and brought into production and as shipment of local products to domestic and international markets increased with improved railroad and highway transportation systems.

1.7 Operating Rules, Regulations, and Agreements that Affect Water Availability

The operating rules, policies, and regulations for the region vary from district to district. In general, operating rules and regulations include lead time for water orders and water shutoff, policies on water allocation, return flows and drainage, and policies related to water transfers into or out of each participating SRSC. The operating rules and regulations for each participating SRSC depends on how each was originally formed. For example, mutual water company policies and procedures are determined by a board of trustees; water districts formed under Chapter 11 of the California Water Code have policies and procedures that are determined by a board of directors who require the districts to hold a certain amount of money in reserve. For a more complete description of the operating rules and regulations for each participating SRSC, see Section 2. Copies of available district rules and regulations are included in Appendix E.

1.7.1 Surface Water Resources

The construction and operation of the integrated and coordinated CVP changed the regimen of the Sacramento River. Various institutional and regulatory measures since construction of this project have occurred that continue to change the way Sacramento River flows are managed.

The operation of the CVP is, and historically has been, affected by the provisions of several regulatory requirements and agreements. The operation of the CVP was affected by State

Water Resources Control Board (SWRCB) Decisions 990 (1961), 1422 (1973), and 1485 (1978), and the Coordinated Operations Agreement (1986). Decision 990 authorized the issuance of permits for the operation of most major CVP facilities. Decisions 1422 and 1485 identify minimum water flow and water quality conditions at specified locations that are to be maintained in part through the operation of the CVP. The Coordinated Operations Agreement specifies the responsibilities between the CVP and SWP for meeting the requirements of Decision 1485.

Beginning in 1987, a series of actions by the SWRCB, U.S. Environmental Protection Agency, NOAA Fisheries (formerly was known as the National Marine Fisheries Service), and USFWS affected interim water quality standards in the Delta. In 1993, NOAA Fisheries, in formal consultation, issued a *Long-term Winter-run Chinook Salmon Biological Opinion* that addresses modifications to the long-term CVP operational plan to avoid jeopardizing the Sacramento River winter-run Chinook salmon. Also in 1993, USFWS released a biological opinion on the effects of operational actions by the CVP and SWP on Delta smelt and associated habitat.

The Central Valley Project Improvement Act was enacted in October 1992. This act defined fish and wildlife use to be equal with other authorized purposes of the project. These requirements further modified the way the CVP was operated.

In December 1994, representatives of the state and federal governments and urban, agricultural, and environmental interests agreed upon a recommendation to the SWRCB for changes in water quality objectives to provide ecosystem protection for the San Francisco Bay/Sacramento-San Joaquin Delta (Bay-Delta) Estuary. This recommendation was called the Principles for Agreement on Bay-Delta Standards between the State of California and the Federal Government. The SWRCB used several elements of this agreement and recommendations from other interested parties to prepare the 1995 Water Quality Control Plan for the Bay-Delta Estuary (1995 WQCP) (SWRCB, 1995). The plan superseded the 1978 Water Quality Control Plan for the Delta and Suisun Marsh adopted by the SWRCB in Decision 1485.

There are several ongoing efforts that will likely affect the way the CVP is operated, including the Bay-Delta CALFED Program (CALFED), the Trinity River Restoration Program, the Bay-Delta Hearings, and numerous other regional programs. In general, the net result of these efforts will likely further narrow the operating flexibility of the CVP.

Other agreements that affect water availability include water transfers and forbearance agreements. As water demands across California continue to increase, the value of water transfers to help meet agricultural, urban, and environmental needs will also increase. Within the Sacramento Valley, the most recent example of a multi-user water transfer is the forbearance agreements among several SRSCs and the Westlands Water District. Although a forbearance agreement technically might not be considered a water transfer, it meets the same objective of making surface water available for other uses in different locations. In April 2001, a group of 21 SRSCs entered into agreements with Reclamation to forbear from diverting certain quantities of water from the Sacramento River. This water was then provided to the Westlands Water District in the San Joaquin Valley. The forbearance agreements stipulated that the participating SRSCs forego diversion from the Sacramento River through groundwater substitution or reducing consumptive uses by 160,000 ac-ft of water, which, in turn, was transferred to Westlands Water District. These agreements could be used as a basis for additional short- or long-term water transfers in the future.

1.7.2 Groundwater Resources

Assembly Bill (AB) 3030, passed by the California legislature in 1992, authorized existing local water service agencies to develop and implement groundwater management plans within their service areas. AB 3030 encourages basinwide coordination of groundwater management. Joint-power agreements among authorized water service agencies, memorandums of understanding, or other agreements between authorized water service agencies and public or private entities can form the organizational basis for regional groundwater management. Because district and county boundaries were not delineated with groundwater basins in mind, it is not uncommon for a single agency to be involved in groundwater management activities in multiple sub-basins.

Within the Sacramento River Basin, several coordinated groundwater management plans have been developed. Groups that have developed these plans include the Redding Area Water Council and the Tehama County Flood Control and Water Conservation District in cooperation with individual, private pumpers and water-related districts. In northern Sacramento and southeastern Sutter Counties, coordinated groundwater management is being planned and implemented by the Sacramento Area Water Forum and the Sacramento North Area Groundwater Management Authority pursuant to the Sacramento County Water Agency Act.

In the northernmost area of the Sacramento River Basin, the Redding Area Water Council has developed an AB 3030 Groundwater Management Plan (AB 3030 Plan) for the Redding Groundwater Sub-basin (see Figure 1-5). Members of the Redding Area Water Council include the following:

- City of Anderson
- City of Redding
- City of Shasta Lake
- Shasta County Water Agency
- ACID
- Bella Vista Water District
- Clear Creek Community Services District
- Centerville Community Services District
- Cottonwood Water District
- Shasta Community Services District
- Mountain Gate Community Services District
- Simpson Paper Company
- McConnell Foundation

This association of public agencies and private entities has agreed to prepare, adopt, and implement an AB 3030 Plan with the Shasta County Flood Control and Water Conservation District serving as lead agency. The Redding Area Water Council plans to develop a cooperative program to assess, monitor, and protect the quality of groundwater in the Redding Sub-basin.

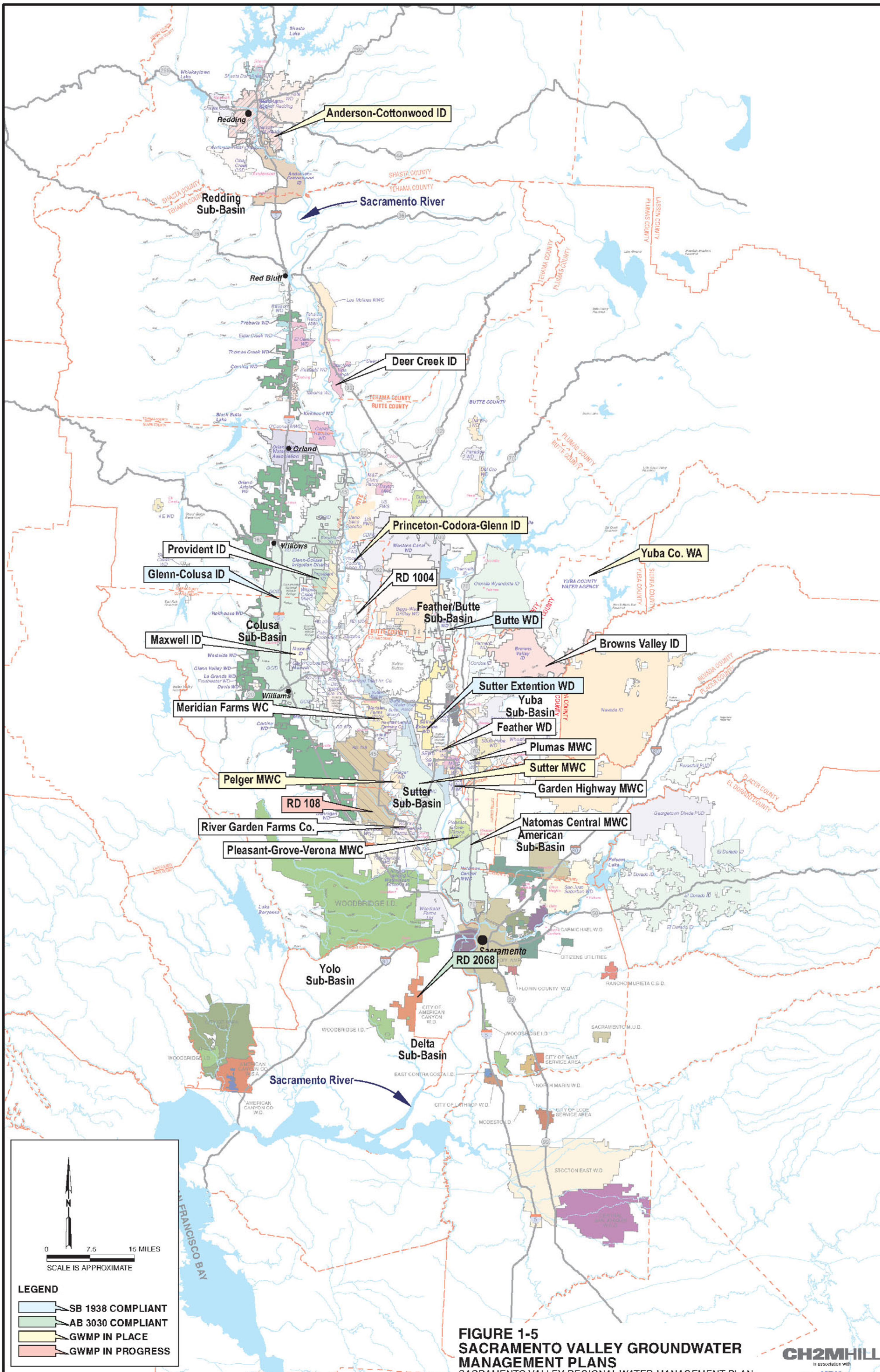


FIGURE 1-5
SACRAMENTO VALLEY GROUNDWATER MANAGEMENT PLANS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

The Tehama County Flood Control and Water Conservation District has adopted a coordinated AB 3030 Plan that will address the management of groundwater resources in the Bend, Antelope, Dye Creek, Los Molinos, Vina, Corning, and Red Bluff Sub-basins, as well as the southern part of the Redding Sub-basin.

In the Colusa Sub-basin (see Figure 1-5), AB 3030 Plans have been drafted and adopted by water service agencies both individually and jointly. The GCID and RD 108 have each adopted plans for their service areas. A joint AB 3030 Plan has been adopted by the PCGID and PID. In the southern part of the Colusa Sub-basin, the Yolo County Flood Control and Water Conservation District is developing a management plan for the conjunctive water management of their surface water and groundwater supplies. In the West Butte Sub-basin, located on the eastern side of the Sacramento River (see Figure 1-4), an AB 3030 Plan has been adopted by the Western Canal Water District whose service area is located in both Glenn and Butte Counties. RD 1004, located primarily in Colusa County and extending into Sutter County, is currently drafting an AB 3030 Plan.

In the Sutter Sub-basin, which lies between the Sutter Bypass and the Sacramento River (see Figure 1-5), RD 1500 has adopted an AB 3030 Plan. The boundaries of SMWC roughly coincide with the boundaries of RD 1500, and PMWC lies within RD 1500.

In the American Sub-basin (see Figure 1-5), South Sutter Water District and the Sacramento Metropolitan Water Authority have adopted AB 3030 Plans. Participants in the Sacramento North Area Groundwater Management Authority include the following:

- Arcade Water District
- Carmichael Water District
- Citizens Utilities
- Citrus Heights Water District
- City of Folsom
- City of Sacramento
- County of Sacramento
- Del Paso Manor Water District
- Fair Oaks Water District
- NCMWC
- Northridge Water District
- Orangevale Water District
- Rio Linda/Elverta Community Water District
- San Juan Water District
- Southern California Water District

Many of the above agencies and private companies are also participants in the Sacramento Area Water Forum, which is pursuing groundwater management for an area that extends into both the North American and South American Sub-basins. Part of Placer County is also included in this sub-basin. Groundwater management for the portion of this sub-basin in western Placer County is under the authority of the Placer County Water Agency, which has adopted an AB 3030 Plan for this area.

Additional authority to manage groundwater is provided through county ordinances. Within the Sacramento River Basin, Shasta, Tehama, Glenn, Butte, Colusa, Yolo, and

Sacramento Counties have adopted groundwater ordinances. Each of these ordinances establishes procedures to apply for a permit to export water and criteria that must be met prior to any out-of-county water transfer. Groundwater overdraft, land subsidence, saltwater intrusion, injury to overlying groundwater users, and adverse effects on long-term groundwater storage or transmission characteristics of the aquifer are among the issues addressed in these ordinances. Each county ordinance requires the completion of an environmental review with financial responsibility for this review resting with the applicant. Butte, Colusa, and Glenn Counties have adopted additional groundwater ordinances that address well spacing and health and safety issues.

1.8 Water Measurement, Pricing, and Billing

Water measurement at the district level provides necessary information and monitoring data to make decisions and efficiently manage the water supply. Water measurement for a typical Sacramento Valley irrigation district can be considered in terms of four basic operations levels – supply, conveyance and distribution, turnout to individual fields or customers, and drainage. The methods used to measure water for these operations are driven largely by several key factors common to most of the SRSC districts. These include scheduled water delivery (as opposed to on-demand or rotation), unlined earthen canals and laterals on open-channel distribution systems, related irrigation methods within a given district, the predominance of particular crops, and the operation and maintenance (O&M) costs related to different measurement methods. There are also many local and site-specific factors that influence the choice of measurement methods, both between and within districts. The extent of water measurement, the methods used, and the level of recording and documentation vary greatly between individual SRSCs, from extensive measurement and reporting at all operational levels to only minimal measurement at key supply and distribution points.

To support a more standardized level of documentation related to current water measurement devices and approach, the participating SRSCs will individually conduct an inventory of current water measurement devices used to measure flows at diversions, laterals, and, if determined to be appropriate in cooperation with Reclamation, turnouts. This inventory will be completed by the first annual update in parallel with the Cooperative Water Measurement Study (Cooperative Study) Work Plan, discussed in Section 1.8.1.7. Table 1-4 shows a template of the table to be provided with this inventory. Section 3 provides additional information about the Cooperative Study.

1.8.1 Measurement Practices

The following discussion summarizes current practices among the SRSCs. In addition, Table 1-5 provides a brief description of measurement methods used by each participating SRSC. The potential benefits of improved water measurement, factors in selecting measurement methods, and water measurement for each operational level for both current practices and potential improvements are provided in Section 2 and in BWMP Technical Memorandum (TM) 5 (see Appendix D).

TABLE 1-4
Agricultural Measurement Device Table
Sacramento Valley Regional Water Management Plan

Measurement Type	Number	Accuracy (+/-percentage)	Reading Frequency (Days)	Calibration Frequency (Months)	Maintenance Frequency (Months)
Orifices					
Propeller					
Weirs					
Flumes					
Venturi					
Metered Gates					
Total					

TABLE 1-5
Existing Sacramento River Settlement Contractors Measurement Methods
Sacramento Valley Regional Water Management Plan

SRSC	Measurement Method
ACID	Main river diversions have meters, which measure both flow rate and total flow volume. Flow rates are measured at major lateral headgates by weirs or gate head-flow tables. Flows at field turnouts are measured using canal headgate position tables. Total volumes pumped by drain pumps are estimated using power consumption and pump efficiency history.
GCID	Main canal flows are metered. Main laterals and sub-laterals serving field turnouts are metered. Drain pumps and groundwater wells are metered. Turnouts to fields are measured and totaled by service area using the measurements of the service lateral. Lateral spills are measured using lateral stage measurement and weir equations. Drain outflows are measured using weirs and meters.
PID	Main pump-station flows are measured using flowmeters. Wells and drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts.
PCGID	Main pump–station flows are measured using flowmeters. Wells and drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts.
RD 108	Pump-station flows are measured using flowmeters. Drain pumps and lift pump flows are estimated using power consumption and pump efficiency curves. Wells and drain pumps are metered. Drain flows discharged into the river are metered at pump stations. Flows in canals and laterals are calculated using head measurements at gates and weirs.
RD 1004	Pump stations at river diversions measure flow and quantity using flowmeters. Canal and lateral flows are measured using meters and totalizers. The well is metered. Drain-pump flows are estimated using power consumption and pump efficiency data.
MFWC	Pump-station flows are measured with flowmeters. Canal and lateral flow rates are measured using weir or gate head/flow curves. Wells are metered. Drain-pump flows are estimated using power consumption and pump efficiency data.
SMWC	Main pump-station flows are measured with flowmeters and pump flowcharts. Flows at lateral headgates are measured using headgate position. Drain lift-pump flows are measured using power consumption records and capacity information. Drainage leaving the company is measured using a Department formula.
PMWC	Main pump-station flows are measured with flowmeters. Flows at lateral headgates are measured using headgate position. Drain-pump flows are measured with meters. Wells have flowmeters. Turnouts are measured using canal stage and turnout gate position.
NCMWC	Main river-diversion pump stations measure flows using flowmeters. Drain-pump and secondary lift-pump volumes are estimated using power consumption and pump efficiency data. This method is also used to estimate outflow amounts from drainage pumps into the river.

1.8.1.1 Sacramento River Diversions – Current Practices

Diversions from the Sacramento River are the primary water source for each participating SRSC. These diversions are delivered via pump or gravity flow. Pumped diversions are measured and recorded using meters or calibrated pump curves. Gravity diversions are measured using either water level measurement at weirs or flumes, or by flowmeters (propeller type) installed in full-flow pipes such as road-crossing culverts. Measurement devices for river diversions are typically installed and maintained by Reclamation staff.

1.8.1.2 Distribution Canals and Laterals – Current Practices

Flows in the canals and laterals are typically measured at major flow-control structures such as in-line gates (checks) and lateral turnouts (headgates). The most common type of measurement uses gate or weir geometry and position, and measured water level (head) in the canal. Typically, only the flow rate is recorded at these points. Some districts measure both flow rate and total flow using the average flow rate and duration of operation. This requires either very stable water level control or continuous water level measurement to provide good accuracy. In some cases, lateral turnouts are measured using propeller meters installed in short runs of full-flow pipes downstream of headgates, such as at road-crossing culverts. This method provides both flow rate and total quantity with good accuracy. In-line flumes and weirs with stage recorders are used in a few locations for main canal flows only.

1.8.1.3 Groundwater Wells – Current Practices

In most districts, wells are primarily privately owned. District-owned wells typically have flowmeters and totalizers. In some cases, the total quantity of flow can be estimated through power use records; however, this requires some measurement of the water level in the well, which may fluctuate over a great range during operation.

1.8.1.4 Drains – Current Practices

Drain flow measurement can be categorized within each district's service area in terms of total inflows and total outflows. Inflows include water coming into the service area from upstream districts, tailwater runoff from individual fields, and operational spills (intentional or otherwise) at the ends of laterals or overflow points. Outflows from drains include water pumped from drains back into the distribution system, gravity outflow as the drain leaves a district service area, and pumped outflow directly into the Sacramento River.

Most districts do not measure total inflows to drains. In some cases, inflows from other districts are estimated by water stage at key drain diversion point check structures. Some districts measure operational spills and intentional turnouts to drains by recording the water level at overflow weirs on a daily basis. Inflows from field tailwater are generally not measured. Outflows from drains are generally measured by a combination of drain pump (relift to laterals) meters or power use records, reclamation drain pump meters or power use records, and recording of stage at key gravity outflow points from the district service area.

1.8.1.5 Field Turnouts – Current Practices

In most cases, delivery of water to individual fields is measured for flow rate only or for flow rate and total quantity delivered in other cases. Districts measure flows using a combination of the following methods:

- Standard canal gates (screw gates) at the upstream end of short culvers measure flow rate using differential head and gate position.
- Flash-board overshot or undershot weirs measure flow rate using head and weir or orifice geometry.
- Constant-head-orifice arrangements measure flow using differential head on upstream gate.
- Gated culverts or constant-head-orifice turnouts with open-channel propeller meters on the downstream end measure flow rate and total quantity.

Measurement of total quantity requires recording flow rate and the total time of delivery with a relatively stable canal water surface, or use of a totalizer device. Several districts measure and record both flow rate and total delivered quantity without using meters, by having operators record both the set flow rate and the start-stop time of each daily delivery.

1.8.1.6 Flowmeters – Current Practices

Most SRSC districts have tried open-channel propeller flowmeters, but many have experienced problems with frequent clogging from debris, resulting in loss of accuracy and necessitating high maintenance requirements. Currently, only RD 1004 uses flowmeters to measure all field turnouts. These meters are used for recording flow rates and delivery quantity for billing purposes. The meters have been in service for several years and are considered by the district to work effectively with reasonable maintenance and regular cleaning by operators.

Discussions with other SRSC operations staff have identified the following concerns related to field turnout meters:

- Accuracy – Meters are typically ±5 percent to 10 percent accurate. Under marginal or poor operating conditions, accuracy may decrease to ±15 percent or worse. This degree of accuracy limits the ability to track proportionate changes in efficiencies.
- Cost – The relatively high capital costs for meters and the necessary related upgrades such as headwalls, new culverts, and downstream stilling wells; O&M costs for cleaning, repair, and calibration.
- Range of flow rates – Rice fields may require two meters for low and high flows.
- Headloss – Minimal head in many canal reaches cannot drive the meter at the required flow rate and velocity combination needed.
- Ability to pass sediment and debris – Standard references such as the Reclamation *Water Measurement Manual* (Reclamation, 1997) do not recommend meters if debris or moss are present. Maintenance issues include calibration, replacement of damaged components, removal before and replacement after winter storage, and frequent debris cleaning.

- Vandalism potential – there is high vandalism potential in many remote areas of the districts.

1.8.1.7 Joint Reclamation/SRSC Cooperative Field-level Measurement Study

The issue of appropriate water measurement at various operational levels within the SRSC service area distribution systems continues to be an important issue for both Reclamation and the SRSCs. The SRSCs and Reclamation are participating in a cooperative study to evaluate options for improved water measurement within the SRSC service areas, including the evaluation of appropriate field-level measurement. The initial effort is focused on establishing a work plan, budget, and schedule for a full program. It is expected that additional funding will be obtained as required according to the final scope and work plan. This funding may come from a variety of sources, including Reclamation programs, CALFED's Agricultural Water Use Efficiency Element (Ag WUE) funds, or Department assistance programs. The SRSCs submitted an application for Ag WUE funding in January 2005 for the next phase of the study.

As part of this initial effort, specific study locations (fields or groups of fields) are being identified within SRSC service areas to collect key baseline information needed during the study process. Study areas are anticipated to consist of a continuous block of fields, served by a single supply lateral. It is intended that measurement devices will be installed and data will be collected at these specific locations at the turnout and lateral level. The study will make general comparisons of these two levels of measurement in terms of irrigation operations, overall water balance accuracy, and device costs and maintenance. Data collected as part of the study could potentially be used by some districts to develop quantity-based pricing. In addition to Reclamation and SRSC technical staff participation, the overall approach and process for selecting specific locations is being conducted in association with an outside technical expert to ensure objectivity and proper focus. The study work plan is included as Appendix B and is discussed further in Section 3.

1.8.1.8 Sub-basin-level Water Measurement Study

To support improved water management in the Sacramento Valley on a broader scale, the *Sub-basin-level Water Measurement Study* (See Appendix A) was proposed by the SRSCs and funded by CALFED. Given the BWMP's recommendation that sub-basin management be further examined, the study focuses on increasing the accuracy of water measurement at the sub-basin level. The ongoing study is a preliminary investigation of potential measurement locations, facilities, and associated implementation issues to allow for water measurement in the five Sacramento Valley sub-basins addressed in the BWMP. The original sub-basin-level proposal included an extensive evaluation, design, permitting, and construction program to install and improve existing measurement capability. The SRSCs submitted an application for Ag WUE funding in January 2005 for the next phase of this study.

The ongoing initial study is focused on identifying key logical measurement locations and the condition of existing facilities. Current water measurement practices at major sub-basin outflow locations are being assessed as to O&M and potential improvements. Data collection procedures and calibration are also being documented along with observed accuracy issues. The measurement study will culminate with recommendations to improve water measurement at key sub-basin outflow locations, anticipated associated costs, and implementation issues. The study work plan is included as Appendix B and is discussed further in Section 3.

Information specific to each participating SRSC's water measurement practices by operations level, including a description of the types of devices typically used, general maintenance, and calibration practices can be found in Section 2.

1.8.2 Pricing Structures and Billing

Water pricing is a fundamental agricultural water management tool. When used effectively, water pricing structures can provide a direct economic signal for the water user between the quantity of use and farm-level water management practices, crop types, and net financial results. As a district-level management option, water pricing structures can encourage more efficient use of existing water supplies or other specific targeted benefits. The mechanisms and influence of water pricing structures on Ag WUE and overall agricultural economics are complex. Detailed evaluation of the impacts of pricing structures on existing district practices requires sophisticated economic modeling to capture the multitude of influences that ultimately determine land use choices, irrigation practices, water use levels, crop prices, and net economic benefits or costs to growers and districts. The following sections provide a summary of existing pricing structures, a range of possible new pricing structures, and issues related to the evaluation and implementation of an incentive pricing program.

1.8.2.1 Existing Pricing Structures

Existing price structures are influenced by many factors, including the cost of water supplies, the water district or company incorporation charter and regulations, operating costs, crop types, and irrigation methods within a service area. Districts typically set a price structure that covers O&M costs and long-term capital replacement and improvement costs. Some of the current price structures include a direct or indirect quantity component.

Pricing structures include a basic annual maintenance charge (e.g., $10 per ac-ft per year or $10 per share of company stock per year) that is independent of water use. In addition to this annual charge, pricing structures typically include one of the following charges:

- Per acre: Dollar per acre per season. May vary by crop type or be the same for all crops.
- Per irrigation: Dollar per acre per irrigation event. Charged for each scheduled irrigation throughout the season. May vary by crop type, or be the same for all crops. May also vary by time of year, with the first irrigation of the season having the highest cost, subsequent regular irrigations a slightly lower cost, and post-harvest irrigations for weed control or rice decomposition another cost.
- Per ac-ft: Dollar per ac-ft delivered. Charged for the volume of irrigation water delivered.

1.8.2.2 Indirect Price Signals Related to Water Use

Water pricing is only one of several direct and indirect cost signals to which a grower might be subject. For a farmer who pays a flat rate, the sum of the base charge and annual irrigation charge as referenced in Table 1-6, for water use as an SRSC customer, may still have a monetary impact through such things as quantity and cost of fertilizers, pesticides, and herbicides. Increased water use may increase costs for these inputs. Poor water management by over irrigating may reduce yields and resulting gross revenue. If the farmer operates a private well or drain pump, the electrical power costs are a direct cost related to water use. Districts must cover operating and capital expenses with revenue from customers. Excessive irrigation results in increased pumping costs from the Sacramento River, the drain system, and wells. These costs are ultimately passed directly back to the growers, albeit at an average rate for all district customers. Many SRSC operating staff have authority to shut off delivery to a customer whose field is observed to be poorly irrigated and allowed to have excessive tailwater runoff.

TABLE 1-6
Existing SRSC Pricing Structures
Sacramento Valley Regional Water Management Plan

SRSC	Pricing Structure
ACID	Base charge of $69.00 per acre per year. Annual irrigation charge of $115.00 per parcel. Irrigation delivery is on rotation basis.
GCID	Base charge of $6.00 per acre per year. Annual irrigation charge of $55.75 per acre (rice).
PID	Base charge of $2.00 per acre per year. Annual irrigation charge of $46.00 per acre (rice).
PCGID	Base charge of $10.00 per acre per year. Annual irrigation charge of $75.00 per acre (rice).
RD 108	Annual irrigation charge of $53.00 per acre for rice. $13.00 per irrigation (first of season) and $7.50 per irrigation (subsequent) for other crops.
RD 1004	Per-ac-ft charge of $8.50 per ac-ft, measured at customer turnout.
MFWC	Base charge of $19.50 per acre per year. Annual irrigation charge of $96.00 (rice).
SMWC	Base charge of $25.00 per acre. Recently implemented a per acre charge of $75.00 (rice). Previously charged on a per ac-ft basis measured at customer turnout.
PMWC	Base charge of $15.00 per share. Annual irrigation charge of $30.00 to $50.00 per acre, varies by crop.
NCMWC	Base charge of $26.30 per acre. Annual irrigation charge of $52.80 per acre (rice) and $5.42 per acre (other crops). Rice decomposition flooding charge of $15.00 per acre. Administration fee is $32.80 per acre.

Information specific to each participating SRSC's pricing structure, including the basis of the water charges and copies of current billing forms used by each, can be found in Section 2.

1.9 Water Shortage Allocation Policies

1.9.1 CVP Sacramento River Contract Supply Requirements

The CVP supplies approximately 6 to 7 million ac-ft (maf) of water annually to water contractors in the Central Valley, Santa Clara Valley, and Contra Costa County. As identified above, total CVP contractual entitlements north of the Delta total approximately 4 maf. Contracts with various entities specify that full contractual water deliveries be made except during dry periods. During periods of reduced supplies, water deliveries are decreased according to the curtailment terms in the contracts.

1.9.2 Criteria for Defining Water Availability

Except in times of critical-year reductions and water shortages, the CVP makes available the amount of water specified in the terms of its water right settlement and CVP water service contracts. Conditions for determining the quantity of water available to the SRSC during water shortage years are based on the Shasta Criteria. The Shasta Criteria are used to determine when a water year is considered to be critical, based on inflow to Shasta Lake. If a water year is determined to be critical, deliveries of Base and Project Supplies to SRSCs are reduced to 75 percent of the contract amount. A critical year is any year when on, or before, February 15 the forecast full natural inflow to Shasta Lake for the current water year (October of the preceding calendar year through September 30 of the current calendar year) is equal to or less than 3.2 maf. A year is also critical when the total accumulated actual deficiencies are below 4 maf in the previous water year or series of successive previous water years, each of which had inflows of less than 4 maf, together with the forecast deficiency for the current water year, exceed 800,000 ac-ft.

Water availability for delivery to CVP water service contractors during periods of insufficient water supply is determined at the discretion of Reclamation according to a combination of operational objectives, hydrologic conditions, and reservoir storage conditions. In years of shortage, Reclamation has historically allocated shortages equally among water service contractors within the same general area (e.g., north of the Delta). There is no limit on the shortage that Reclamation can declare for CVP agricultural water service contractors, and Reclamation can reduce their water supplies to zero. Some CVP M&I water service contracts provide for a minimum allocation of 75 percent of the contract supply, and in drought years, Reclamation has applied that standard to M&I water service contracts.

The CVP contractors along the Sacramento River are grouped into the following three major categories.

1.9.2.1 Sacramento River Service Contractors

Most of these SRSCs claimed water rights in the Sacramento Basin prior to the construction of Shasta Dam. Contract provisions specify potential reductions of no more than 25 percent of contracted amounts during dry conditions (as determined by the Shasta Inflow Index). Approximately 2.2 maf of water (1.8 maf being designated as Base Supply) is allocated annually for delivery to the SRSCs. This total represents approximately 55 percent of the total quantity of water Reclamation must provide for agricultural, M&I, and wildlife refuge uses north of the Delta. The SRSC entitlements represent the majority of CVP water that is used north of the Delta. Additionally, SRSC supplies are the most reliable among contract holders because the SRSC entitlements are subject to the least severe curtailments.

1.9.2.2 CVP Water Service Contractors

These agricultural and M&I water service contractors entered into agreements with Reclamation for delivery of CVP water as a supplemental supply. Water deliveries to agricultural water service contractors can be reduced up to 100 percent in particularly dry years. Maximum curtailment levels are not specified for most M&I water service contractors. Water availability for delivery to CVP water service contractors during periods of insufficient supply is determined by a combination of operational objectives, hydrologic conditions, and reservoir storage conditions. Given the curtailment provisions, water service contractors holding these contracts have a relatively less reliable supply than the SRSCs. Examples of this type of water service contractor within the Sacramento River Basin include those associated with the TCCA.

Approximately 1 maf of water is allocated annually for delivery to CVP water service contractors (approximately 0.5 maf is allocated to both agricultural and M&I water service contractors) in the basin. This represents approximately 25 percent of the total quantity of water Reclamation must provide for agricultural, M&I, and wildlife refuge uses north of the Delta.

1.9.2.3 Colusa Drain Mutual Water Company

This company was chartered in 1988, to serve as a vehicle for entering into a contract with Reclamation. The company is composed of diverters from the Colusa Basin Drain who are not within previously existing water districts. The company's service area includes approximately 57,500 acres, extending over 80 miles of the Colusa Drain from Glenn to Yolo Counties. The Reclamation contract with the company has no provisions for a physical supply of water. The company pays Reclamation for project releases, which are required to offset the impacts to senior water rights holders downstream of the company diverters, caused by calculated consumptive use within the company's service area. The company has historically required approximately 25,000 to 30,000 ac-ft of replacement water that has been met with Project Supply provided under its contract with Reclamation or has been met with water transfers from SRSCs.

1.10 Water Quality

1.10.1 Surface Water Quality

Water from the Sacramento River and its major tributaries is generally of good quality. Total dissolved solids in the Sacramento River and its major tributaries (Yuba, Feather, and American Rivers) is typically low, while higher median concentrations of dissolved solids occur at agricultural sites such as the Sacramento Slough and Colusa Basin Drain, but are diluted upon mixing with Sacramento River water. Nutrient concentrations such as nitrate are low (below drinking water standards) throughout the Sacramento River Basin. At some locations, algae attached to streambed material is abundant, indicating that further investigation of nutrient dynamics and their consequences to the streams of this watershed is warranted. Excess algal growth, which is usually related to higher-than-normal nutrient inputs to streams, is a water quality concern when the algae affect the aquatic community (because of dissolved oxygen depletion). No such effects were observed in the Sacramento River or its major tributaries. Excess algae also can contribute to taste and odor problems in drinking water.

Some stream segments are listed as impaired by various contaminants. Impairment means that a standard of water quality for beneficial uses (for example, as a source of drinking water or for recreation or industrial use) is not being met. Pursuant to Section 303(d) of the Clean Water Act, states are required to periodically review water quality data and develop lists of water bodies that do not meet their designated beneficial uses.

On the basis of California's 2002 list of impaired water bodies, the segment of the Sacramento River from Keswick Dam to Knight's Landing is listed as impaired because of toxicity of unknown origin, and the segment from Knight's Landing to the Delta is listed as impaired due to diazinon, mercury, and toxicity of unknown origin. Diazinon is attributable to agricultural runoff, while mercury is primarily attributable to discharges from abandoned mines such as those located upstream of Keswick and from the Feather River Basin.

1.10.1.1 Mineral Water Quality

The segment of the Sacramento River between Keswick Dam and Red Bluff has excellent to good mineral quality; therefore, the water is suitable for most M&I uses[2]. Most of the water can be classified as calcium-magnesium bicarbonate, is slightly hard but does not require softening. Many tributaries drain to the upper Sacramento River without deteriorating mineral quality, indicating the excellent mineral quality of the tributaries.

From Red Bluff to the Delta, the Sacramento River is generally of good mineral quality, although water quality is periodically degraded because of the discharge of toxins, untreated sewage, and other nonpoint-source contaminants. In the lower Sacramento River, agricultural drainage influences water quality by contributing to increased turbidity and mineral, nutrient, and herbicide loads. The state agencies and agricultural entities continue to promote management practices to ensure that discharges from agricultural lands do not exceed performance goals established by the Central Valley Regional Water Quality Control Board (Water Board).

1.10.1.2 Sediment

Turbidity levels are generally excellent but become seasonally elevated because of high flows in Cottonwood Creek, which is highly susceptible to sediment loading during high runoff[3]. Sediment levels in the Sacramento River and Feather River are typically low when compared to tributary contributions comprised primarily of agricultural return flows.

1.10.1.3 Dissolved Oxygen

The Sacramento River downstream of Keswick Dam is a designated spawning area for anadromous fish and has a minimum allowable dissolved oxygen level of 7 milligrams per liter (mg/L). At the Red Bluff Diversion Dam, the river maintains oxygen levels near saturation, with concentrations that have ranged from slightly below 10 mg/L to over 12 mg/L.

1.10.1.4 Salinity

The two primary parameters for characterizing irrigation water are salinity hazard and sodium hazard. Salinity hazard is classified as low if specific conductance is less than 250 microhms per centimeter at 25 degrees Celsius. The maximum specific conductivity at

[2] For drinking water purposes, mineral quality has been defined using the following hardness levels: calcium carbonate less than 75 milligrams per liter (mg/L) – soft (excellent mineral quality); calcium carbonate between 75 and 150 mg/L – moderately hard (good mineral quality); $CaCO_3$ between 150 and 300 mg/L – hard (fair mineral quality); and calcium carbonate greater than 300 mg/L – very hard (marginal to unacceptable mineral quality).

[3] For drinking water purposes, source-water turbidity levels have been defined accordingly: turbidity less than 5 nephelometric turbidity units (NTU) – excellent; turbidity between 5 and 50 NTUs – good; turbidity between 50 and 100 NTUs – fair; and turbidity greater than 100 NTUs – impaired.

any of the Sacramento River locations did not exceed 250 microhms per centimeter at 25 degrees Celsius during 1997. The sodium hazard is classified as low if the sodium adsorption ratio is less than 10.

1.10.1.5 Heavy Metals

Acid mine drainage has been a serious environmental problem in the northern portion of the Sacramento River Basin. Several Sacramento River tributaries are listed as impaired due to high concentrations of metals such as cadmium, copper, lead, and zinc. Detected metals concentrations have been toxic to fish in the upper Sacramento River near, and downstream of, Redding.

1.10.1.6 Pesticides

The agricultural use of herbicides, insecticides, and fungicides (collectively referred to as pesticides) may result in seasonal aquatic toxicity, sediment toxicity, or exceedance of drinking water quality standards. Historically, discharges of rice herbicides resulted in impacts to the drinking water quality of the cities of Sacramento and West Sacramento. Water quality regulations enacted in the 1980s resulted in changes in rice water management practices, which significantly reduced the levels of rice herbicides present in drainage water.

Pursuant to the Central Valley Water Board’s “Conditional Waiver of Waste Discharge Requirements for Irrigated Lands,” water quality monitoring for specific classes of pesticides, including organophosphates, carbamates, and pyrethroids, is being undertaken in the Sacramento River and the Delta. The monitoring effort will provide data over the next few years to better understand of the timing, magnitude, and duration of potential pesticide water quality concerns.

1.10.1.7 Organic Carbon

Organic carbon is a concern to municipal drinking water agencies. During the disinfection process, organic carbon reacts with chlorine to form disinfection by-products. Organic carbon can be present in dissolved and particulate forms. Dissolved organic carbon can pass through a 0.45-micrometer filter; particulate organic carbon is retained by the filter. Collectively, dissolved organic carbon and particulate organic carbon are referred to as total organic carbon. The specific types of organic molecules that may be present in natural water range from small compounds, such as formic or acetic acid, to large macromolecules such as proteins.

Dissolved organic carbon comprises the majority of the total organic carbon load in the Sacramento River. During the irrigation season, dissolved organic carbon levels in the Sacramento River at Colusa typically range from 1 to 2 mg/L, while dissolved organic carbon levels in the Sacramento River at Verona typically range from about 2 to 3 mg/L. During the irrigation season, levels in tributaries dominated by agricultural return flows can range from 3 to 9 mg/L.

1.10.1.8 Water Quality Monitoring

Water quality monitoring is undertaken by a number of agencies and organizations in the Sacramento Valley. The Department Northern and Central Districts maintain a network of water quality monitoring and surface water sampling stations in the Redding Sub-basin and in counties throughout the Sacramento Valley. The agency operates electronic continuous recorders for field monitoring of water quality parameters. Periodically, agency personnel conduct field analyses and collect water quality samples for laboratory analysis from rivers, lakes, reservoirs, and certain drains in the Sacramento Valley. The agency also conducts studies to determine the physical, chemical, and biological characteristics of streams, lakes, and reservoirs in the districts. The studies, in part, are conducted to evaluate factors contributing to enrichment (eutrophication), factors affecting drinking water quality, and the influence of watershed development. The Department also maintains a database of current and historical water quality data.

Under new water quality requirements, agricultural water users in the Sacramento Valley began implementation of water quality monitoring programs in 2004. Monitoring locations are at mainstem and tributary sites, including agricultural drains. The parameters monitored include conventional water quality parameters (pH, temperature, dissolved oxygen, turbidity, and salinity), and aquatic and sediment toxicity. Future phases of monitoring will focus on analysis of specific high-use pesticides and other drinking water constituents of concern such as organic carbon and nutrients. Monitoring is being under-taken by the Sacramento Valley Water Quality Coalition (Coalition) and by the California Rice Commission. The Coalition includes members throughout the Sacramento Valley, while the California Rice Commission includes commercial rice acres within the Sacramento Valley. The Coalition monitoring program includes 26 sites and the California Rice Commission program includes 5 main sites.

1.10.2 Groundwater Quality

Groundwater quality is generally excellent throughout the Redding and Sacramento Valley Basins and is suitable for most uses. Concentration of total dissolved solids is normally less than 300 mg/L, although water in some areas may contain total dissolved solids to 1,500 mg/L (such as those observed in shallow groundwater, locally known as connate water, in areas south of Sutter Buttes) (Department, 1978). However, concerns over water quality are on the increase, as evidenced by recent actions taken by the Water Board with respect to the proposed extension of the *Conditional Waiver of Water Discharge Requirements for Discharges from Irrigated Lands*, commonly called the Agricultural Waiver. In response to these concerns, the Coalition was formed in 2002 and includes approximately 200 agricul-tural and wetlands entities and local governments. The Coalition is developing and will soon be implementing a regional water quality monitoring and reporting program to ensure that water quality levels are maintained in the Sacramento Valley.

In a few places in the Sacramento Valley, shallow, high-salinity water makes the ground-water unusable. In other areas, elevated levels of naturally occurring boron restrict the type of crops that can be irrigated with groundwater. In some areas, nitrates and other intro-duced chemicals make the groundwater unfit for domestic use. The Department’s Northern and Central Districts currently monitor groundwater quality in 315 wells in Northern California and about 400 wells in Central California to identify areas of poor quality and to track changes in overall groundwater quality (Department, 2005). Groundwater quality analyses typically include field measurements (temperature, pH, and conductivity), minerals (calcium, magnesium, and chloride), nutrients (phosphorus and nitrate), minor elements (arsenic, cadmium, and iron), organic compounds (pesticides and petroleum derivatives), and pathogens (bacteria). The districts' groundwater quality data extend back to the early 1950s.

Redding Sub-basin

SECTION 2.0

Sub-basin Water Use, Supply, and District Descriptions

2.1 Redding Sub-basin

The Redding Sub-basin is located at the northern part of the Sacramento Valley (see Figure 2-1; figures pertaining to each sub-basin are presented at the end of each sub-basin discussion section). It covers the segment of the Sacramento River from Shasta Dam to just above Red Bluff. This sub-basin consists of significant urban areas, including the Cities of Redding, Anderson, Shasta Lake, and the Town of Cottonwood. ACID is the participating SRSC within this sub-basin.

Relative to the sub-basins in the central and southern extent of the study area, the Redding Sub-basin receives approximately twice as much rainfall annually, and the rainy season may extend further into the spring months, which may delay the demand for irrigation water. Inflows to the sub-basin are dominated by natural runoff from tributaries to the Sacramento River and regulated Sacramento River flows released from Shasta Dam and Keswick Reservoir. Water is also imported into the Sacramento River system from the Trinity River Basin. Outflows from the basin consist primarily of the Sacramento River flows.

Numerous water users along the Sacramento River divert water for agricultural and municipal uses. Many diversions are controlled (between April 1 and October 31) by contracts with Reclamation. There are also many water users with riparian and appropriative rights to Sacramento River water and associated tributaries in the sub-basin. There are no SWP contractors located in the sub-basin. A portion of most diversions returns back to the sub-basin water system as system leakage or deep percolation, which enters the groundwater basin. Once in the groundwater basin, a portion remains in storage, and the rest of this water flows as subsurface flow until reaching the Sacramento River or major streams. A small percentage of these flows may be rediverted for irrigation purposes before reaching the river. Unique to this sub-basin is the large percentage of irrigated pasture relative to other crop types. For example, more than 75 percent of irrigated lands in the ACID service area is pasture (BWMP TM 3; see Appendix D).

2.1.1 Water Supply within the Redding Sub-basin

2.1.1.1 Surface Water

Surface water is the primary source of water for ACID, which is the sole participating SRSC (the City of Redding is also an SRSC) in the Redding Sub-basin, accounting for approximately 80 percent of agricultural water use within the sub-basin. A majority of the M&I water purveyors also access surface water to meet customer demand. These surface water sources include the Sacramento River, Whiskeytown Reservoir, and Lake Shasta.

Water availability during critical or shortage years varies by contract type and water right. As dictated by the SRSCs, surface water allocations can be reduced up to 25 percent of the contract total in years determined to be critical by Reclamation (using the Shasta Index criteria) referred to in the contracts. A majority of the surface water purveyors hold CVP water service contracts.

The Bella Vista Water District and the Clear Creek Community Services District hold contracts with both CVP M&I and agricultural allocations. These contracts include shortage provisions that allow reductions in allocations during years when full supplies cannot be delivered. While the SRSCs and the CVP water supply contractors supply the vast majority of water uses in the Redding Sub-basin, other users such as those with riparian rights and groundwater users are not subject to contract-related reductions. Additional information related to water shortage allocation policies is provided in Section 1 Regional Description (BWMP TM 6; see Appendix D).

2.1.1.2 Groundwater

The Redding Groundwater Basin is in the northernmost portion of the Sacramento Valley. Underlying Tehama and Shasta Counties, it is bordered by the Klamath Mountains to the north, the Coast Range to the west, and the Cascade Mountains to the east. The Red Bluff Arch, between Cottonwood and Red Bluff, separates the Redding Groundwater Basin from the Sacramento Valley Groundwater Basin to the south. Department Bulletin 118 subdivides the Redding Groundwater Basin into six sub-basins: Anderson, Enterprise, Millville, Rosewood, Bowman, and South Battle Creek (Department, 2003c).

Geology, Hydrogeology, and Hydrology. The Redding Groundwater Basin consists of a sediment-filled, southward-plunging symmetrical trough (Department, 2003a). Simultaneous deposition of material from the Coast Range and the Cascade Mountains resulted in two different formations, which are the principal freshwater-bearing formations in the basin. The Tuscan Formation in the east is derived from Cascade Mountains volcanic sediments, and the Tehama Formation in the western and northwest portion of the basin is derived from Coast Range sediments. These formations are up to 2,000 feet thick near the confluence of the Sacramento River and Cottonwood Creek, and the Tuscan Formation is generally more permeable and productive than the Tehama Formation (Pierce, 1983). Groundwater recharge occurs in the higher elevations by stream seepage and direct infiltration of precipitation. Rivers and streams transition to gaining streams at lower elevations and receive direct groundwater discharge. Areas of riparian vegetation occur along surface water features throughout the basin.

The water budget of the Redding Groundwater Basin is dominated by a large annual influx of water falling as precipitation on the surrounding mountains and on the valley floor. A large portion of recharge to the Redding Groundwater Basin is from precipitation and snowmelt from higher elevations. Average annual precipitation in the Redding Groundwater Basin ranges from 22 to as much as 40 inches in the higher elevations (California Spatial Information Library/Department Statewide isohyet map). As is typical throughout the Central Valley, 80 to 90 percent of the area’s precipitation occurs from November to April. In the surrounding mountain ranges, precipitation ranges from 40 to 75 inches, much of it in the form of snow. A portion of this water is consumed by evapotranspiration (ET) by native vegetation, and the remainder occurs as runoff and groundwater recharge.

It has been estimated that an average of 850,000 ac-ft of annual runoff occurs within the Redding Basin (CH2M HILL, 2003). Much of this water is potentially available to recharge the Redding Groundwater Basin and replenish water levels that have been depressed because of groundwater pumping. Applied water totals approximately 270,000 ac-ft in the Redding Groundwater Basin (CH2M HILL et al., 1997). The exact quantity of groundwater that is pumped from the basin is not known; however, it has been estimated that approximately 45,000 to 55,000 ac-ft of water is pumped annually from municipal, industrial, and agricultural production wells (CH2M HILL, 2003). This magnitude of pumping represents approximately 6 percent of the average annual runoff into the basin.

Conjunctive Use. The Redding Sub-basin is coincident with the Redding Groundwater Basin. Groundwater use varies from 15 percent to 20 percent of total water use, depending on hydrologic conditions, and is estimated to range from 45,000 to 55,000 ac-ft per year (ac-ft/yr). Groundwater use also varies with location within the sub-basin. The Cities of Cottonwood and Anderson rely solely on groundwater. Overall, the Department has reported that the Redding Groundwater Basin is stable, has good to excellent water quality, and has significant quantities of groundwater in storage.

Groundwater has been used historically in the Redding Sub-basin as a supplemental source for irrigation purposes, and also as a source of supply for domestic uses. However, conjunctive use potential is restricted by the limited facilities. Because groundwater is not used extensively in the sub-basin, additional infrastructure is needed. In addition, regional conjunctive use programs have not yet been implemented in the area, and developing the institutional framework for carrying out such a program would likely be the most challenging task.

A cooperative Redding Basin water supply and management plan is being developed under the direction of the Shasta County Water Agency, working with the Redding Area Water Council. As part of this planning effort, an integrated ground-surface-water model has been developed evaluate conjunctive use programs.

A key factor relevant to conjunctive use in the sub-basin is that the majority of the groundwater resource is in the central and southern end of the basin, while the purveyors that require supplemental water supplies are primarily in the north and north-central portions of the basin. Two potential major options exist for facilitating conjunctive use: in-lieu transfer and a regional pipeline network. An in-lieu transfer would consist of pumping water located in the high-yield areas into existing distribution facilities (such as the ACID canal or laterals off of the canal) to supply large users in the central and southern end of the sub-basin (essentially ACID). This would free upstream surface water supplies for diversion to M&I users such as Bella Vista Water District, City of Shasta Lake, and the City of Redding. The cost of a regional pipeline network would likely result in prohibitive water costs to the end users because the areas of need are remote from the areas where groundwater is plentiful.

Potential participants in a conjunctive use program include the CVP water supply contractors and the water purveyors that overlie the high yielding portions of the Redding Groundwater Basin, principally ACID. Transfers would be required to allow changes in the point of surface water diversion from ACID to cities.

Groundwater management within the sub-basin to date includes the adoption of a groundwater management plan under AB 3030, and the adoption of a county ordinance by Shasta County that stipulates permit requirements to extract groundwater underlying lands in Shasta County. The Redding Area Water Council (which includes members from both private and public entities) is implementing a groundwater management plan effort, with the Shasta County Flood Control and Water Conservation District serving as lead agency.

2.1.1.3 Reuse and Other Water Supplies

The Redding Sub-basin does not have significant levels of water use. ACID is the only major irrigation district in the sub-basin; it has crop types and irrigation methods that do not result in the levels of generation and reuse typical of the other sub-basins in the Sacramento Basin. Therefore, regional agricultural management is not considered a significant potential future action for the Redding Sub-basin.

Potential does exist within the Redding Sub-basin to use treated wastewater for a number of uses, including agricultural irrigation, landscape irrigation, and industrial processes such as cooling systems. Domestic potable use is also possible with proper treatment (BWMP TM 6; see Appendix D).

No other significant sources of supply are used in the sub-basin.

2.1.2 Water Use within the Redding Sub-basin

2.1.2.1 Agricultural

Agricultural land use within Redding Sub-basin is primarily pasture, in addition to alfalfa and some deciduous orchard crops. Pasture use is typically in the range of 75 percent of the total crop mix served by the sub-basin (Department, Northern District). Water requirements are typically highest during the summer months (June, July, and August) due to the area's hot, dry climate. Little groundwater is used across the sub-basin; the small portion used is limited primarily to deciduous crops. Annual cropping patterns have not varied a great deal since the mid-1970s. Associated on-field crop water requirement needs and diversions therefore have been more a function of water-year type and climate than changes in cropping.

Table 2-1 shows the total irrigated acreage by crop for ACID, which is the only SRSC and the primary agricultural diverter in the Redding Sub-basin.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current needs in terms of crop mix; however, the District anticipates an overall decrease in irrigated acreage associated with continued urban encroachment.

2.1.2.2 Urban

M&I requirements within the Redding Sub-basin (approximately 25 percent of the overall sub-basin requirement) are expected to increase by 50 percent by 2020. This increasing M&I use comes with a decrease in agricultural water requirement in the Redding sub-basin associated with conversion of agricultural lands to M&I use. The following are the M&I water users within the Redding Sub-basin:

- City of Redding
- City of Anderson
- Bella Vista Water District
- Centerville Community Services District
- Clear Creek Community Services District
- Cottonwood Water District
- Jones Valley County Service Area
- Keswick County Service Area
- Shasta Community Services District
- Mountain Gate Community Services District
- City of Shasta Lake

TABLE 2-1
ACID Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Pasture	10,500 (± 5%)[c]	9,900 (± 5%)[c]
Other Deciduous	1,600 (± 5%)[c]	1,600 (± 5%)[c]
Alfalfa	400 (± 5%)[c]	200 (± 5%)[c]
Almonds and Pistachios	200 (± 5%)[c]	200 (± 5%)[c]
Other Crops	1,200 (± 5%)[c]	1,200 (± 5%)[c]
Total Irrigated Acreage	**13,900 (± 5%)[c]**	**13,100 (± 5%)[c]**

[a] Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be "normal," i.e., drought or wet condition assumed not to occur). Source: Department, Northern District.

[b] Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in 2020. Source: Department, Northern District.

[c] Percentages obtained from ACID.

2.1.2.3 Environmental

Current and proposed environmentally beneficial water management actions in the Redding Sub-basin include the following:

- ACID's Lake Redding fish screen and ladder project
- Replacement of fish screens on the City of Redding's main pump station diversion, just upstream from ACID's new facility
- Many major watershed programs that are associated with Clear Creek, Battle Creek, Cottonwood Creek, Cow Creek, Bear Creek and Stillwater Creek

Additionally, ACID operations contribute to groundwater recharge through the District's unlined canal, as well as support habitat largely influenced by the conveyance of water through the District (BWMP TM 6; see Appendix D).

2.1.2.4 Transfers and Exchanges

Water users in the sub-basin have engaged in water transfers to a limited degree in the past, and are expected to continue to use transfers to the extent possible. Existing surface and groundwater supplies support the potential for water transfers to play a valuable role in helping balance the supplies and demands and alleviate the deficits caused by drought/critical-year CVP supply cutbacks. There is typically some availability of water from the agricultural sector that could assist in meeting M&I needs.

The Redding Sub-basin is in the unique position of being at the upstream end of the entire Sacramento Valley and can potentially transfer water to any of the other sub-basins. Transfers that use the Sacramento River as the conveyance route could contribute to in-stream flows at beneficial times along the segment of the river between the Redding Sub-basin and the receiving entity's diversion.

2.1.2.5 Other Uses

Beyond M&I and agricultural use, there are no other significant water uses within the Redding Sub-basin.

2.1.2.6 Sub-basin Water Budget

The Redding Sub-basin, as shown on Figure 2-1, is located in the northern section of the Sacramento Valley. It covers the segment of the Sacramento River from Shasta Dam to just north of Red Bluff. This sub-basin consists of significant urban areas, including the cities of Redding, Anderson, and Shasta Lake, and the community of Cottonwood. ACID is the only participating SRSC within this sub-basin. No SWP contractors are in the sub-basin.

Relative to the sub-basins in the central and southern end of the study area, the Redding Sub-basin receives approximately twice as much annual rainfall, and the rainy season may extend further into the spring months, delaying the demand for irrigation water. Numerous water users along the Sacramento River divert water for agricultural and M&I uses; they hold riparian and appropriative rights to Sacramento River water and associated tributaries in the sub-basin. Unique to this sub-basin is the large percentage of irrigated pasture relative to other crop types. For example, over 75 percent of irrigated lands in the ACID service area are pasture.

A water use balance for the Redding Sub-basin for the 2020 average-year condition is presented on Figure 2-2. Under 2020 average conditions for the sub-basin, the following projections are made:

- On average, surface water and groundwater pumping will be approximately 80 percent and 20 percent of the total water supply, respectively.
- For the negotiated agreements, the total diversions could range from 125 thousand ac-ft per year (taf/yr) to 175 taf/yr, depending on hydrologic conditions and other outstanding issues. (The lower bound corresponds to average diversions for critically dry years 1977, 1991, 1992, and 1994; the upper bound corresponds to full Base and Project Supplies.)
- Relative to other sub-basins in this technical memorandum, a larger portion of most diversions returns back to the sub-basin water system as system leakage or deep

percolation, that enters the groundwater system. Once in the groundwater system, a portion remains in storage, and the rest of this water flows as subsurface flow until reaching the Sacramento River or another part of the surface water system.

Figure 2-3 presents a water use balance for Redding Sub-basin under 2020 critical-year conditions.

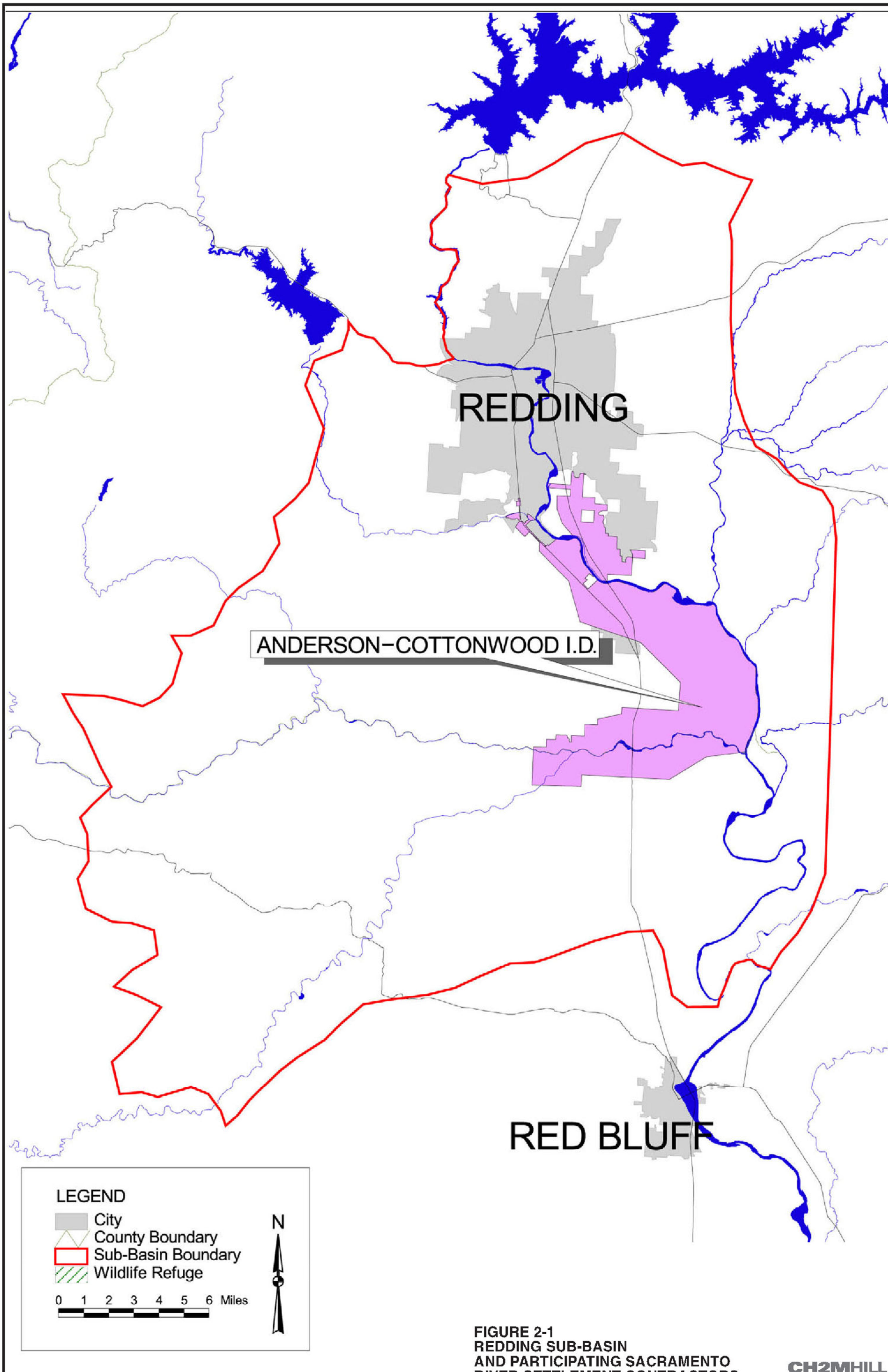
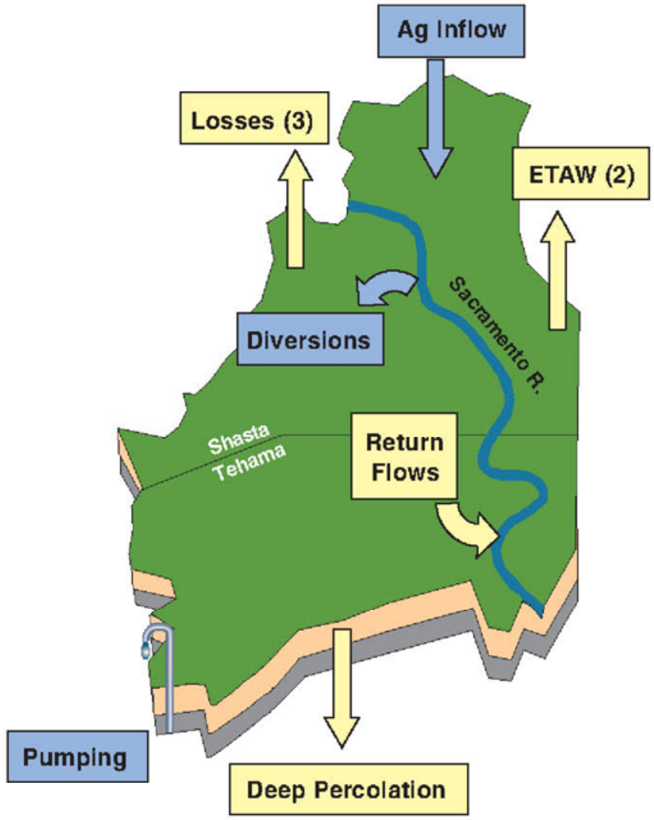


FIGURE 2-1
REDDING SUB-BASIN
AND PARTICIPATING SACRAMENTO
RIVER SETTLEMENT CONTRACTORS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W032005010RDD_55 (3/17/05)



WATER USE (1)

ETAW (2):	Agricultural	= 66
	M&I	= 41
Fall Flooding		= 0
Wildlife Refuges		= 0
SUBTOTAL		= 107
Other:	Losses (3)	= 14
	Deep Perc	= 42
	Return Flows	= 120
TOTAL		= 283

WATER SUPPLY (4)

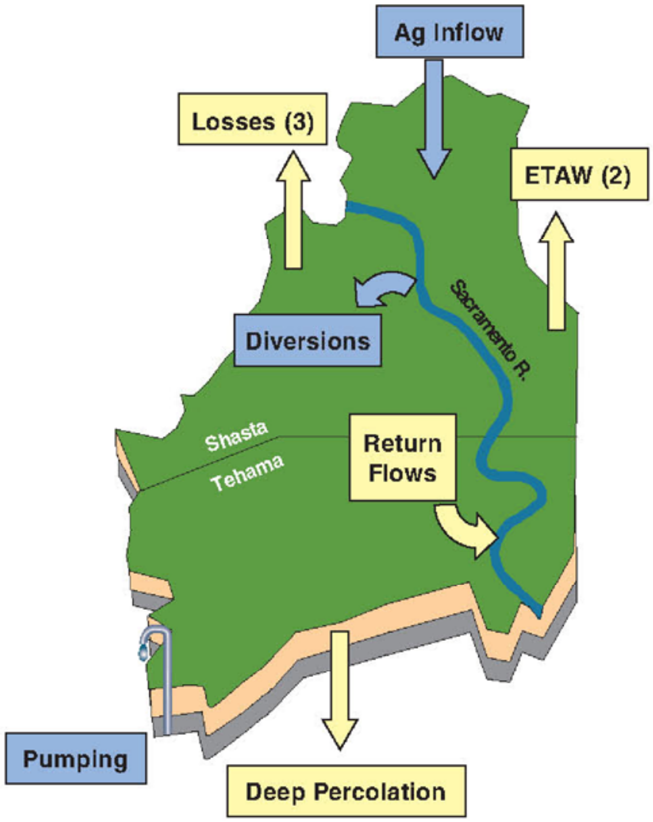
Surface Water Diversions:	
Riparian	= 1
Settlement Contracts:	
Base Supply	= 163
Project Supply	= 5
CVP Water Service Contracts (5)	= 45
Local Surface Water	= 17
SUBTOTAL	= 231
Agricultural Drainage Inflow	= 0
Groundwater Pumping	= 46
TOTAL	= 277

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Annual average for the 1980 to 1989 period, unless otherwise specified.
(5) ACID Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 2-2
REDDING SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL In association with MBK



WATER USE (1)

ETAW (2):	Agricultural	= 81
	M&I	= 42
Fall Flooding		= 0
Wildlife Refuges		= 0
SUBTOTAL		= 124
Other:	Losses (3)	= 13
	Deep Perc	= 28
	Return Flows	= 100
TOTAL		= 265

WATER SUPPLY

Surface Water Diversions:	
Riparian	= 1
Settlement Contracts:	
Base Supply	= 137
Project Supply	= 9
CVP Water Service Contracts (4)	= 48
Local Surface Water	= 17
SUBTOTAL	= 212
Agricultural Drainage Inflow	= 0
Groundwater Pumping	= 57
TOTAL	= 269

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) ACID Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 2-3
REDDING SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_701 (8/17/05)

Anderson-Cottonwood Irrigation District

2.1.3 Anderson-Cottonwood Irrigation District

2.1.3.1 History

ACID was formed under Division 11 of the State Water Code and is the oldest such district in the Sacramento Valley. On November 24, 1914, McCoy Fitzgerald posted a "Notice of Appropriation of Water" on the west bank of the Sacramento River in Redding. In December of that same year, title to this appropriation was deeded to ACID. The State Division of Water Rights issued a certificate in June 1918, prescribing the time to complete application of water to the proposed place of use. ACID subsequently made beneficial use of the water and established a pre-1914 water right. In June 1967, ACID entered into a negotiated agreement with Reclamation quantifying the amount of water ACID could divert from the Sacramento River. The resulting negotiated agreement (which remains in effect until March 2006) recognized ACID's annual entitlement to a Base Supply of 165,000 ac-ft/yr) of flows from the Sacramento River and also provided for a 10,000 ac-ft allocation of Project Supply, resulting in a total contract entitlement of 175,000 ac-ft/yr.

2.1.3.2 Service Area and Distribution System

ACID's service area encompasses approximately 32,000 acres and extends south from the City of Redding within Shasta County to northern Tehama County, encompassing the City of Anderson and the Town of Cottonwood. Although ACID overlaps the service area boundaries of these water purveyors, the District does not currently provide water for M&I uses in these communities. Approximately 90 percent of ACID's customers irrigate pasture for haying or livestock; however, some orchard and other food crops are also grown. In total, ACID's service area accounts for about two-thirds of irrigated pasture in the Redding Sub-basin.

2.1.3.3 Water Supply

The Sacramento River serves as the principal water source for ACID. ACID has water rights to the Sacramento River, as shown in Table 2-2. To a lesser extent, ACID also uses recycled water and groundwater. The following discussion describes these sources and their historical use.

Surface Water. ACID holds a water right, under pre-1914 postings, to divert water from the natural flow of the Sacramento River. The ACID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1967, Contract No. 14-06-200-3346A (Contract No. 3346A). This contract provides for an agreement between ACID and the United States on the diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 3346A provides for a maximum total of 175,000 ac-ft/yr, of which 165,000 ac-ft is considered to be Base Supply and 10,000 ac-ft is Project Supply, as shown in Table 2-3. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-2
ACID: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity (cfs)[e]**
Sacramento River	S012208[f] (N/A)	N/A	N/A	Mar 1 to Oct 31	50
Sacramento River	Z000916 (N/A)	N/A	120003 (6/12/18)	Jan 1 to Dec 31	400

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for these types of water rights.

[c]The type of water right is indicated by the first letter in the application reference, as follows:

A – Appropriative right

J – Adjudication

S – Statement of Water Diversion and Use

Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

[f]Water right is for nonconsumptive power use.

Note:

cfs = cubic feet per second

TABLE 2-3
ACID: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Month		
Non-critical Month		0
Total Annual	**122,000**	**7,000**

The contract specifies the total quantity of water that may be diverted by ACID each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-4. Figures pertaining to each district or company are presented at the end of each district or company discussion section. The monthly Base Supply ranges from a minimum of 20,000 ac-ft in October to a maximum of 27,000 ac-ft in June. Project Supply is available during the months of July and August, with entitlements of 3,500 and 6,500 ac-ft, respectively. The contract identifies July and August as the critical months. For the critical months, the total Base Supply is 46,000 ac-ft, and the total Project Supply is 10,000 ac-ft, as shown in Table 2-3.

Settlement Contract Historical Diversions. Until the 1990s, ACID historically used between 121,000 to 158,100 ac-ft of their Base and Project entitlements, as shown on Figure 2-5. In recent years, ACID's ability to divert their entitlement was reduced because of fishery limitations associated with the District's operation and management of its distribution facilities. In response to a pending lawsuit by NOAA Fisheries in 1992, ACID reduced the quantity of water circulating in their delivery system. Previously, ACID had maintained higher water levels within its distribution system that corresponded to larger diversions from the Sacramento River but also maintained large return flows from the conveyance facilities back to the Sacramento River. In addition, 4 years (1977, 1991, 1992, and 1994) were classified as "critical years" and contract supplies were reduced to 75 percent or 131,250 ac-ft. During this period, ACID diverted between 96,500 and 125,800 ac-ft of their surface water entitlement. ACID, in 1999, completed the improvements to the fish ladder and screen facilities at their seasonal dam near Redding. These improvements provide greater flexibility in diverting their contract entitlements but are not expected to affect diversion quantities.

Figure 2-4 shows the historical monthly average diversions for the following three periods:

1. 1977 to 1991: Long-term period of record from beginning of recording period to just before the listing of winter-run Chinook salmon as an endangered species (also NOAA Fisheries lawsuit filed) in 1992
2. 1979 to 1982: A period of near-normal hydrologic and water use conditions
3. 1992 to 1996: The period following the listing of the winter-run Chinook salmon (also NOAA Fisheries lawsuit filed) to present

The following observations are noted:

- The average monthly diversions of Sacramento River water by ACID reflect the pattern of monthly quantities specified in the contract entitlements.
- With the exception of April, the average monthly diversions (1977 to 1991) are within 5,000 ac-ft of the total contract entitlement. However, diversions in April (1977 to 1991) average less than 10,000 ac-ft in comparison to the monthly contract entitlement of 21,000 ac-ft. Diversions in the month of April are greatly affected by late-spring precipitation.
- Since 1991, total annual diversions have decreased and, thus, average diversions during each respective month have also decreased.
- Every year between 1977 and 1991, ACID had diverted some portion of their Project Supply.
- Since 1991, ACID has only diverted Project Supply during critically dry years (see also Figure 2-5). Reductions in Project Supply diversions relates to the increased cost of that associated with CVPIA Restoration Fees assessed on diverted Project Supply.

Non-contract Period (November – March). Contract No. 3346A does not limit ACID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. However, the existing land use within ACID's service area does not require non-contract-period diversions.

Other Surface Water Sources. Excluding Sacramento River water rights/contract entitlements, ACID does not hold water rights to any other surface water sources, as shown in Table 2-3.

Groundwater. Approximately 12 privately-owned wells are located within the District's boundaries. Very little groundwater is used within the District for agricultural purposes, except occasionally during drought years. Additional information about wells and groundwater conditions in this area can be found online at the Department Water Data

Library; see http://well.water.ca.gov/. The District does not own or operate any production wells, but is developing a plan for a future groundwater-surface water conjunctive water management Program with an estimated 12 District-owned production wells. Further, ACID has been working with the Department to establish a groundwater monitoring program within the District's boundaries. The District currently owns 13 monitoring wells with plans to expand this network as funds become available.

Most of the ACID service area overlies the Redding Groundwater Basin, within the Anderson Sub-basin. The Redding Groundwater Basin is in the northernmost portion of the Sacramento Valley. Underlying Tehama and Shasta Counties, it is bordered by the Klamath Mountains to the north, the Coast Range to the west, and the Cascade Mountains to the east. The Red Bluff Arch, between Cottonwood and Red Bluff, separates the Redding Groundwater Basin from the Sacramento Valley Groundwater Basin to the south. Department Bulletin 118 subdivides the Redding Groundwater Basin into six sub-basins: Anderson, Enterprise, Millville, Rosewood, Bowman, and South Battle Creek (Department, 2003c).

The Redding Groundwater Basin consists of a sediment-filled, southward-plunging symmetrical trough (Department, 2003a). Simultaneous deposition of material from the Coast Range and the Cascade Mountains resulted in two different geologic formations, which are the principal freshwater-bearing formations in the basin. The Tuscan Formation in the east is derived from Cascade Mountains volcanic sediments, and the Tehama Formation in the western and northwest portion of the basin is derived from Coast Range and Klamath Mountain sediments. These formations are up to 2,000 feet thick near the confluence of the Sacramento River and Cottonwood Creek, and the Tuscan Formation is generally more permeable and productive than the Tehama Formation (Pierce, 1983). Groundwater recharge occurs at the higher elevations by stream leakage and direct infiltration of precipitation. Rivers and streams transition to gaining streams at lower elevations and receive groundwater discharge. Areas of riparian vegetation occur along surface water features throughout the basin.

Above the Tuscan-Tehama Formation lies the discontinuous Quaternary Red Bluff Formation, which consists of coarse gravel, commonly with large boulders, in a red sandy-clay matrix. The Red Bluff Formation is of low to moderate permeability and, at a local scale, can contain perched water (Pierce, 1983).

Overlying the Red Bluff and/or the Tuscan-Tehama Formation are Quaternary terrace and alluvial deposits located in the Sacramento River floodplain and its tributaries. These materials are moderately to highly permeable (Pierce, 1983).

Based on the hydrogeologic setting, the groundwater system in the Redding Basin can be thought of as a single unconfined to a semi-confined (leaky) aquifer system with groundwater levels in the heart of the basin typically within 100 feet below ground surface (bgs).

The water budget of the Redding Groundwater Basin is dominated by a large annual influx of water falling as precipitation on the surrounding mountains and on the valley floor. A large portion of recharge to the Redding Groundwater Basin is from precipitation and snowmelt from higher elevations. Average annual precipitation in the Redding Groundwater Basin ranges from 22 to as much as 40 inches in the higher elevations (California Spatial Information Library/Department Statewide isohyet map). As is typical throughout the Central Valley, 80 to 90 percent of the area's precipitation occurs from November to April. In the surrounding mountain ranges, precipitation ranges from 40 to 75 inches, much of it in the form of snow. A portion of this water is consumed by ET by native vegetation, and the remainder occurs as runoff and groundwater recharge.

It has been estimated that the Redding Groundwater Basin yields an average of 850,000 ac-ft of annual runoff (CH2M HILL, 2003). Much of this water is potentially available to recharge the Redding Groundwater Basin and replenish groundwater levels that have been temporarily depressed because of groundwater pumping. Applied water totals approximately 270,000 ac-ft in the Redding Groundwater Basin (CH2M HILL, 1997). The exact quantity of groundwater that is pumped from the basin is not known; however, it has been estimated that approximately 55,000 ac-ft of water is pumped annually from municipal, industrial, and agricultural production wells (CH2M HILL, 2003). This magnitude of pumping represents approximately 6 percent of the average annual runoff into the basin. ACID's facilities and irrigation are significant contributors to groundwater recharge in the Redding Groundwater Basin. Annual leakage from the ACID Main Canal is estimated to be approximately 44,000 ac-ft.

Past pumping and drought conditions have not historically adversely affected the overall long-term groundwater level trends in ACID. Based on hydrograph data from Department monitoring wells located within ACID, it is evident that groundwater levels have not substantially increased or decreased over the last 45 years (Department, 2003b. Water levels are also consistently within 100 feet bgs in the District. Temporary fluctuations in groundwater levels are evident from seasonal climatic variations and drought conditions. Groundwater level declines did occur temporarily during the 1976-1977 and 1987-1992 drought periods. However, groundwater levels recovered to pre-drought levels after the drought period (Department, 1996a).

Other Water Supplies. No tailwater from outside of the service area is available for use by ACID. However, the District does operate five pumping plants to recapture some return flows from lands within the District's boundaries. ACID reuses approximately 5,000 ac-ft annually.

2.1.3.4 Water Use

District Water Requirements. Land use within ACID's service area is primarily pasture, in addition to alfalfa and some deciduous orchard crops. Pasture use is typically in the range of 75 percent of the total crop mix served by the District (Department, Northern District). Water requirements are typically highest during the summer months (June, July, and August) due to the area's hot, dry climate. Little groundwater is used across the District; the small portion used is limited primarily to deciduous crops. Annual cropping patterns have not varied a great deal since the mid-1970s. Associated on-field crop water requirement needs and diversions, therefore, have been more a function of water-year type and climate than changes in cropping.

Table 2-1 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

Figure 2-6 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current needs in terms of crop mix; however, the District anticipates an overall decrease in irrigated acreage associated with continued urban encroachment.

Urban. ACID's service area overlays several municipal water purveyors, but the District currently does not serve any major M&I users. Many of these users are projecting increased demands in the year 2020. The Department estimates growth in the M&I sector in the vicinity of ACID to result in an increased annual water requirement of approximately 30,000 ac-ft by the year 2020, which would represent an increase of about 75 percent (Department, Northern District). A majority of the increase is assumed to be met by surface water taken from the Sacramento River. The District is currently exploring programs that would increase supply to these purveyors.

Examples of programs include direct supply to water treatment facilities, direct supply for municipal irrigation, provision of water for cooling buildings and industrial developments, water marketing, and assisting with the fulfillment of area of origin needs. The District is currently working with the following entities to identify their potential requirements:

- City of Shasta Lake (to meet long-term growth projections)
- Bella Vista Water District
- Anderson Union High School (use of District water for cooling operations)
- City of Redding (potential South Bonnyview water treatment plant using ACID supplies)

In addition to these potential M&I demands, the District is currently participating in the Shasta County Water Resources Master Plan, which is assessing needs in the year 2030. Additional demands, as well as the potential for water transfers, may arise during the process of formulating the plan.

Environmental. There are no managed designated environmental or wetlands areas within the District. Approximately 3,000 acres of riparian vegetation are estimated to be incidentally supplied by irrigation associated with delivery laterals or adjacent lands (CH2M HILL, 1997). The application of water to pasture lands (historically ranging from 10,000 to 12,000 acres) and associated vegetation provides habitat to common and special-status terrestrial and avian species that use such habitat. Additionally, pasture provides habitat for a number of species of small mammals, ground-dwelling birds, and reptiles and amphibians, all of which provide a prey base for predatory birds. Dryland pasture in the region often supports a vernal pool ecosystem that is occupied by a number of special-status plant and animal species.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the District. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on water management practices is negligible.

Complete descriptions of the soil associations and the corresponding acreage of each association in the District are provided in the NRCS Soil Surveys for Shasta and Tehama Counties (see Appendix C) The soil associations that are found within the District are as follows:

- Newtown-Red Bluff: Nearly level to steep, well-drained and moderately well-drained clays and clay loams formed in old alluvium on high terraces.
- Churn Perkins-Tehama: Nearly level to moderately steep, well-drained and moderately well-drained clay loams and silty clay loams formed in recent alluvium on low terraces.
- Tuscan-Igo: Nearly level to gently sloping, well-drained cobbly clay loams and gravely loams that contain a hardpan and were formed in old basic alluvium on high terraces.
- Reiff cobbly alluvial land association: Nearly level to gently sloping, moderately well-drained to excessively drained loamy fine sands to loams and frequently flooded cobbly land on valley bottoms and floodplains.
- Maywood-Tehama: Very deep to moderately deep silt loam, nearly level to very gently sloping soils on floodplains and terraces along tributaries of the Sacramento River.
- Corning-Redding: Nearly level to sloping, gravely, medium-textured soils that are moderately deep to shallow to claypan or hardpan on terraces west of the Sacramento River and along its tributaries.
- Newville-Dibble: Shallow to deep gravely loam and silt loam, moderately steep or steep, medium- to fine-textured soils underlain by soft sedimentary rock.

Transfers and Exchanges. The ACID is one of 34 SRSCs that currently participate in the Pool Program. Since 1974 the Pool Program has been the forum to move available Project Supply water in certain years to other SRSCs. Each year, members participating in the Pool Program have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool Program rather than for diversion. Past water transfers from ACID to the Sacramento River Water Contracting Association are shown in Table 2-4.

TABLE 2-4
ACID Water Transfers
Sacramento Valley Regional Water Management Plan

Year	Transfer Amount (ac-ft)
1989	2,993
1990	5,000
1993	217
1996	477

Source:
BWMP May 1999 Research Data

Other Uses. There are no other uses other than those discussed above within ACID.

2.1.3.5 District Facilities

Diversion Facilities. ACID's primary water source is surface water diversion from the Sacramento River. Water pools behind the District's seasonal dam (creating Lake Redding) and flows by gravity through an intake screen, tunnel, and ultimately into the Main Canal. In 1999, ACID completed the improvements to the fish ladder and screen facilities as part of a CALFED-funded effort to enhance the Sacramento River anadromous fishery. ACID also has one pump station diversion on the Sacramento River, which is used to supply water to its Churn Creek Lateral. The District does not currently have any significant groundwater pumping capability, although the District service area does overlay portions of the Redding Groundwater Basin. Table 2-5 summarizes ACID's surface water supply facilities. See Figure 2-7 for a map of ACID's major conveyance facilities.

TABLE 2-5
ACID Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
ACID Diversion Dam	Sacramento River	Gravity	450	114,700[a]
Churn Creek Lateral Pump Station	Sacramento River	Pump	75	19,400[a]

[a]Estimated proportion of total diversions based on pump station capacity.

Conveyance System. ACID's distribution system includes approximately 30 miles of unlined canals and main laterals. Approximately 5 miles of the Main Canal are concrete lined. The Main Canal flows through several inverted siphons for conveying the canal flows under cross drainage channels such as Clear Creek. The District has an ongoing program for replacement of open-channel farm laterals with pipeline laterals. Several wasteways are located along the canal route at creek crossings and natural drains. These wasteways return water to the river or local streams when flow exceeds the capacity of the canal, which typically occurs in the winter months during storm runoff. Table 2-6 summarizes ACID's Main Canal and irrigation lateral features.

TABLE 2-6
ACID Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
ACID Canal	ACID Diversion Dam	450	Partial (5 miles)	Cottonwood Creek	25
Churn Creek Lateral Canal	Churn Creek Pump Station	75	No	None	25

Storage Facilities. ACID currently has no storage facilities.

Spill Recovery. ACID has a network of unlined drainage ditches for conveying irrigation return flows. The drains generally empty into the Sacramento River or one of the local tributary creeks. Most of the soils in the District's service area are well drained; therefore, the field-applied water generally percolates directly to the underlying groundwater basin, which minimizes the need for extensive drainage facilities. Drainage flows out of the District by gravity. However, the District operates five drain pump stations for recapture of drain flows. Table 2-7 summarizes these drain recapture facilities.

TABLE 2-7
ACID Drain Pump Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Simpson	Anderson Creek	Lateral	10	1,400
Jesson	Anderson Creek	Lateral	5	700
Supan	Anderson Creek	Lateral	10	1,400
Perry's Pond	Perry's Pond	Lateral	5	700
Dymesich's Pond	Dymesich's Pond	Lateral	5	700

2.1.3.6 ACID Operating Rules and Regulations

According to the *Rules and Regulations of ACID* (see Appendix E):

> *The Anderson-Cottonwood Irrigation District is [the] government agency acting under and by virtue of Division 11 of the California Water Code. It is governed by a Board of Directors that is elected by the voters of the District. The District operates for the sole benefit of the lands and the people situated within the District boundaries. The benefits people within the District derive from the District will be measured by the extent to which the people within the District and the District's employees and Board of Directors cooperate to make the District a success.*
>
> *The rules and regulations are adopted pursuant to California Water Code Section 22257 to effect an orderly and equitable distribution of water within the District, and a procedure for operation, maintenance, repair and replacement of District facilities.*

Water rotation, apportionment, and shortage allocation:

> *Water will be furnished in rotation to each irrigator. Ditchtenders will endeavor to give advance notice, personally or through others, to irrigators of the approximate time their rotation will start. Any irrigator not taking water when his turn arrives may forfeit his right during that rotation. In the event of shortages, the District will endeavor to equitably apportion the available water supply.*

Use of drainage waters:

> *All water introduced into the District by the District facilities remains District water and is subject to rediversion and reuse by the District for the benefit of its customers. All such water, whether drainage or seepage water, intercepted and put to beneficial use will be charged for at the rates established by the District.*

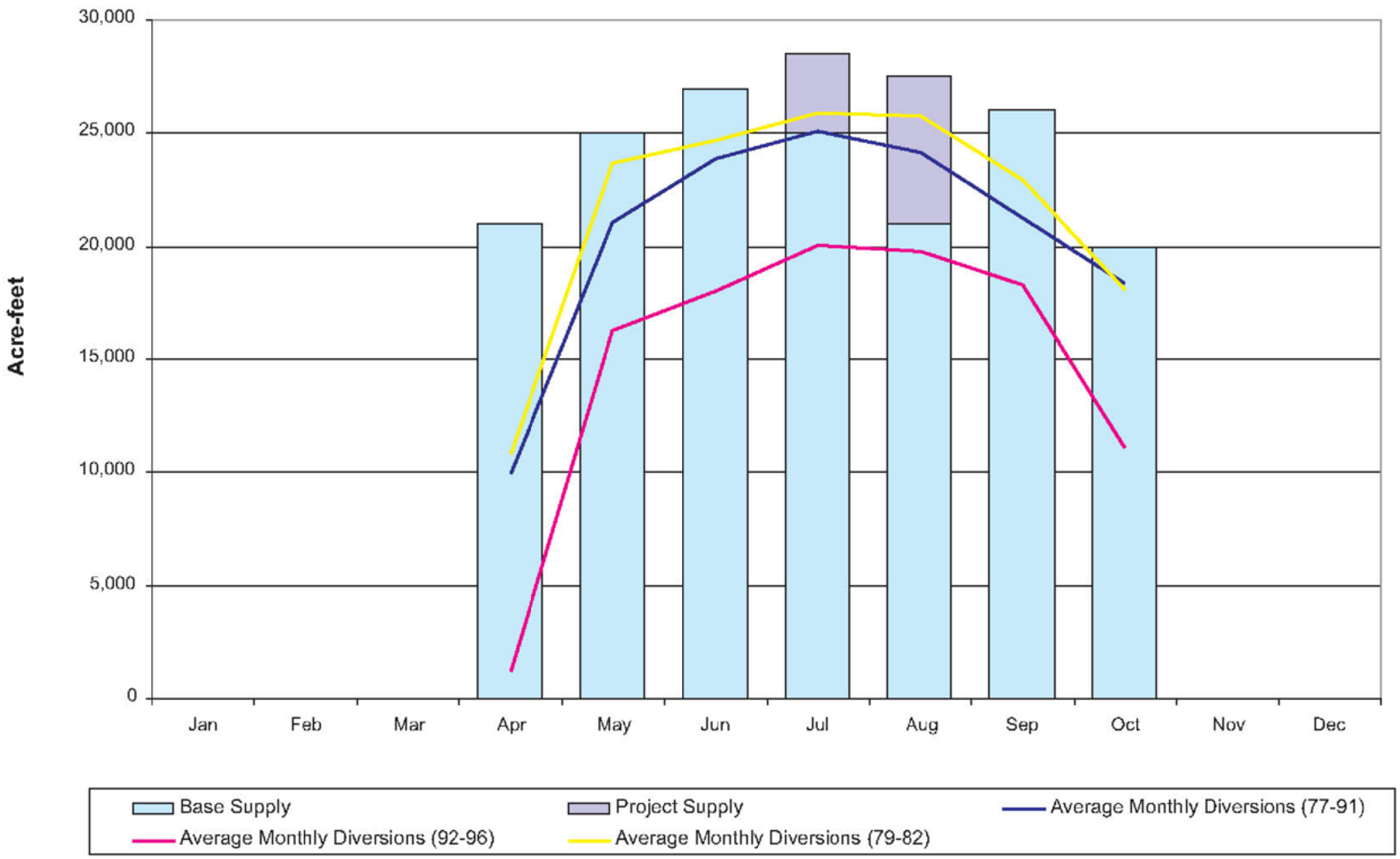
Policies for wasteful use of water:

> *Water must be used continuously by the irrigator throughout the period of delivery. If water is wasted, or inefficiently or improperly used the General Manager may refuse further delivery of water until the cause of waste or inefficient or improper use is removed. The General Manager may also levy appropriate monetary penalties for waste or inefficient or improper use.*

2.1.3.7 Water Measurement, Pricing, and Billing

ACID's main river diversions (Lake Redding and Churn Creek) have meters installed and operated by Reclamation, which provide both flow rate and total volume of flow. At major lateral headgates, the District measures flow rates manually using weir or gate head-flow tables. Flows at field turnouts are measured using canal headgate position tables. Drain pump flows are not metered, but the total volume pumped is estimated using power consumption and pump efficiency history. Increases in conveyance efficiency may be achieved with a program of water measurement that includes installation of intermediate measurement points along the Main Canal, improved lateral flow measurement, and installation of flowmeters and totalizers on drain pumps.

ACID does not currently meter individual customer turnouts. Estimates of flow rate are made based on canal headgate position relationships. Total deliveries per customer are not recorded. ACID's on-farm efficiency is relatively low (45 percent based on 1982 NRCS study). Field metering in combination with modifying the delivery arrangement from a rotation basis to arranged, an appropriate incentive pricing structure, and on-field improvements such as land leveling may increase the average on-farm efficiency, with some savings in water use. However, the effective implementation of such a program would depend on the correct combination of the above factors, in addition to basic economic considerations such as the return on investment to the District and landowners. Additionally, the installation, maintenance, and reading of the meters (950) would represent a major up-front capital cost to the District as well as an ongoing labor and capital expense.



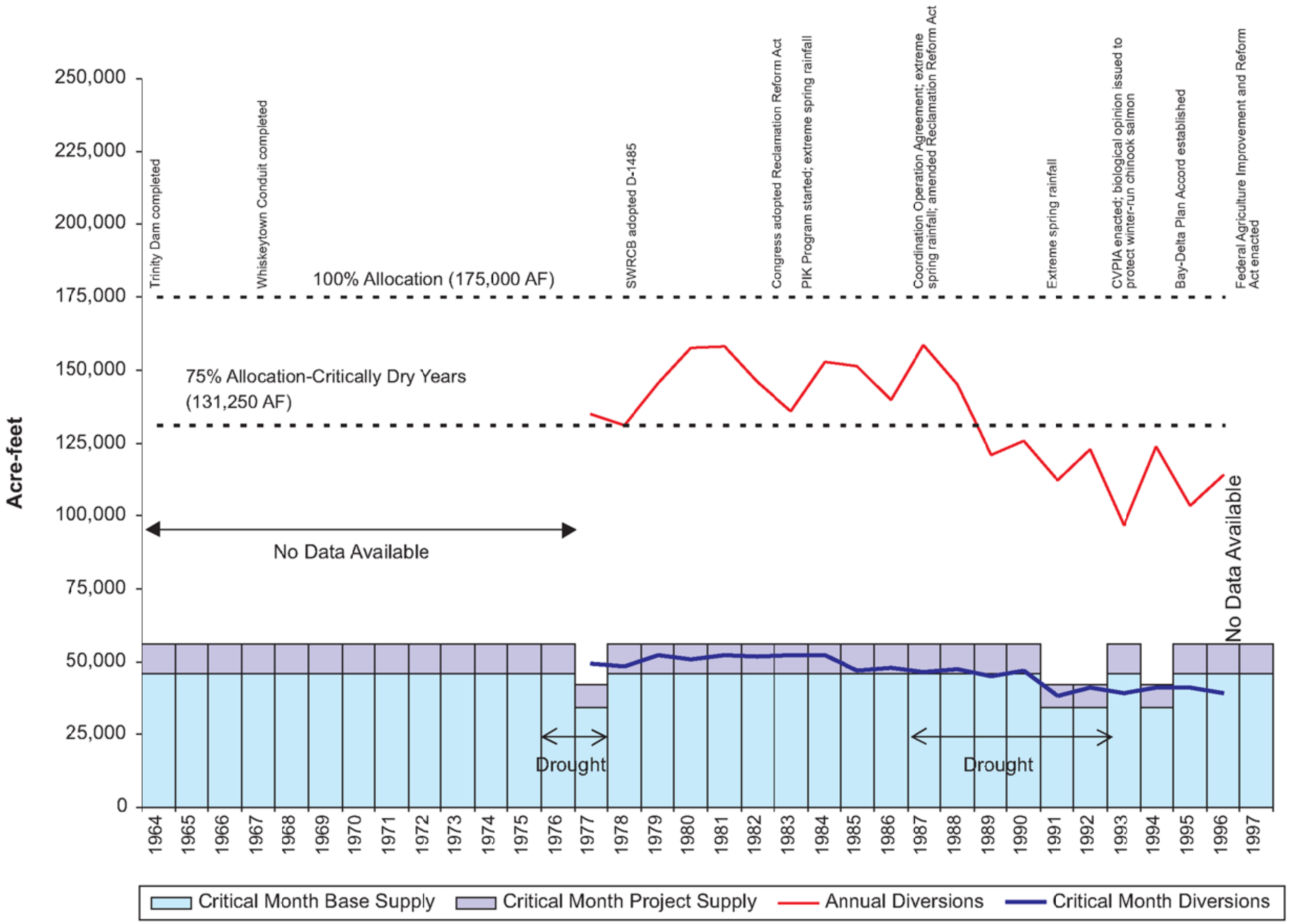
Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (77-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-96).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-4
ANDERSON-COTTONWOOD IRRIGATION DISTRICT MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
In association with
MBK

W032005010RDD_129 (6/13/05)



Note: Annual quantities are based on contract period from April to October; Critical Months include July and August.

FIGURE 2-5
ANDERSON-COTTONWOOD IRRIGATION DISTRICT ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGMENT PLAN

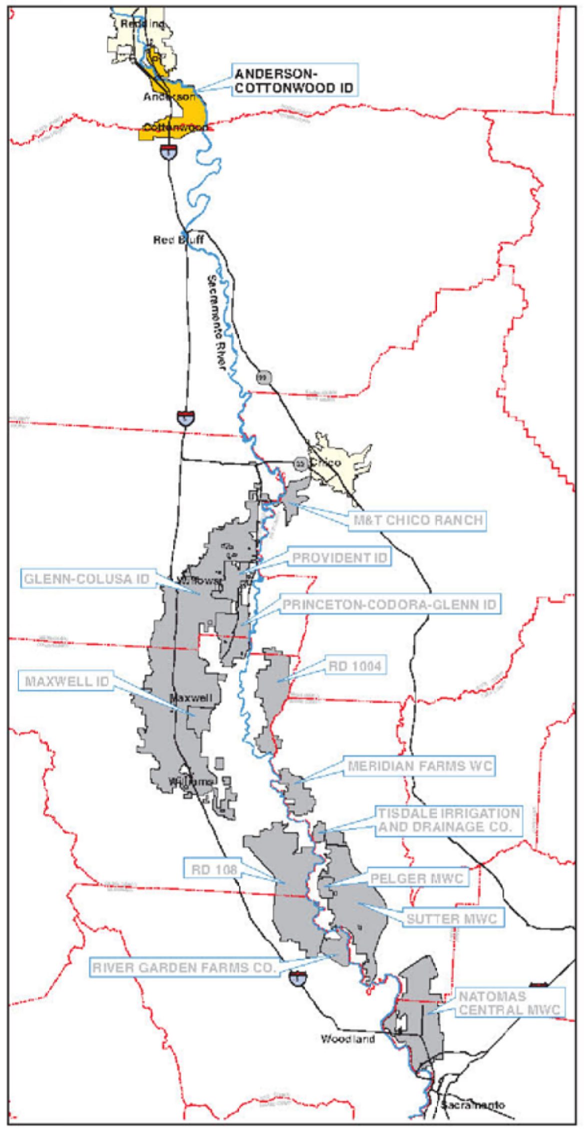
CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

Anderson-Cottonwood Irrigation District

Manager: Dee Swearingen • 2810 Silver Street • Anderson, CA 96007 • (530) 365-7329

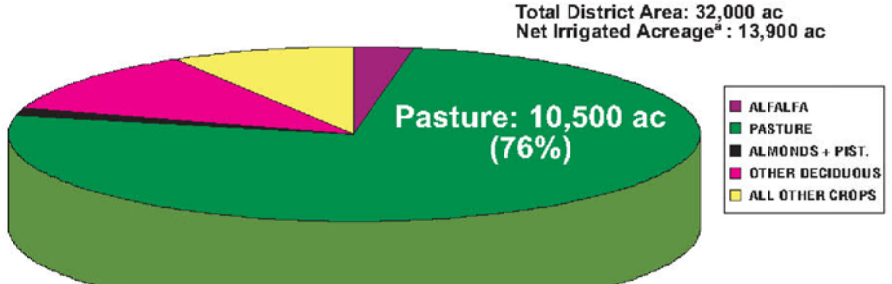
Settlement Contract:	175,000 af
Base Supply:	165,000 af
Project Supply:	10,000 af

Location Map



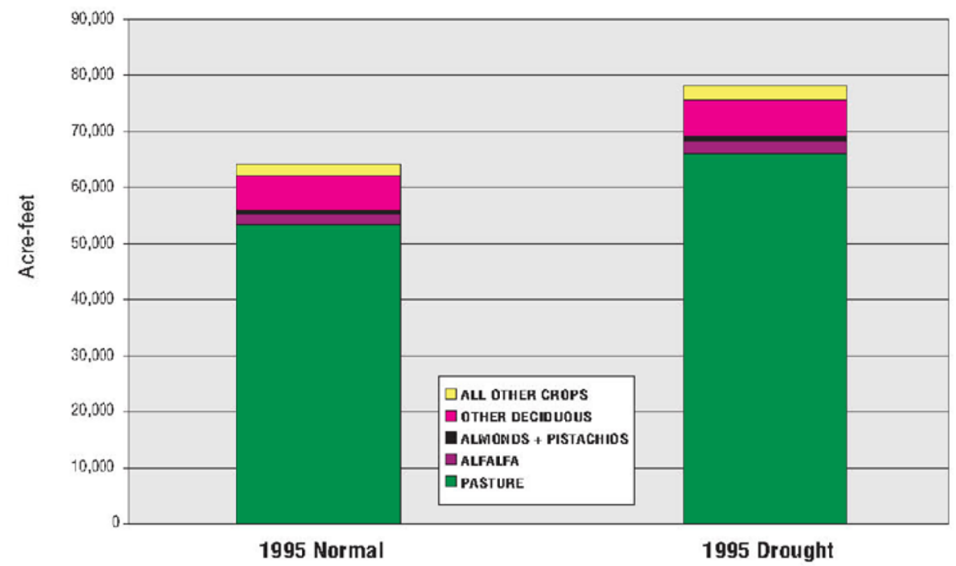
Irrigated Acreage by Crop

Total District Area: 32,000 ac
Net Irrigated Acreage[a] : 13,900 ac

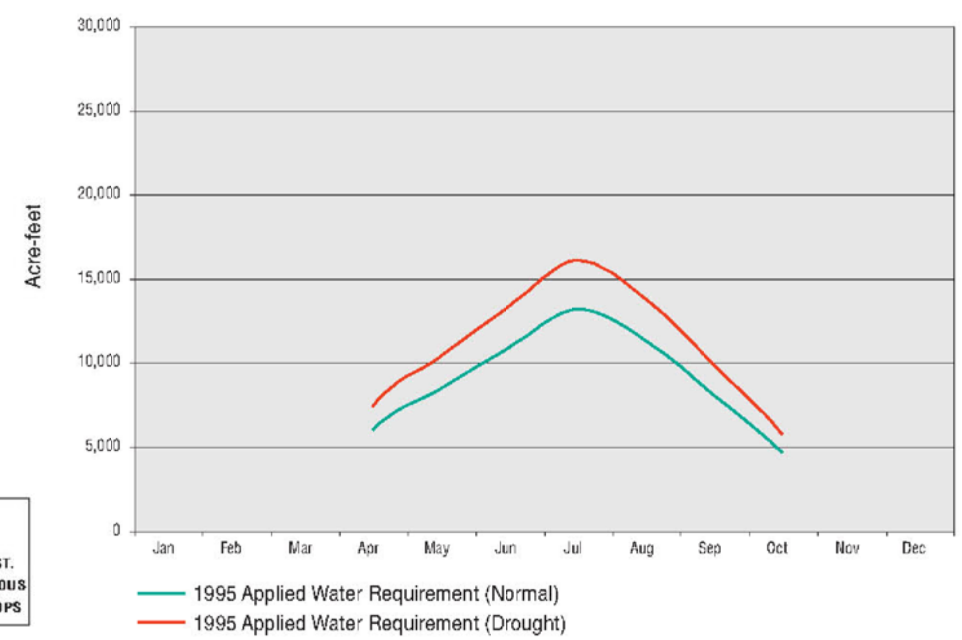


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

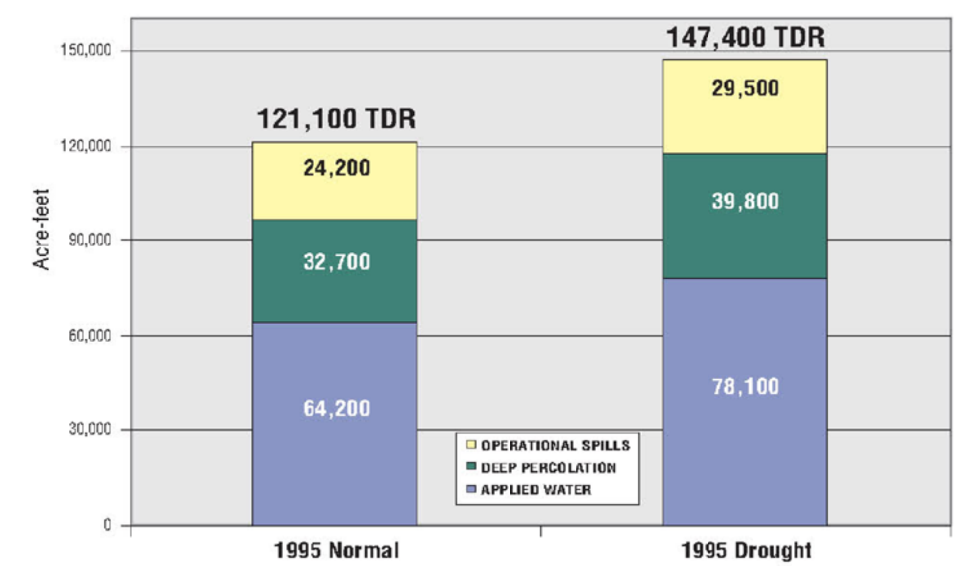


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

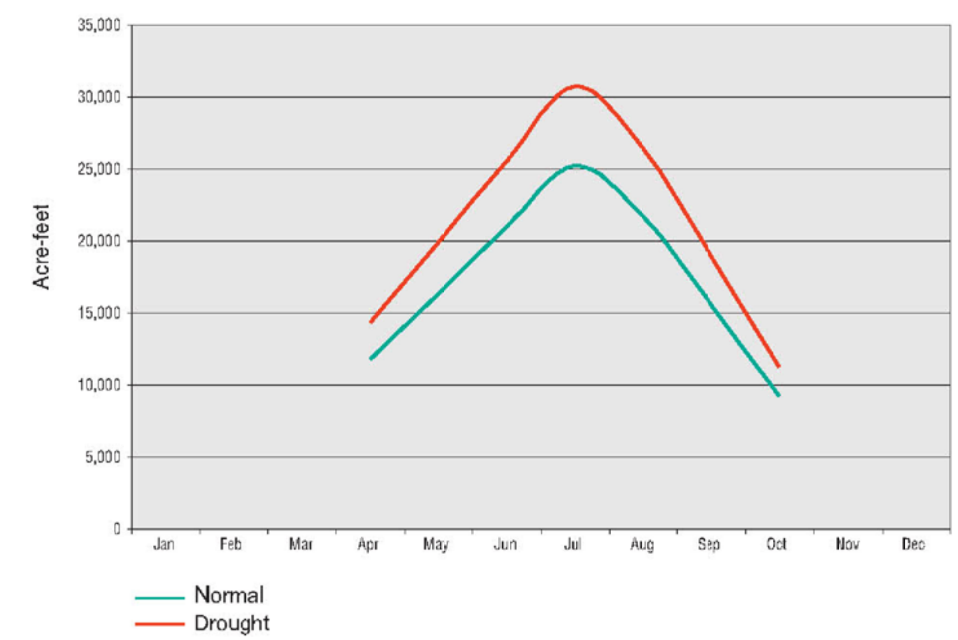


District Water Requirements

Annual Total District Water Requirement
(Includes 20% Operational Spills and 27% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 20% Operational Spills and 27% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 2-6
ANDERSON-COTTONWOOD
IRRIGATION DISTRICT IRRIGATED ACREAGE

CH2MHILL in association with MBK

W032005010RDD_16 (8/17/05)

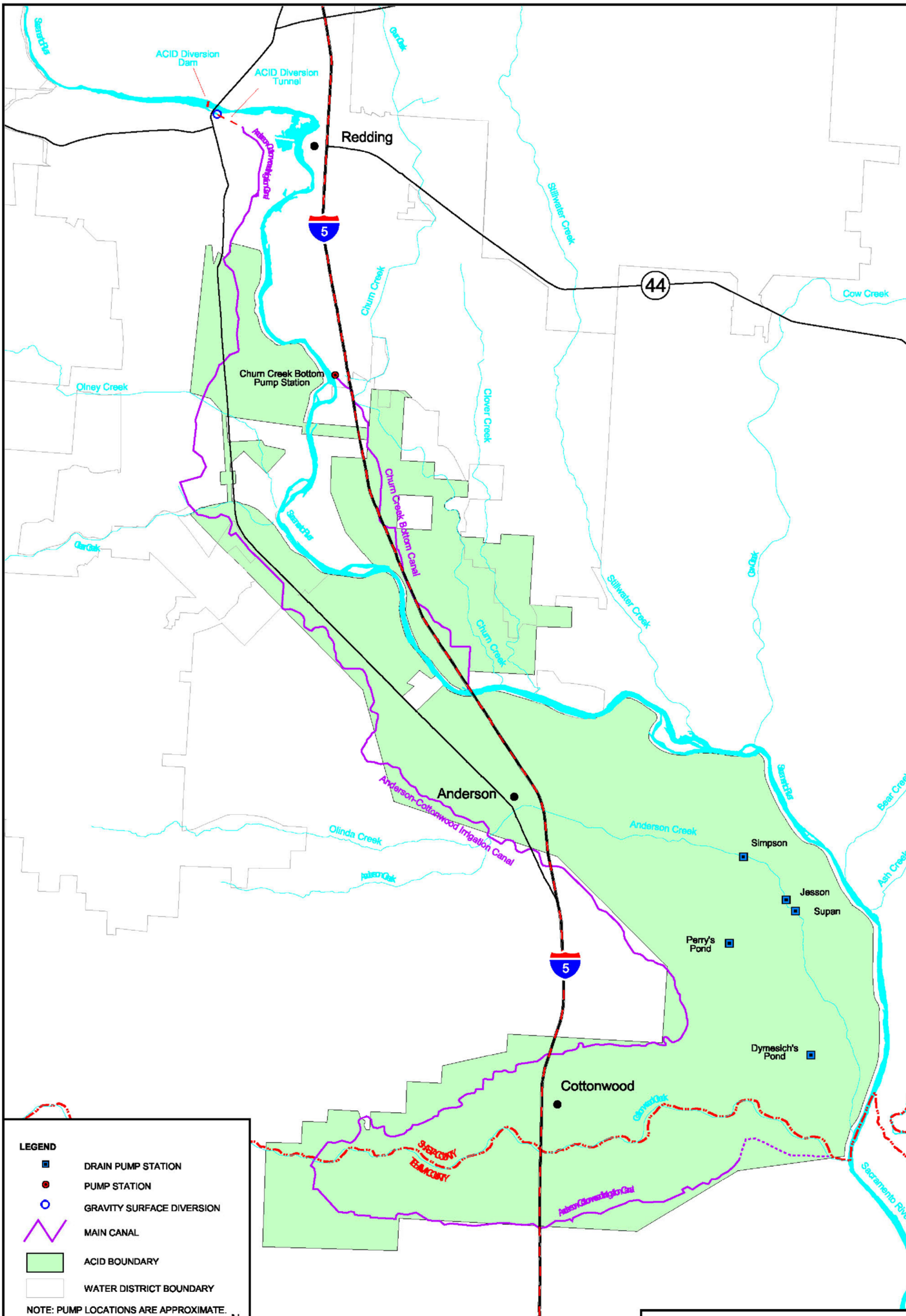


FIGURE 2-7
ANDERSON-COTTONWOOD IRRIGATION DISTRICT
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2M HILL RDD \\LOKI\projects\rddgis\SacBWMP\gisdata\newhydro3_0605.apr acid.pdf 06/08/2005

Colusa Sub-basin

2.2 Colusa Sub-basin

The Colusa Sub-basin, shown on Figure 2-8, encompasses a large portion of the drainage area on the west side of the Sacramento Valley floor and is bounded on the west by the Coast Ranges, on the north by Stony Creek, on the east by the Sacramento River (from GCID's Sacramento River diversion facility to the Knights Landing Outfall Gates), and on the south by Cache Creek. The participating SRSCs within this sub-basin include the following:

- GCID
- PID
- PCGID
- RD 108

Combined, these SRSCs account for more than 50 percent of surface diversions in the sub-basins. Other water users in the sub-basin include other CVP contractors, such as other SRSCs (short- and long-form), Tehama-Colusa Canal districts (e.g., Orland-Artois Water District), Stony Creek Angle Decree users (e.g., Orland Unit Water Users Association), as well as Sacramento River riparian diverters and groundwater users. There are no SWP contractors in the sub-basin.

2.2.1 Water Supply within the Colusa Sub-basin

2.2.1.1 Surface Water

Surface water is the primary source of water for the majority of water users in the sub-basin and accounts for approximately three-quarters of the total supply used in the Colusa Sub-basin. Inflows to the sub-basin include diversions from the west bank of the Sacramento River and imports through Tehama-Colusa Canal. Stony Creek flows under the Angle Decree are also diverted by some users. Outflows occur either through Colusa Basin Drain to the Sacramento River, Knights Landing Ridge Cut to Yolo Bypass, or RD 108's pumping plant to the Sacramento River.

Water availability during critical or shortage years varies by contract type and water right. As dictated by the CVP settlement contracts, surface water allocations can be reduced up to 25 percent of contract total in years determined to be critical by Reclamation per the Shasta Index criteria referred to in the contracts. Contractors such as members of TCCA hold Water Service contracts. These contracts include shortage provisions which allow for reductions of up to 100 percent of contract total in extreme conditions. Historically, the maximum reduction in allocation for the water service contractors in the Colusa Sub-basin has been 25 percent of contract total. Although these two types of contractors represent the vast majority of water users within the Colusa Sub-basin, other users such as those with riparian rights and groundwater users are not subject to contract-related reductions. The exception to this is the Colusa Drain Mutual Water District. The Company's service area includes approximately 57,500 acres, extending over 80 miles of the Colusa Drain from Glenn to Yolo Counties. The Reclamation contract with the Company has no provisions for a physical supply of water. Rather, the Company pays Reclamation for project releases, which are required to offset the impacts to senior water rights holders downstream of the Company diverters, caused by calculated consumptive use within the Company's service area. The

Company has historically required approximately 25,000 to 30,000 ac-ft of replacement water that has been met with Project Supply provided under its contract with Reclamation or has been met with water transfers from SRSCs. Additional information related to water shortage allocation policies is provided in Section 1, Regional Description and Resources.

2.2.1.2 Groundwater

At present, groundwater accounts for approximately 15 to 25 percent of the total water supply in the Colusa Sub-basin, and several conjunctive use investigations (efforts involving SRSCs such as RD 108, GCID, PID, MID, and other districts) are in progress in the sub-basin.

Underlying the floodplain deposits across the entire sub-basin is the Tertiary-Quaternary continental deposits of the Tehama Formation (Department, 1978). The floodplain deposits are low-energy, fluvial deposits composed primarily of fine-grained material (silt and clay). Due to their fine-grained character, these deposits typically exhibit low permeabilities.

Underlying the floodplain deposits are the alluvial fan deposits. These deposits are coarse-grained sands and gravels, with minor amounts of silt and clay. Due to the coarse-grained nature of these deposits, the permeability of these deposits are generally quite high. Beneath the alluvial fan deposits is the Tehama Formation. These deposits comprise thickly bedded silt and clay with thinner lenticular zones of sand and gravel (Department, 1978). The Tehama Formation is distinctly different in the northern and southern portions of the sub-basin. In the north, the Tehama Formation contains extensive deposits of interbedded gravel from ancestral Stony Creek. These deposits are referred to as the Stony Creek Member of the Tehama Formation. The Stony Creek Member of the Tehama Formation is typically a very productive aquifer, yielding large quantities of water to wells (Department, 1978).

In the general area between the towns of Artois and Glenn, groundwater movement is generally to the southeast towards the Sacramento River, at a gradient of between 4 to 15 feet per mile. Seasonal fluctuations in groundwater levels are minimal and generally less than about 10 feet, but can be up to 30 feet in drought years (Department, 1996b). Wells located near recharge sources typically show less of an annual change in groundwater levels. Based on the water level information of six wells in the GCID area that date back to the 1950s, there has been little significant change in groundwater levels over time. Historical groundwater levels indicate that the basin fully recharges during years of normal precipitation.

Groundwater elevation hydrographs within this area do not reveal any distinct long-term trends in groundwater levels through time over the last 20 years or so. Seasonal variations in groundwater levels do occur from wet season to dry season in response to changes in recharge conditions, and some groundwater variation is seen from year to year depending on the long-term climatic conditions. For example, water levels are significantly higher during the wet period that occurred in the early 1980s and somewhat lower during the dry period of the early 1990s. It should be noted that wells located in the broad alluvial flood-plain of the Sacramento River show very stable groundwater levels close to the ground surface. These data suggest that the aquifer is full and recharges completely in response to average annual precipitation.

2.2.1.3 Reuse and Other Water Supplies

Reuse of water is extensive within the sub-basin. from upstream districts is a substantial source of water for many agricultural districts, and reuse of water within district boundaries is also substantial.

Reuse (both within and across districts) accounts for over 420,000 ac-ft/yr of supply within the Colusa Sub-basin (BWMP Plan Summary; see Appendix D). Major entities that use or are involved in its management within the sub-basin include the TCCA member districts, GCID, PID, PCGID, MID, RD 108, the Colusa Basin Drain Users Association members, the Sacramento National Wildlife Refuge complex, and several reclamation districts.

Given the high level of reuse, presence of large sub-basin drains (the primary feature being the Colusa Basin Drain), existing management agreements, and reuse infra-structure, the Colusa Sub-basin is considered to have a strong potential for effective regional management.

No other significant sources of supply are used in the sub-basin.

2.2.2 Water Use within the Colusa Sub-basin

2.2.2.1 Agricultural

Land use within the sub-basin is primarily rice, due to the presence of fine-textured and poorly drained soils within the majority of the area. Other key crops include alfalfa, tomatoes, and cotton. Rice accounts for a high percentage of the sub-basin's irrigated acreage on an annual basis (Department, Northern District). Water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Although surface water is the primary source of irrigation water, groundwater is used in drought years on an individual grower basis. The total amount of water used during a normal year within the Colusa Sub-basin is 2,200 taf, and this rises to 2,400 taf during a drought year (BWMP Plan Summary; see Appendix D). The total amount of acreage irrigated within this sub-basin is 823,000 acres. Due to air quality concerns, approximately 100,000 to 150,000 acres of rice fields are being flooded annually to promote winter rice straw decomposition.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and diversions have therefore been more a function of water-year type and climate than changes in cropping. Table 2-8 presents total irrigated acreage by crop within the three counties of which portions are in the defined Colusa Sub-basin.

Surplus water from precipitation and return flows from irrigation typically flow to the Colusa Basin Drain. This surplus water is rediverted (several times in some cases) for irrigation before leaving the basin as outflow. Much of GCID's surplus is captured for use by downstream districts such as the PID, PCGID, and MID. GCID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share O&M of the drains within their respective service areas and to share the right to recirculate the water in those drains. In addition, Colusa Basin Drain Mutual Water Company members (57,500 acres, gross) rely on tailwater from GCID and other upstream water users.

TABLE 2-8
Colusa Sub-basin: Irrigated Acreage
Sacramento Valley Regional Water Management Plan

Crop Type (acres)	Irrigated Acreage		
	Glenn County	Colusa County	Yolo County
Alfalfa	19,280		55,914
Tomatoes		16,900	38,274
Cotton	2,292	4,200	
Rice	87,793	127,350	37,303
Irrigated pastureland	10,436	925	13,000

Source: Acreages from 2003 county crop reports.

RD 108 also makes use of available tailwater. Because a large portion of RD 108 lies within an area of relatively little slope, RD 108 has a unique capability of recirculating drainage water so that no drainage is pumped into the Sacramento River. Known as lock-up capability, this allows RD 108 to control rice pesticide-contaminated water within its drainage and irrigation systems for the prescribed holding period, thereby permitting early release of pesticide water from rice fields. Typically, the lock-up period was 8 to 10 weeks, approximately from May 1 to early July. In addition, RD 108 has recirculated a certain amount of drainage water beyond the normal 2-month lock-up period as a water management practice. Approximately 60,000 ac-ft was recycled annually during the lock-up program. However, after about 15 years of recycling water during the peak irrigation season, it was found that continued recycling of drainage water detrimentally affected crop production within certain areas of RD 108 because of salt buildup in the soil. Therefore, in 1997, RD 108 suspended the lock-up program and has curtailed its recirculation of drainage water (BWMP TM 3; see Appendix D).

2.2.2.2 Urban

None of the SRSCs within the Colusa Sub-basin currently serve municipal or industrial centers or currently plan to provide water for these uses. The agricultural communities of Willows, Maxwell, and Williams, are in the Colusa Sub-basin, but these communities obtain their water through groundwater pumping. The districts within the sub-basin have been involved in water transfer programs with municipalities in the past where growers within the sub-basin are given incentives to pump groundwater that can in turn be transferred to eligible candidates. Future transfers will be dependent on water availability and overall economics. M&I water demand within the vicinity of the sub-basin is anticipated to increase only slightly, with additional annual water requirements in 2020 expected to increase by less than 10,000 ac-ft (which represents approximately 1 percent of total sub-basin water requirements) compared to 1995 estimated levels (Department, Northern District).

2.2.2.3 Environmental

Within the Colusa Sub-basin thousands of acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system (BWMP TM 2; see Appendix D). Such vegetation includes habitat often found within drainage ditches or adjacent to irrigation facilities and/or farmed areas used by the federally listed giant garter snake. The flooding of rice fields in spring and summer provides wetlands habitat during these periods for waterfowl and upland birds as resting areas. Additionally, the SRSCs within the Colusa Sub-basin serve thousands of acres of privately owned duck clubs.

In addition to the environmental uses discussed above, stricter air quality regulations have recently prompted many rice farmers in the Valley to flood rice fields in the winter to promote the decomposition of rice straw that was historically burned. This practice has substantially increased the amount of winter habitat available to migrating waterfowl. Approximately 100,000 to 150,000 acres of rice fields are being flooded annually to promote winter rice straw decomposition. Given that managed federal/state refuges and hunting clubs provide approximately 30,000 to 40,000 acres of flooded habitat, it is clear that the flooding of rice fields can provide a significant amount of waterfowl and related wildlife habitat benefits.

Three national wildlife refuges are located within the Sacramento River complex in the sub-basin: Sacramento, Delevan, and Colusa. These refuges encompass approximately 22,500 acres. Level 4 (total quantity of water identified for each refuge to optimize management by the year 2002 identified by the Central Valley Project Improvement Act) water requirements for these three refuges total 105,000 ac-ft. Water for these refuges is purchased from willing sellers as necessary and is in part delivered via GCID facilities per agreement with Reclamation.

2.2.2.4 Transfers and Exchanges

Water users in the Colusa Sub-basin have engaged in water transfers in the past and are expected to continue to use transfers to the extent possible. Each SRSC within the sub-basin (GCID, PID, PCGID, and MID) participates in the Sacramento River Water Contractors Association Project Supply Pool, transferring a portion of Project Supply when it is available and demand warrants use by other agricultural water users in the Sacramento River Water Contractors Association.

Several of the SRSCs (GCID, PID, PCGID, and RD 108) in the Colusa Sub-basin have an ongoing agreement to transfer water directly to the Colusa Basin Mutual Water Company via the Sacramento River Water Contractors Association Project Supply Pool. In general, the water transferred to the Colusa Basin Mutual Water Company is made available through the Colusa Basin Drain for Colusa Basin Mutual Water Company use.

Transfers have also been conducted by GCID, including the transfer of 11,000 ac-ft in 1998 to the Sacramento Area Flood Control Association. GCID's formal policy on transfers is that priority is first given to in-basin uses, environmental uses, and then out-of-basin uses. GCID is also continuing their in-basin transfer program to adjacent landowners, which was begun in 1997 and will likely continue. In addition to GCID's programs, PID and PCGID have transferred water when available to the state during dry periods, and RD 108 recently participated in a successful transfer to the Contra Costa Water District.

Given in-basin needs can be met, the transfers with other Sacramento Valley water users downstream, as well as out-of-basin users, have occurred and remain a possibility depending on in-basin needs and out-of-basin demand. Like the Redding Sub-basin, individual water purveyors within the sub-basin face potentially significant deficits in drought/critical years under their current CVP contracts. Key entities that fall within this category are the members of TCCA given their status as CVP Water Service Contractors, and the Colusa Drain Mutual Water Company.

2.2.2.5 Other Uses

As discussed above, the relatively recent practice of flooding rice fields to assist in rice straw decomposition in response to air quality regulations has resulted in additional winter waterfowl habitat being provided throughout the sub-basin. No other significant water uses other than those discussed above occur within the sub-basin.

2.2.2.6 Sub-basin Water Budget

The Colusa Sub-basin, shown on Figure 2-8, encompasses six SRSCs participating in the BWMP. Combined, these six contractors make up more than 50 percent of the SRSC entitlements. Three other metered SRSCs are in the sub-basin, as well as numerous short-form SRSCs. Other water users in the basin include CVP contractors (i.e., TCCA, Sacramento River riparian diverters, and groundwater users). No SWP contractors are in the sub-basin.

A water use balance for the Colusa Sub-basin for 2020 average-year conditions is presented on Figure 2-9. Under 2020 average conditions for this sub-basin, the following projections are made:

- On average, surface water and groundwater pumping will be approximately 75 percent and 25 percent of the total water supply, respectively. SRSC diversions will make up approximately two-thirds of the surface water supply. This proportion could be even larger given the uncertainty in potential deficiencies in CVP agricultural water service contractor deliveries under 2020 conditions.
- For the negotiated agreement's average 2020 diversion of 990 taf/yr, 870 taf/yr (or 88 percent of this total diversion) is Base Supply and 120 taf/yr (or 12 percent of this total diversion) is Project Supply. These Project Supply diversions occur during the critical months of July, August, and September (July and August only for GCID).
- SRSC diversions could range from 800 taf/yr to 1,225 taf/yr, depending upon hydrologic conditions and other outstanding issues (the lower bound representing 75 percent of contract delivery quantities, and the upper bound representing maximum diversions of current Base and Project Supply entitlements).

Given the relative proportion and potential range of supplies available to the SRSCs in the Colusa Sub-basin, several management options designed to improve water supply reliability for users within the sub-basin, and possibly enhance CVP operations system-wide, could be considered. In addition, given the uncertainty associated with Project Supplies, another possibility would be to explore how a given management option might accommodate or replace the Project Supply portion of the current negotiated agreements (averaging 120 taf/yr in this sub-basin). This information will be used to explore these and other possible options further in TM 5.

Figure 2-10 presents a water use balance for Colusa Sub-basin under 2020 critical-year conditions.

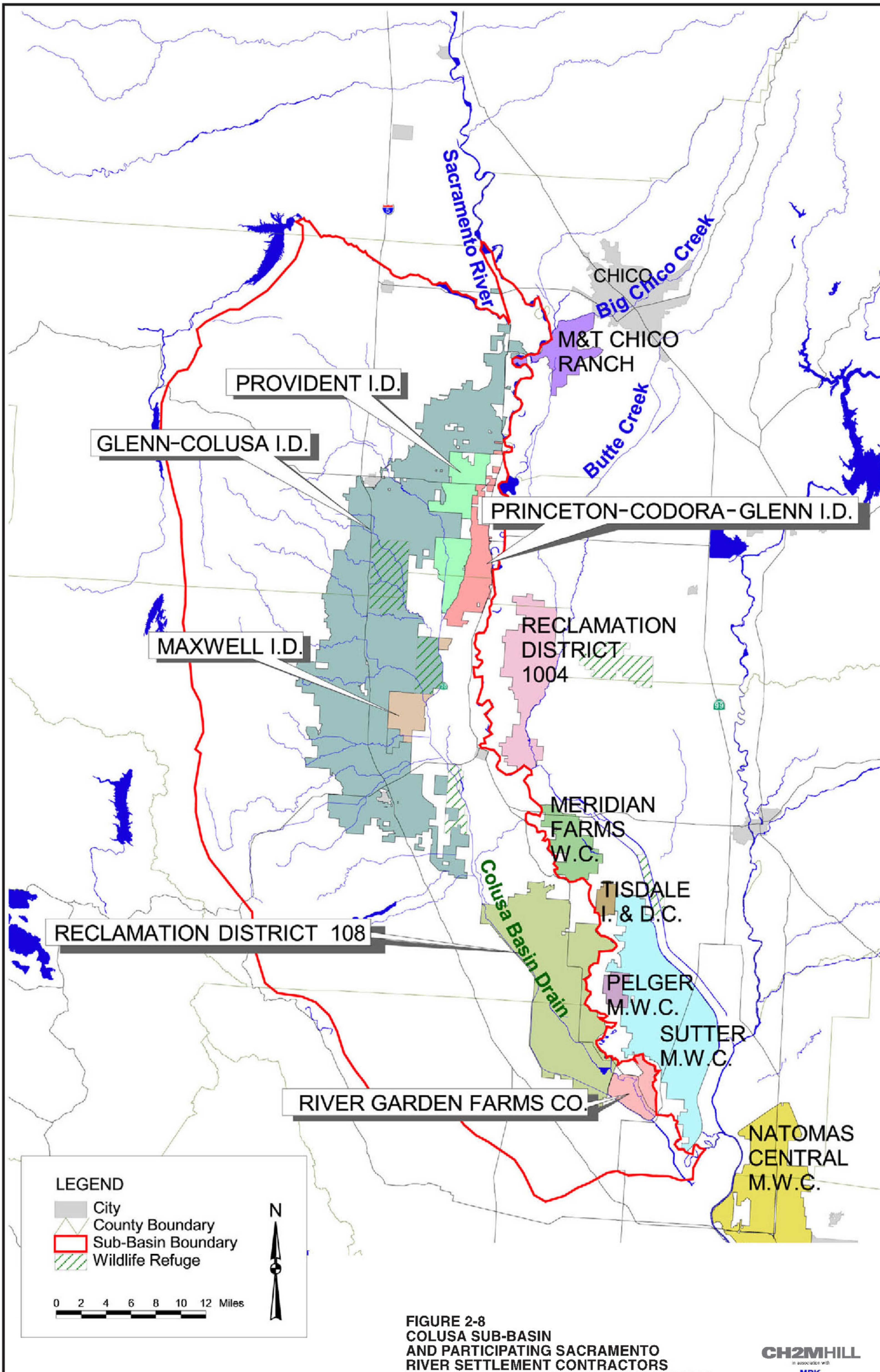
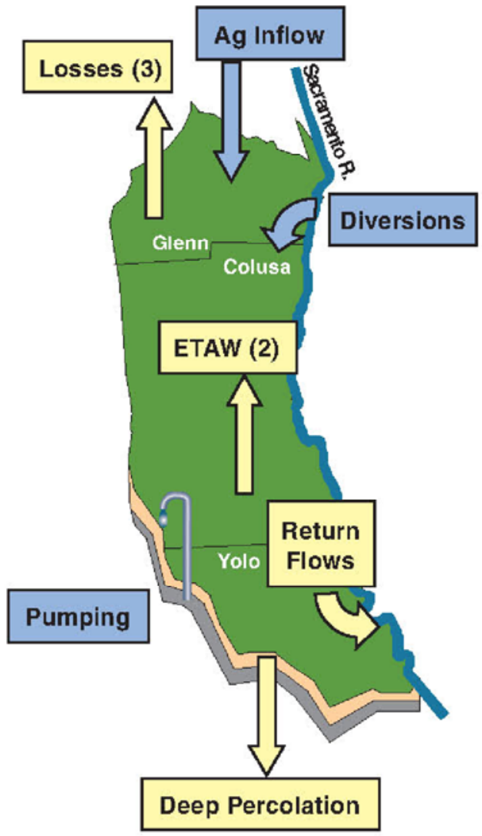


FIGURE 2-8
COLUSA SUB-BASIN AND PARTICIPATING SACRAMENTO RIVER SETTLEMENT CONTRACTORS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN



WATER USE (1)

ETAW (2):	Agricultural	=	1306
	M&I	=	7
Fall Flooding		=	67
Wildlife Refuges		=	43
SUBTOTAL		=	1,423
Other:	Losses (3)	=	87
	Deep Perc	=	128
	Return Flows (4)	=	285
TOTAL		=	1,923

WATER SUPPLY (5)

Surface Water Diversions:		
Riparian	=	126
Settlement Contracts:		
Base Supply	=	929
Project Supply	=	120
CVP Water Service Contracts (6)	=	235
CVP Wildlife Refuges	=	129
Local Surface Water	=	7
SUBTOTAL	=	1,546
Agricultural Drainage Inflow	=	0
Groundwater Pumping	=	363
TOTAL	=	1,909

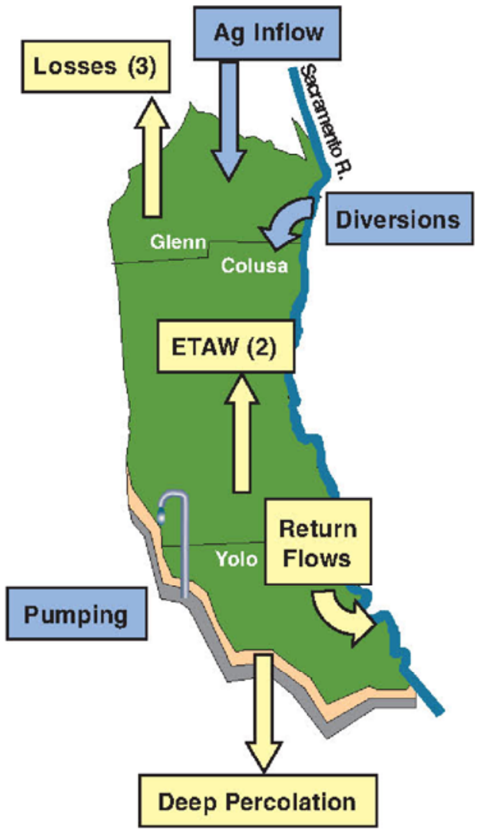
(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 20 percent of the sum of ETAW, fall flooding, and wildlife refuges).
(5) Annual average for the 1980 to 1989 period, unless otherwise specified.
(6) Tehama-Colusa Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 2-9
COLUSA SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W062004006RDD_702 (8/17/05)



WATER USE (1)

ETAW (2):	Agricultural	= 1,374
	M&I	= 7
Fall Flooding		= 55
Wildlife Refuges		= 42
SUBTOTAL		= 1,478
Other:	Losses (3)	= 80
	Deep Perc	= 137
	Return Flows (4)	= 148
TOTAL		= 1,843

WATER SUPPLY

Surface Water Diversions:	
Riparian	= 126
Settlement Contracts:	
Base Supply	= 788
Project Supply	= 67
CVP Water Service Contracts (5)	= 136
CVP Wildlife Refuges	= 129
Local Surface Water	= 7
SUBTOTAL	= 1,253
Agricultural Drainage Inflow	= 0
Groundwater Pumping	= 477
TOTAL	= 1,730

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 10 percent of the sum of ETAW, fall flooding, and wildlife refuges).
(5) Tehama-Colusa Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 2-10
COLUSA SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_704 (8/17/05)

Glenn-Colusa Irrigation District

2.2.3 Glenn-Colusa Irrigation District

2.2.3.1 History

GCID (or the District) claims a water right, under pre-1914 postings, to divert water from the natural flow of the Sacramento River. The water right dates back to 1883, when Will S. Green posted notices for the appropriation and diversion of irrigation water on the west bank of the Sacramento River, at the upstream end of the Oxbow Channel near the current diversion at the main pump station. GCID also has adjudicated pre-1914 water rights under the Angle Decree, issued in 1930 by the Federal District Court, Northern District of California, to divert water from the natural flow of Stony Creek, a tributary to the Sacramento River.

GCID entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water GCID could divert from the Sacramento River. The resulting negotiated agreement recognized GCID's annual entitlement of a Base Supply of 720,000 ac-ft/yr of flows from the Sacramento River and also provided for a 105,000 ac-ft allocation of Project Supply, resulting in a total contract entitlement of 825,000 ac-ft/yr. The 825,000 ac-ft/yr entitlement recognized under contract for GCID is inclusive of their entitlement recognized under their Angle Decree rights, which, on average, yield about 15,000 to 18,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Table 2-9 to the Settlement Contract.

TABLE 2-9
Schedule of Monthly Water Diversions – GCID
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	100,000	0	100,000
May	140,000	0	140,000
June	150,000	0	150,000
July	130,000	55,000	185,000
August	90,000	50,000	140,000
September	65,000	0	65,000
October	45,000	0	45,000
Total	**720,000**	**105,000**	**825,0000**

Notes:

Contract No. 14-06-200-855A-R-1

Points of Diversion: 154.7R, 154.8R

2.2.3.2 Service Area and Distribution System

GCID is located in the central portion of the Sacramento Valley on the west side of the Sacramento River and is the largest irrigation district in the Sacramento Valley, encompassing approximately 175,000 acres. The service area extends from northeastern Glenn County near Hamilton City to south of Williams in Colusa County. District boundaries also encompass the communities of Willows and Maxwell. GCID does not currently supply M&I

water to any of the regions that overlie its service area. Rice is the predominant crop, accounting for approximately 85 percent of the District's irrigated acreage. Other important crops include tomatoes, orchards, vineseeds, cotton, alfalfa, and irrigated pasture.

2.2.3.3 Water Supply

Surface Water. GCID holds both pre- and post-1914 appropriative water rights to divert water from the natural flow of the Sacramento River. GCID also has adjudicated pre-1914 water rights under the Angle Decree, issued in 1930 by the Federal District Court, Northern District of California, to divert water from the natural flow of Stony Creek, a tributary to the Sacramento River. In addition, as the successor in interest to Central Canal and Irrigation Company, GCID may have, under a May 9, 1906 Act of Congress, "the right to divert, at all seasons of the year, from the Sacramento River...an amount of water which...shall not exceed nine hundred cubic feet per second, to be used for irrigating the lands of the Sacramento Valley, on the west side of the Sacramento River..." (Public Law 151, Ch. 439). These water rights are shown in Table 2-10 with associated dates and quantities.

TABLE 2-10
GCID: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A000018 (3/3/15)	000029 (10/20/15)	002871 (5/14/47)	Mar 1 to Nov 1	110 cfs
Sacramento River	A001554 (12/3/19)	000796 (12/14/20)	007208 (3/20/65)	Apr 15 to Oct 1	83.27 cfs
Sacramento River	A001624 (1/14/20)	000797 (12/14/20)	007209 (3/30/65)	Apr 15 to Nov 1	32.0 cfs
Hunters Creek	A008688 (5/28/36)	004795 (8/17/36)	005387 (1/14/59)	Apr 15 to Oct 1	2 cfs
Stone Corral Creek	A012125 (10/8/47)	008272 (12/20/50)	004340 (4/24/56)	Apr 20 to Sep 30	11 cfs
Unnamed Stream Tributary to Funks Creek	A023005 (3/12/68)	015687 (9/10/68)	010635 (4/23/76)	Primary: Apr 1 to Jun 30 Secondary: Sep 1 to Dec 31	2 cfs 415 ac-ft/yr
Sacramento River	A030838 (2/19/1999)	21101 (5/16/2001)	Pending	Nov 1 to Mar 31	1,200 cfs 182,900 ac-ft/yr
Sacramento River	S007367 (N/A)	N/A	N/A	Apr 1 to Oct 31	2,700 cfs
Colusa Basin Drain	S007368 (N/A)	N/A	N/A	Apr 1 to Aug 31	134 cfs

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).
[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.
[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings
[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.
[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

The GCID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0855A (Contract No. 0855A). This contract provides for an agreement between GCID and the United States on the diversion of water from both the Sacramento River and Stony Creek from April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Pursuant to provisions of the contract, Reclamation can require GCID to divert from the Sacramento River water quantities equal to and in lieu of its entitlement under the Angle Decree. Such water, along with Sacramento River water, is made available to GCID under Contract No. 0855A for diversion at its main pump station. In 1998, GCID executed a new agreement with Reclamation (Agreement No. 1425-98-FC-20-17620) for the conveyance of wildlife refuge water and other related purposes. Under the terms of this separate wheeling agreement with Reclamation, GCID can request to receive a portion of its entitlement water via two points on interconnections with the Tehama-Colusa Canal: the Cross-Tie, a 48-inch diameter pipe at Canal Mile 56, and the Inter-Tie, a 1,000-csf flume, at Canal Mile 37. The use of the Tehama-Colusa Canal for delivery of entitlement water is subject to available capacity as determined by Reclamation, in accordance with the terms and conditions of the wheeling agreement. However, GCID has agreed to pay TCCA the O&M costs associated with wheeling a minimum of 20,000 ac-ft annually of Sacramento River water to GCID from the TC Canal whether GCID uses the water or not. This water is typically acquired during rice season flood up after May 15 when the gates are put in at the Red Bluff Diversion Dam.

Contract No. 0855A provides for a maximum total of 825,000 ac-ft/yr, of which 720,000 ac-ft is considered to be Base Supply and 105,000 ac-ft is CVP water (Project Supply). The contract also provides that additional Project Supply can be purchased if surplus water is available. Water from Stony Creek and water diverted from the Sacramento River at the main pump station is accounted for as water diverted under Contract No. 0855A. For purposes of the contract, it was determined that GCID’s Angle Decree rights yielded, on a long-term average, about 15,000 ac-ft/yr. This yield was included in the 720,000 ac-ft of Base Supply entitlement recognized under Contract No. 855A.

The contract specifies the total quantity of water that may be diverted each month during the period April through October each year. The monthly Base Supply ranges from a minimum of 45,000 ac-ft in October to a maximum of 150,000 ac-ft in June. CVP Supply water is available during the months of July and August, with entitlements of 55,000 and 50,000 ac-ft, respectively. The contract identifies July and August as the critical months. For the critical months, the total Base Supply is 220,000 ac-ft and the total Project Supply is 105,000 ac-ft, as shown in Table 2-11. The monthly distribution of the Base and Project Supply is shown on Figure 2-11.

TABLE 2-11
GCID: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Months	220,000	105,000
Non-critical Months	500,000	0
Total Annual	**720,000**	**105,000**

Settlement Contract Historical Diversions. Historically, GCID has used all of its Base Supply and diverted a majority of its Project Supply. In 1981 and 1984, GCID purchased additional

CVP water above the 105,000 ac-ft amount provided for in the contract. During the critical months, GCID diverted CVP water every year from 1964 to 1997, as shown on Figure 2-12. Furthermore, during the 1980s and early 1990s, GCID used nearly all their entitlement water (Base and Project Supply) during the critical months.

Since GCID’s peak demand generally occurs in the spring, it often coincides with the peak out-migration of juvenile salmon. Four runs of Chinook salmon (fall, late fall, winter, and spring) inhabit the Sacramento River. In general, all four runs have declined over the past 25 years. One reason for the decline was the lack of fish screens or, in the case of GCID, poor performance of an existing 20-year–old drum screen.

The District’s diversion was identified as a significant impediment to the downstream migration of juvenile salmon as the lower water surface elevations contributed to unacceptable fish losses at the existing drum screen facility. Following the state and federal listing of the winter-run Chinook salmon as endangered through the Endangered Species Act, pumping restrictions were imposed on GCID by a court-ordered injunction in the early 1990s, preventing the District from diverting its full water entitlement until a long-term solution was implemented.

In addition to pumping restrictions from the injunction, 3 years were classified as critical years, and contract supplies were reduced to 75 percent of contract entitlements. The District managed several programs to supplement these reduced supplies, including a water reuse program, water conservation program, and groundwater conjunctive water management program which contributed up to an estimated 63,000 ac-ft in 1994 in response to reductions in surface water supply.

To address the fisheries issue, an interim flat-plate screen was installed in front of the existing 480 foot long drum screens in August 1993. In 2001, GCID completed the improvement and enlargement of the fish screen facility at the main pump station located near Hamilton City. Once these improvements were completed, the District was able to divert its full entitlement.

Figure 2-13 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- The distribution of the monthly average diversions for the three periods is similar.
- The average monthly diversions for the recent period (1992 to 1997) are about 75 percent of those observed for the 1964 to 1991 and 1979 to 1982 periods. The recent decline in diversions correlates with restrictions from the listing of the winter-run Chinook salmon and drought periods. This required GCID to reuse greater quantities of water, reducing tailwater leaving the District.

- On average, GCID diverts at or above their contract amounts in May and June, except during the recent period. This is because of increased high cultural practice demands for rice during the month of May. (As previously stated, the District is permitted to shift contract supply allocations between non-critical months.)
- During the 1992-1997 period of record, diversions in May and June show the greatest decline relative to the other two period averages. This decline is attributed to strict conservation practices implemented and monitored by the District and the ESA-imposed pumping restrictions (which have since been lifted).

Non-contract Period (November – March). Contract No. 0855A does not limit GCID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. GCID has recently obtained a water right permit for non-contract-period diversions in the amount of 182,900 ac-ft (up to 1,200 cfs), as shown in Table 2-10. Although some pre-irrigation occurs within the District, non-contract-period diversions are predominantly used for rice straw decomposition and waterfowl habitat. In response to increasingly stringent limitations on rice burning, many of the District's land-owners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 54,000 acres were flooded in 2004 with expecta-tion that this acreage number will increase in the future.

GCID has an agreement with Reclamation to convey water to approximately 20,000 acres of wildlife refuges year-round. GCID is strictly a water conveyor for Reclamation in this agreement and is paid on an ac-ft basis. The water delivered to the refuges by GCID is not counted toward GCID's water right entitlement. Approximately, 60,000 to 80,000 ac-ft/yr of supply is conveyed by GCID to the refuges. However, the District must be prepared, if necessary, to convey up to 105,000 ac-ft to meet Level 4 requirements. In addition, as noted above, GCID may hold a right to divert up to 900 cfs from the Sacramento River during "all seasons of the year," pursuant to the May 9, 1906 Act of Congress (Pub. L. No. 151, Ch. 2439).

As discussed above, GCID has entitlements to water from Stony Creek, which can be diverted from Stony Creek, or equivalent quantities can be diverted from the Sacramento River. The GCID service area is relatively large and contains a number of small tributaries to the Sacramento River. GCID holds water rights to pump from Hunters Creek, Funks Creek, and Colusa Basin Drain, as shown in Table 2-10.

Groundwater. The GCID boundary lies within the Sacramento Groundwater Basin. The area is located on alluvium and flood basin sediments, as well as alluvial fan deposits. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities. Alluvial fan sediments are deposited in higher energy, continental environments. Because they are coarser grained, alluvial fan deposits generally have high permeabilities. These recent sediments are underlain by older deposits of the Tehama and Tuscan Formations (Department, 1978).

In the northern portion of GCID, the Tehama Formation contains extensive deposits of interbedded gravel from the ancestral Stony Creek (the Stony Creek Member). The Stony Creek Member of the Tehama Formation is typically very productive, yielding large quantities of water to wells. In the south-central portion of GCID, between Willows and

Williams, the Tehama Formation is predominately clayey, and wells in this area are generally less productive than those in the northern portion of GCID (Department, 1978).

The Tuscan Formation is an important water-bearing unit in the northeastern portion of the Sacramento Valley (Department, 2003a). In the Colusa Sub-basin, the Tuscan Formation interfingers with the Tehama Formation at depths of 300 to 1,000 feet bgs. Coarse-grained deposits within the Tuscan Formation can provide high well yields; however, the unit is generally too deep to be tapped by wells west of Chico (Department, 1978).

Groundwater quality in the Sacramento Groundwater Basin is generally good and is sufficient for agricultural, domestic, and M&I uses. The total depth of freshwater aquifer in the GCID area is estimated as 900 to 1,500 feet bgs. The freshwater is underlain by saline water found in older marine units

In the northern portion of GCID, between the towns of Artois and Glenn, groundwater movement is generally to the southeast, toward the Sacramento River, at a gradient of between 4 and 15 feet per mile (Department, 2003a). In the middle of GCID, near the Town of Maxwell, the flow changes to a more easterly direction with a gradient of approximately 4 to 10 feet per mile. At the southern end of GCID, near the town of Williams, groundwater flows east to slightly northeast, toward the Sacramento River, with the gradient ranging from 7 to 10 feet per mile. The steeper gradients exist at the southwest and northwest edges of GCID. Groundwater throughout the Sacramento Groundwater Basin, and therefore within GCID, occurs in a broad alluvial basin and is therefore not confined to any well-defined subsurface stream channels.

Groundwater use within GCID is generally limited because of the availability of surface water supplies and is driven primarily by climatic conditions. GCID manages and operates a voluntary groundwater conjunctive water management program to increase capacity when water supply does not meet demand. Up to 100 landowners have participated in the groundwater program, representing a combined capacity of approximately 500 cfs. Pumping ranges from 20,000 ac-ft/year during years of high surface water supply to as much as 77,000 ac-ft in critically dry years. Seasonal fluctuations in groundwater levels are generally less than 10 feet, but can be up to 30 feet in drought years. Historical trends show that groundwater levels in the GCID area are generally stable over the long term, although short-term fluctuations in groundwater levels are observed that can be correlated with precipitation trends. GCID implemented a conjunctive water management project pilot study where up to 65,000 ac-ft of groundwater was pumped from private wells during the 1994 irrigation season.

Other Water Supplies. An aggressive recapture program, which captures both subsurface flows (from system leakage and deep percolation recovered by open surface drains) and tailwater runoff from cultivated fields from within GCID’s service area, is a part of GCID’s overall water management program. GCID recaptures this water with both gravity and pump systems. This captured water is delivered to either laterals or the main canal for reuse. Currently, GCID recycles approximately 155,000 ac-ft annually. Relatively small quantities of tailwater are available to GCID from areas outside of the District’s boundaries.

Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability. The

District has established a program that encompasses the entire District to monitor soil and water salinity and test for electrical conductivity and pH.

Much of GCID's surplus water is captured for use by downstream districts such as the PID, PCGID, and MID. GCID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share O&M of the drains within their respective service areas and to share the right to recirculate the water in those drains. In addition, Colusa Basin Drain Mutual Water Company members (57,000 acres, gross) rely on tailwater from GCID and other upstream water users.

GCID adopted a Water Transfer Policy in 1995. This policy identifies agricultural water users within the Sacramento Valley as the highest priority, and environmental purposes as the second highest priority for future water transfers. An in-basin water transfer program was introduced in 1997 that provides for up to 20,000 ac-ft to be transferred to neighboring lands in full water supply years.

2.2.3.4 Water Use

District Water Requirements. Land use within GCID's service area is primarily rice, due to the presence of fine-textured and poorly drained soils within the majority of the District. Other key crops include alfalfa, tomatoes, and cotton. Rice accounts for approximately 80 to 85 percent of the District's irrigated acreage on an annual basis (Department, Northern District). Water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Although surface water is the primary source of irrigation water, groundwater is used in drought years on an individual grower basis, as well as per agreements with the District.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Figure 2-14 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

Table 2-12 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

In response to increasingly stringent limitations on burning, many of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. GCID estimates that approximately 54,000 acres were flooded in 2004, a trend that is expected to continue or increase, assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible.

TABLE 2-12
GCID Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Rice	99,300 (± 10%)[c]	99,100 (± 10%)[c]
Grain	5,500 (± 10%)[c]	5,000 (± 10%)[c]
Alfalfa	4,300 (± 50%)[c]	4,500 (± 50%)[c]
Pasture	4,100 (± 20%)[c]	3,300 (± 20%)[c]
Tomatoes	3,800 (± 40%)[c]	6,400 (± 40%)[c]
Other Crops	13,200 (± 10%)[c]	18,500 (± 10%)[c]
Total Irrigated Acreage	**130,200 (± 10%)[c,d]**	**136,800 (± 10%)[c,d]**

[a]Values are estimates derived from field data that have been normalized (data has been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Northern District.

[b]Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Northern District.

[c]Percentages obtained from GCID.

[d]Includes 200 double-cropped acres for 1995, and 3,700 double-cropped acres for 2020.

This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation-season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Urban. Although GCID overlays the agricultural communities of Willows, Maxwell, and Williams, the District currently does not serve these or other major M&I users. The District has been involved in water transfer programs with municipalities in the past where growers within GCID are given incentives to pump groundwater so that Sacramento River surface water can in turn be transferred to eligible candidates. Future transfers will be dependent on water availability and overall economics. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 10,000 ac-ft compared to 1995 estimated levels (Department, Northern District). This water (in addition to current demands) is assumed to be groundwater. Although lands that are incorporated within a municipality are currently uncoupled from the District, GCID could serve at least a portion of the current and/or future M&I water requirement given a mutual agreement.

Environmental. GCID conveys water to three National Wildlife Refuges (Sacramento, Delevan, and Colusa), encompassing approximately 22,500 acres. Level 4 (total quantity of water identified for each refuge to optimize management by the year 2002 identified by the Central Valley Project Improvement Act) water requirements for these three refuges total 105,000 ac-ft. The District has recently upgraded its water system to better supply the refuges and provide year-round service. Additionally, the District serves approximately 700 acres of privately owned duck clubs. Approximately 8,350 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes elderberry shrubs, which provide habitat for the federally listed valley elderberry longhorn beetle, and habitat used by the giant garter snake.

As previously described, approximately 54,000 acres of rice stubble were flooded in 2004, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the District. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The District's topography consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Glenn County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Glenn and Colusa Counties.

Soil associations in the Glenn County area of GCID are as follows (Appendix C):

- Arbuckle-Kimball-Hillgate: Sandy loam, well-drained, moderately permeable to very slowly permeable soils on low terraces.
- Tehama-Plaza: Silt loam, deep, well-drained to somewhat poorly drained soils mainly on alluvial fans.
- Myers-Hillgate: Clay loam well-drained, slowly and very slowly permeable soils mainly on alluvial fans.
- Willows-Capay: Clay, somewhat poorly drained and poorly drained, fine-textured soils.
- Willows-Plaza-Castro: Clay loam, somewhat poorly drained and poorly drained, medium- to fine-textured soils.
- Wyo-Jacinto: Sandy loam, well-drained to somewhat excessively drained, medium-textured and moderately coarse-textured soils on young alluvial fans or on wind-deposited material.
- Cortina-Orland: Gravely sandy loam, shallow to deep, well-drained to excessively drained soils on recent alluvial fans and on floodplains.

Soil profile characteristics in the Colusa County area of GCID are as follows (Appendix C):

- Young alluvial fan and basin soils with moderately compacted subsoils.
- Older alluvial fan and basin soils with moderately compacted subsoils.
- Older plain or terrace soils with dense clay subsoils.
- Upland soils formed in place from the underlying softly consolidated sedimentary materials.

Transfers and Exchanges. GCID makes conserved water available for its annual in-basin base supply transfer program and to Colusa Drain Mutual Water Company. GCID manages a fallowing program whereby landowners forego their use of water to grow crop and makes the foregone surface water available to State Water Contractors.

Other Uses. No other significant water uses other than those discussed above occur within GCID.

2.2.3.5 District Facilities

GCID's main facilities within its service area include a 3,000-cfs pumping plant and fish screen structure, a 65-mile main canal, and approximately 900 miles of lateral canals and drains that serve its approximately 175,000-acre service area (Figure 2-15). The pump station is situated on an oxbow off the main stem of the Sacramento River. Waterflow passes through a 1,100-ft fish screen structure where a portion of it is pumped into GCID's main irrigation canal. The remaining flow in the oxbow passes by the screens and then back into the main stem of the Sacramento River. The construction of a large siphon at Stony Creek in 1998, and various other siphons and cross-drainage structures in 1999/2000, has eliminated the need for a seasonal dam in Stony Creek and allows for winter deliveries.

Diversion Facilities. GCID's primary diversion supply facility is the Hamilton City Pump Station located on the Sacramento River. The existing pump station was constructed in 1984. In 2001, GCID, completed the improvement and enlargement of the fish screen, including the construction of a gradient control facility along a segment of the main stem of the Sacramento River, and a water control structure for the Oxbow Channel where the pump station is located. The District has historically diverted from Stony Creek via a seasonal gravel dam. This diversion is no longer used following the construction of the Stony Creek Siphon, which conveys main canal flows under the Stony Creek Channel. GCID now receives its Stony Creek water supply through diversion from the Sacramento River or via Reclamation's Tehama-Colusa Canal facilities. GCID can convey refuge water and some of the Settlement Contract water through TCCA via two points of interconnection with the GCID Main Canal: the Inter-Tie, a 1,000-cfs flume, near the Glenn and Colusa County boundary line (Main Canal Mile Post 37); and the Cross-Tie, a 48-inch-diameter pipe, west of Williams (at Main Canal Mile Post 56).

Table 2-13 summarizes GCID's surface water supply facilities. See Figure 2-15 for a map of GCID's major conveyance facilities.

TABLE 2-13
GCID Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Hamilton City Pump Station (Mile 1.4)	Sacramento River	Pump	3,000	659,900
Tehama-Colusa Canal Intertie (Mile 37.2)	Tehama-Colusa Canal	Gravity	1,000	25,400
Tehama-Colusa Canal Crosstie (Lateral 56-1G)	Tehama-Colusa Canal	Gravity	130	23,400

Conveyance System. GCID has approximately 65 miles of main canal and 900 miles of laterals canals and drains. The main canal is the primary conveyance facility for the District. The main canal generally runs along the west side of the District and supplies the various laterals for delivery to field turnouts. Several main canal major improvements have been made recently, including upgrades being constructed this year. These include the installation of new cross-drainage structures and the replacement of existing drainage and control structures. These improvements allow year-round operation of the main canal for Supplying the wildlife refuge complex lands. Table 2-14 summarizes GCID's main canal and irrigation lateral features. GCID does not currently have any lined canals. Estimation of the leakage losses from the GCID main canal indicates that losses are minimal due to the low permeability of the clay soils that are common in the area. A relatively minor quantity of water could be saved by lining some portion of the main canal, but the preliminary analysis shows this to be a prohibitively expensive water management option. Most seepage from District canals returns to surface drains adjacent to the canals, or recharges the underlying groundwater basin, making net regional water savings from canal lining minimal.

TABLE 2-14
GCID Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
GCID Main Canal	Hamilton City Pump Station	3,000	No	NA	13
River Branch Canal (Lateral 12-4)	GCID Main Canal at MCM 12.8/12.9	200	No	Lower part of PCGID	15
Bondurant Slough (Drain A) (Laterals 17-1 and 17-2)	GCID Main Canal (48-inch Sluice Gate)	200	No	Colusa Basin Drain	12
Quint Canal (Lateral 21-2)	GCID Main Canal	100	No	Colusa Basin Drain (20-47 Drain)	12
Willow Creek (Drain B)	GCID Main Canal	100	No	Quint Canal	12
Lateral 25-1	GCID Main Canal	50	No	Western Canal	12
Lateral 26-2	GCID Main Canal	130	No	Sacramento National Wildlife Refuge	10
Lateral 35-1	GCID Main Canal	30	No	Sacramento National Wildlife Refuge	10
Hunter Creek (Drain D) (aka Willits Slough)	GCID Main Canal (Sluice Gate at MCM 40.3)	75	No	Logan Creek and Colusa Basin Drain, MID	10 (clay)
Lateral 41-1	GCID Main Canal	80	No	Delevan National Wildlife Refuge, MID	10 (clay)
Stone Corral Creek (Drain E)	GCID Main Canal	50	No	Delevan, Maxwell, and Colusa Basin Drain	<10
Lateral 45-1 (Drain F3 System)	GCID Main Canal	43	No	Kulh Weir-MID	11
Lateral 48-1 (Lurline Creek System)	GCID Main Canal	100 (Lurline Creek)	No	CDMWC and MID	12

TABLE 2-14
GCID Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Lateral 49-2 (Lurline Creek System)	GCID Main Canal	100 (Lurline Creek)	No	CDMWC and MID	12
Lateral 51-1 (Freshwater Creek System	GCID Main Canal	50	No	CDMWC Colusa Drain	12
Salt Creek System (including Spring Creek)	GCID Main Canal	50	No	Joins Freshwater Creek and goes into Colusa Drain (Davis Weir)	10 (can gain water)
Lateral 64-1 (at M.P. 64.95)	GCID Main Canal	80	No	Colusa National Wildlife Refuge	10
Lateral 56-1	Tehama-Colusa Canal Crosstie	130	No	Spring Creek/Salt Creek System	10

Notes:
NA = not applicable
CDMWC = Colusa Drain Mutual Water Company

GCID has been modernizing its facilities to create a canal system with automated control and monitoring, including motor-operated radial and slide gates, water-level and flow measurement at key points in the system, and integrated SCADA to match supplies and demands throughout the system. The District also has an ongoing program to increase the coverage of the SCADA system and to automate remaining major flow control structures. Only five major control structures on the main canal require replacement and modernization. The District's operational spills are minimal based on the standard performance and requirements of an open-channel distribution systems, and it is not likely that significant reductions in the quantity of operational spills can be achieved.

Storage Facilities. GCID currently has no significant storage facilities. The Department is currently studying the feasibility of constructing the Sites Reservoir west of the Town of Maxwell. There is potential benefit to the reintroduction of water from Sites Reservoir, through the District's Main Canal, to the Colusa Basin Drain and then to the Sacramento River. For example the water from Sites Reservoir could be blended with drain flow from the District to improve water quality released to the downstream system. In addition from the regulating reservoir could be pumped back upstream, check by check, in the Main Canal and diverted to Sites Reservoir.

The Stony Creek Fan Partnership, a partnership between GCID and its neighbors, Orland Unit Water Users Association, and Orland-Artois Water District, is funded through the Department Storage Investigations Program to examine the potential for groundwater production and recharge within a gravely strata located in Glenn County, the Stony Creek Fan. GCID's Conjunctive Use Program is being developed in conjunction with the Stony Creek Fan Program and builds upon data obtain through this investigation and the Sacramento Valley Water Management Program.

Spill Recovery. An aggressive recapture program, which includes groundwater seepage and tailwater runoff from cultivated fields, is part of the District's overall water management program. GCID has a network of unlined drainage ditches for conveying irrigation return flows and regional surface runoff. The drainage ditches generally empty into regional sloughs and creeks, which in turn drain into the Colusa Basin Drain. The District operates 19 drain recapture pump stations to divert for reuse. These pump stations have a total combined capacity of 912 cfs, and recapture an average of 76,000 ac-ft/season. The District also has 18 gravity surface diversions for recapturing, which recapture an average of 77,000 ac-ft/season. These facilities are not shown on Figure 2-15.

2.2.3.6 District Operating Rules and Regulations

GCID was formed under Chapter 11 of the California Water Code. As such, the District is subject to the rules and regulations of this code including governing its actions through an elected Board of Directors and is required to keep a minimum amount in financial reserves.

Water rotation, apportionment, and shortage allocation:

> According to Rule 13 of GCID Rules and Regulations: *All consumer requests for water must be received at the District's office, or by the responsible water operations worker, at least three days before the water is needed by the consumer.*
>
> According to Rule 14 of GCID Rules and Regulations: *In the event of water shortage or water delivery constraints, the District will endeavor to equitably apportion the available District water to the District land entitled thereto.*
>
> *In years in which the Board concludes that the District's water supply will be inadequate to serve all lands entitled to service from the District, the District will estimate the total water supply available for the irrigation season, and after deducting estimated canal losses, apportion the balance to each District landowner in accordance with California Water Code section 22250 and 22251. To accomplish this apportionment, the District will accept primary applications for acreages of crops for which the landowner's apportioned water share will bring appurtenant crops to maturity. All additional acreage applied for will be placed on a secondary application list. On expiration of the time to submit primary water applications, if the total estimated water required to serve the primary application is less than the total estimated water available, the excess shall be equitably allocated to secondary applications at the discretion of the Board.*

Use of drainage waters:

> According to Rule 14 of GCID Rules and Regulations: *District landowner(s) are advised that drain water in the District is considered water supplied by the District, and any such water recaptured by the landowner(s) or user(s) may not be used to increase irrigated acreage.*

Policies for wasteful use of water:

> According to Rule 16 of GCID Rules and Regulations: *If, in the opinion of the General Manager, a consumer is wasting water, either willfully, carelessly,*

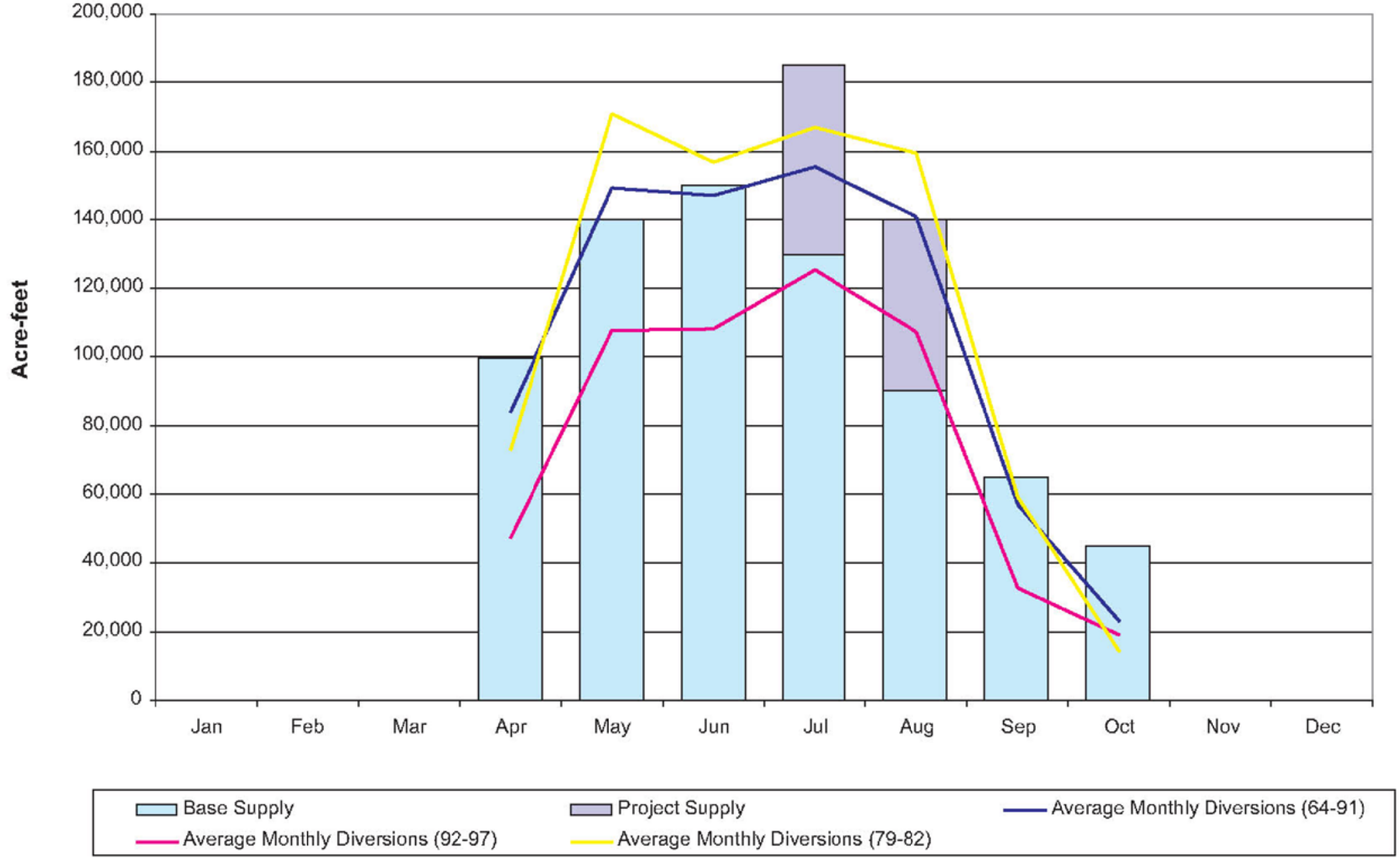
> *negligently or on account of defective private conduits, the District may refuse the delivery of water until the wasteful conditions are remedied, or the District may reduce the water inflow into the consumer's fields to a flow that would be reasonable if such wasteful conditions were remedied. Wasteful water use practices include, but are not limited to, (1) using water on roads, vacant land, or land previously irrigated, (2) flooding any portions of a consumer's land to an unreasonable depth or using an unreasonable amount of water in order to irrigate other portions of such land, (3) using water on land that has been improperly prepared for the economical use of water, and (4) allowing an unnecessary amount of water to escape from any tailgate.*
>
> *The District reserves the right to refuse delivery of water when, in the opinion of the District Manager, the proposed use, or method of use, will require excessive quantities of water which constitute waste.*

2.2.3.7 Water Measurement, Pricing, and Billing

Main canal flows are measured using meters at key points, including a new acoustic measuring device at the recently constructed Stony Creek siphon. Main laterals and sub-laterals that serve field turnouts are metered. The District drain pumps and the single District groundwater well are metered. Turnouts to fields are measured and totalized by service area using the measurements for the service lateral that serves each area. Lateral spills are measured and totalized using lateral stage measurement and weir equations. Drain outflows from the District are measured and recorded using a combination of weirs and meters.

GCID does not currently meter individual field turnouts, with the exception of several test plots that are used to provide detailed quantitative data for use in monitoring efforts to improve farm-level water management. GCID does, however, measure flow rates at turnouts using canal stage and head-discharge relationships for orifices and gates. Total deliveries per service lateral are recorded. The average on-farm efficiency for the District is approximately 65 percent, which is near the practical upper limit of around 70 percent. Farm-level measuring in combination with incentive pricing and on-farm improvements may potentially increase the average on-farm efficiency and provide a quantity of conserved water.

GCID also participates in an effort to support improved water management in the Sacramento Valley on a broader scale, the *Sub-basin-level Water Measurement Study* was proposed by the SRSCs and subsequently funded through CALFED. Given the BWMP's recommendation that sub-basin management be further explored, this water measurement study focuses on increasing the water measurement level of accuracy at a sub-basin level. This ongoing study is a preliminary investigation of potential measurement locations, facilities, and associated implementation issues to allow for water measurement in the five Sacramento Valley sub-basins addressed in the BWMP.



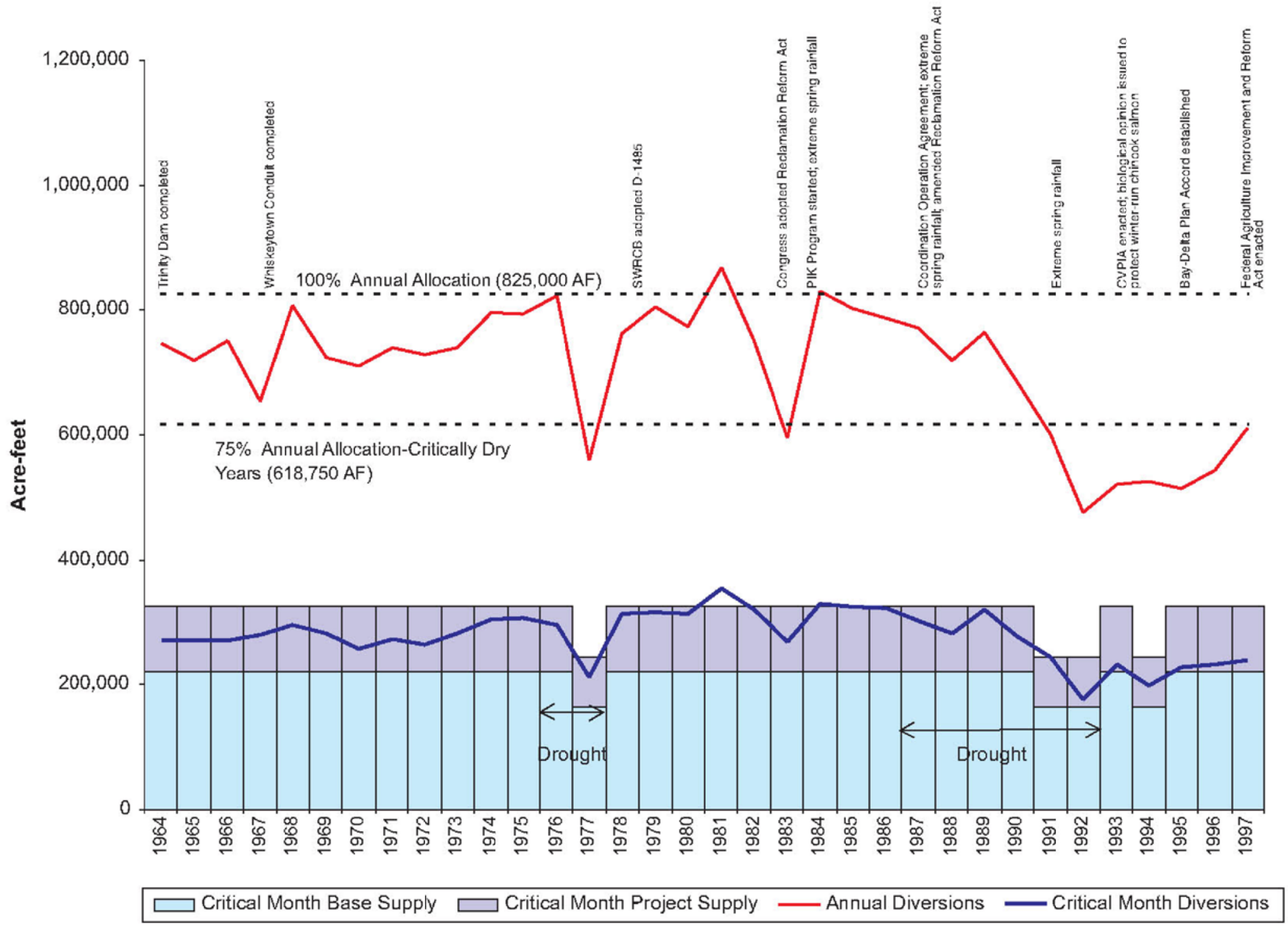
Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-11
GLENN-COLUSA IRRIGATION DISTRICT MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

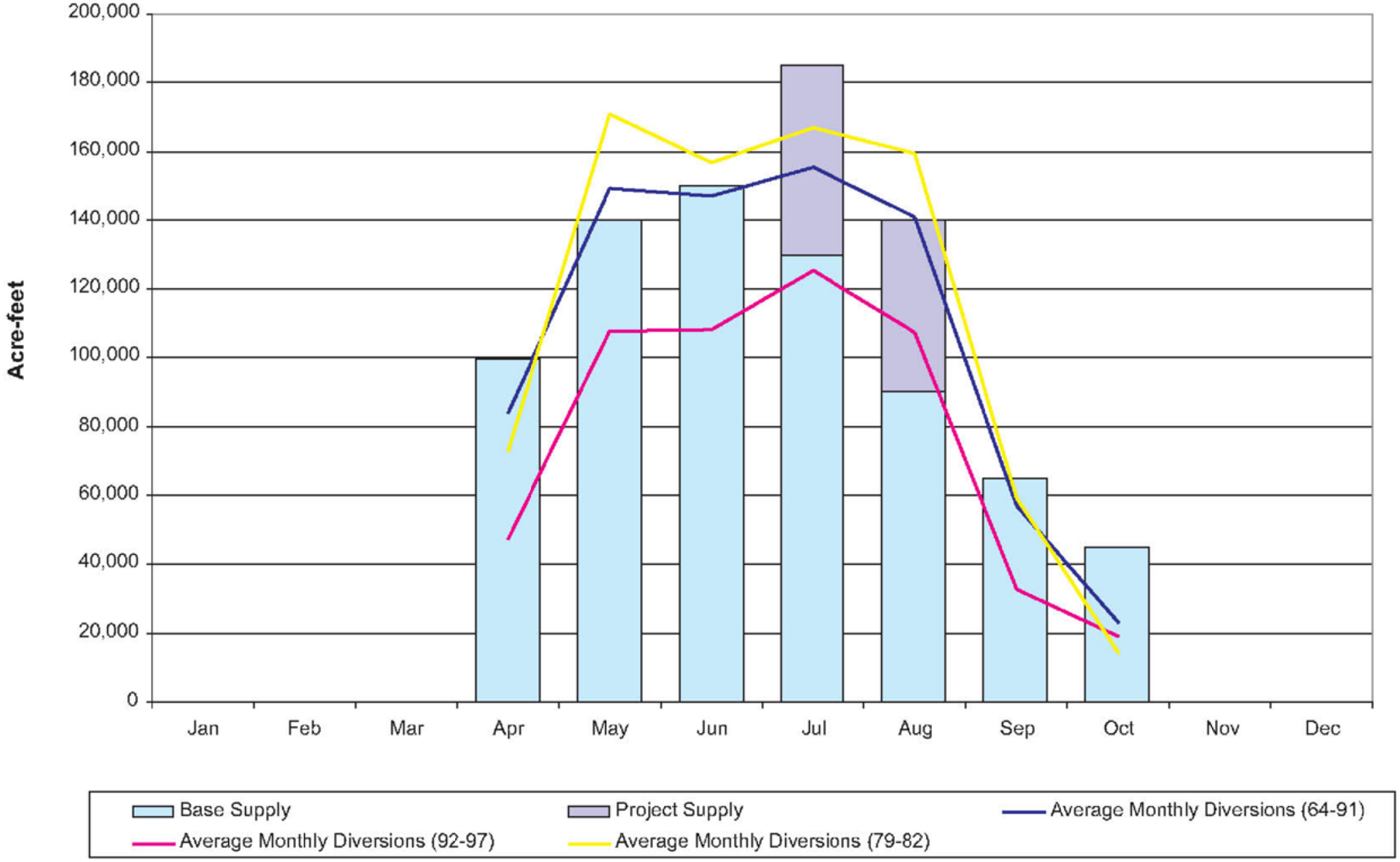
W032005010RDD_852 (8/17/05)



Note: Annual quantities are based on contract period from April to October; Critical Months include July and August.

FIGURE 2-12
GLENN-COLUSA IRRIGATION DISTRICT
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-13
GLENN-COLUSA IRRIGATION DISTRICT MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
In association with
MBK

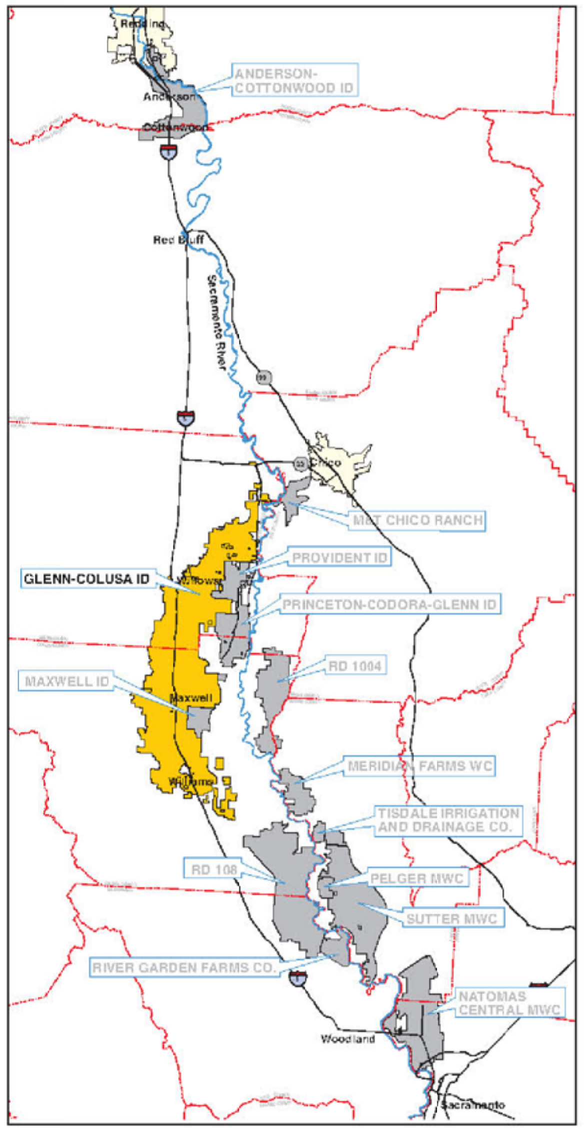
W032005010RDD_102 (8/17/05)

Glenn-Colusa Irrigation District

Manager: O. L. Van Tenney • 344 East Laurel Street • Willows, CA 95988 • (530) 934-8881

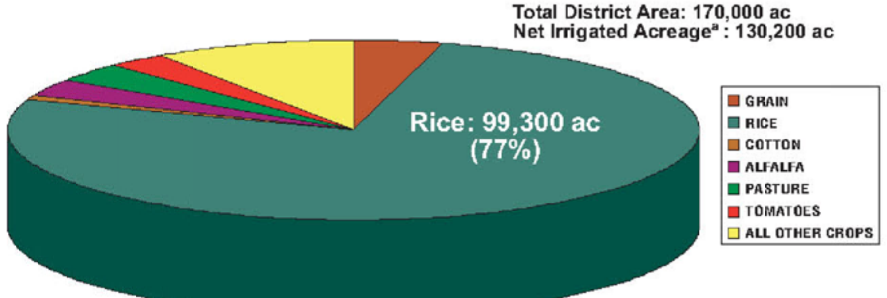
Settlement Contract:	825,000 af
Base Supply:	720,000 af
Project Supply:	105,000 af

Location Map



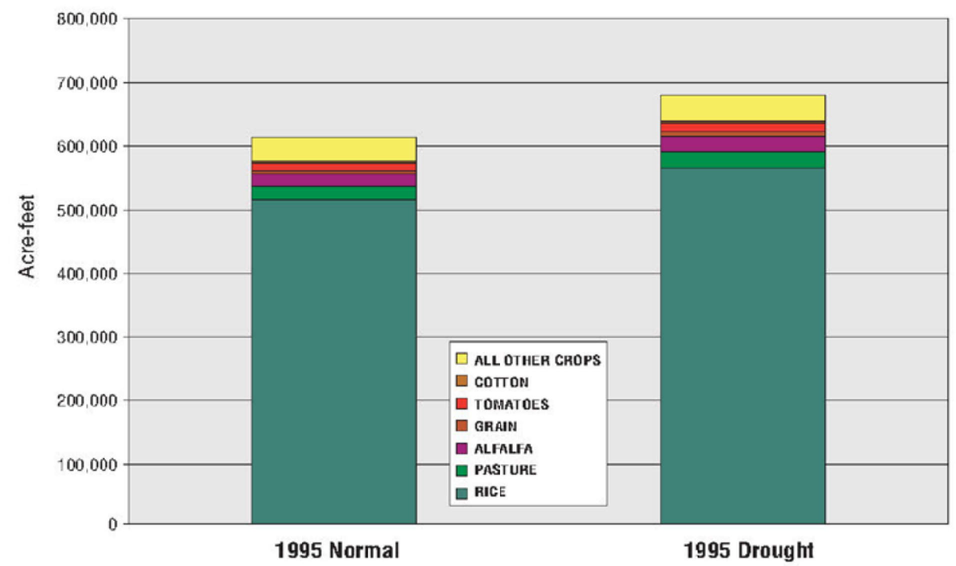
Irrigated Acreage by Crop

Total District Area: 170,000 ac
Net Irrigated Acreage[a]: 130,200 ac

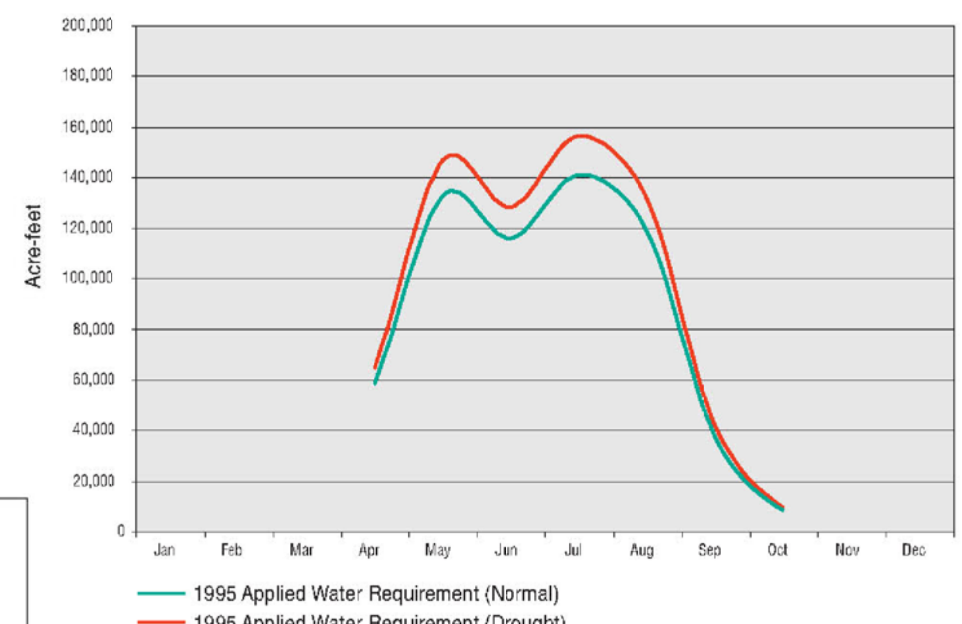


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

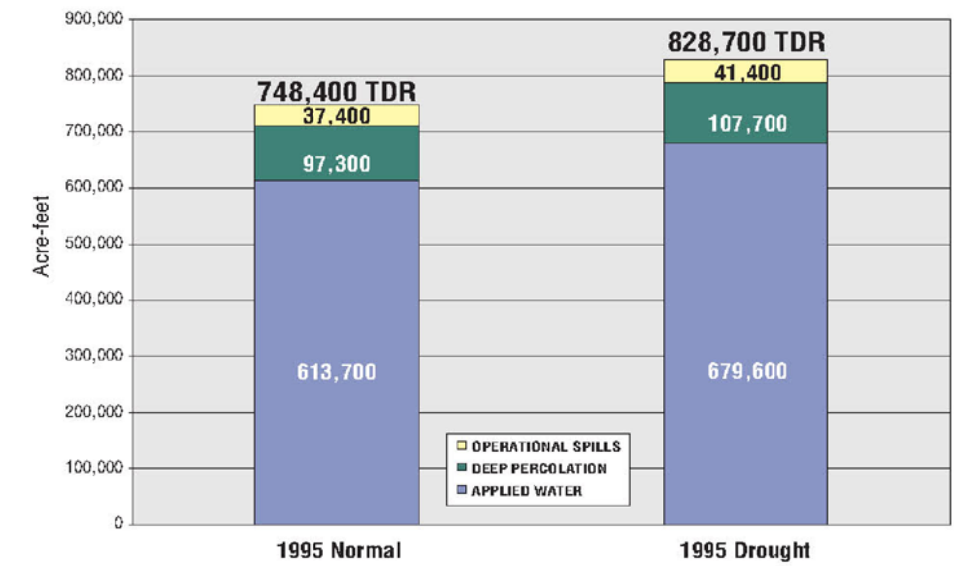


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

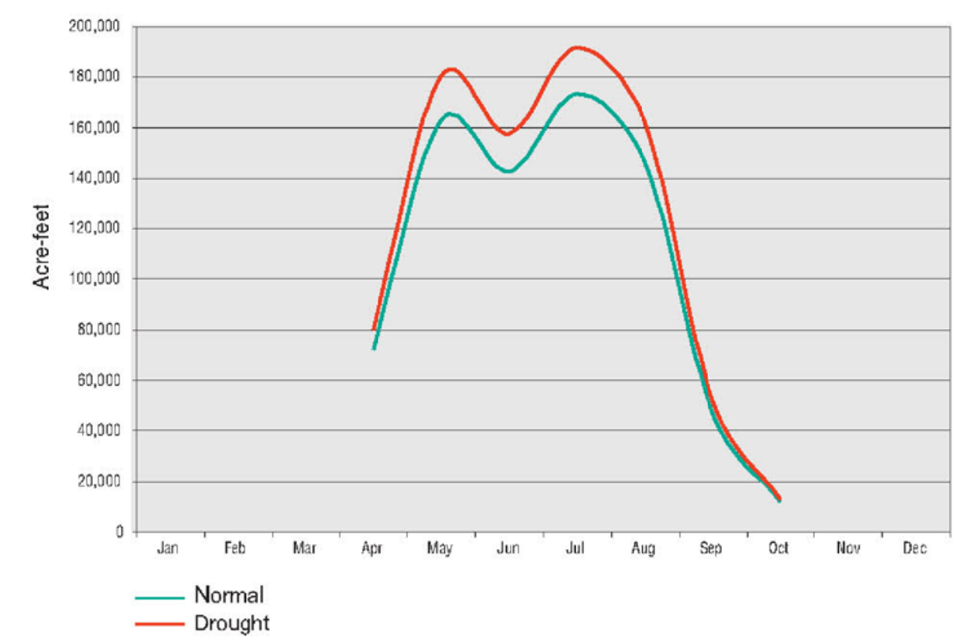


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 13% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 13% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 2-14
GLENN-COLUSA IRRIGATION DISTRICT IRRIGATION ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_13 (8/17/05)

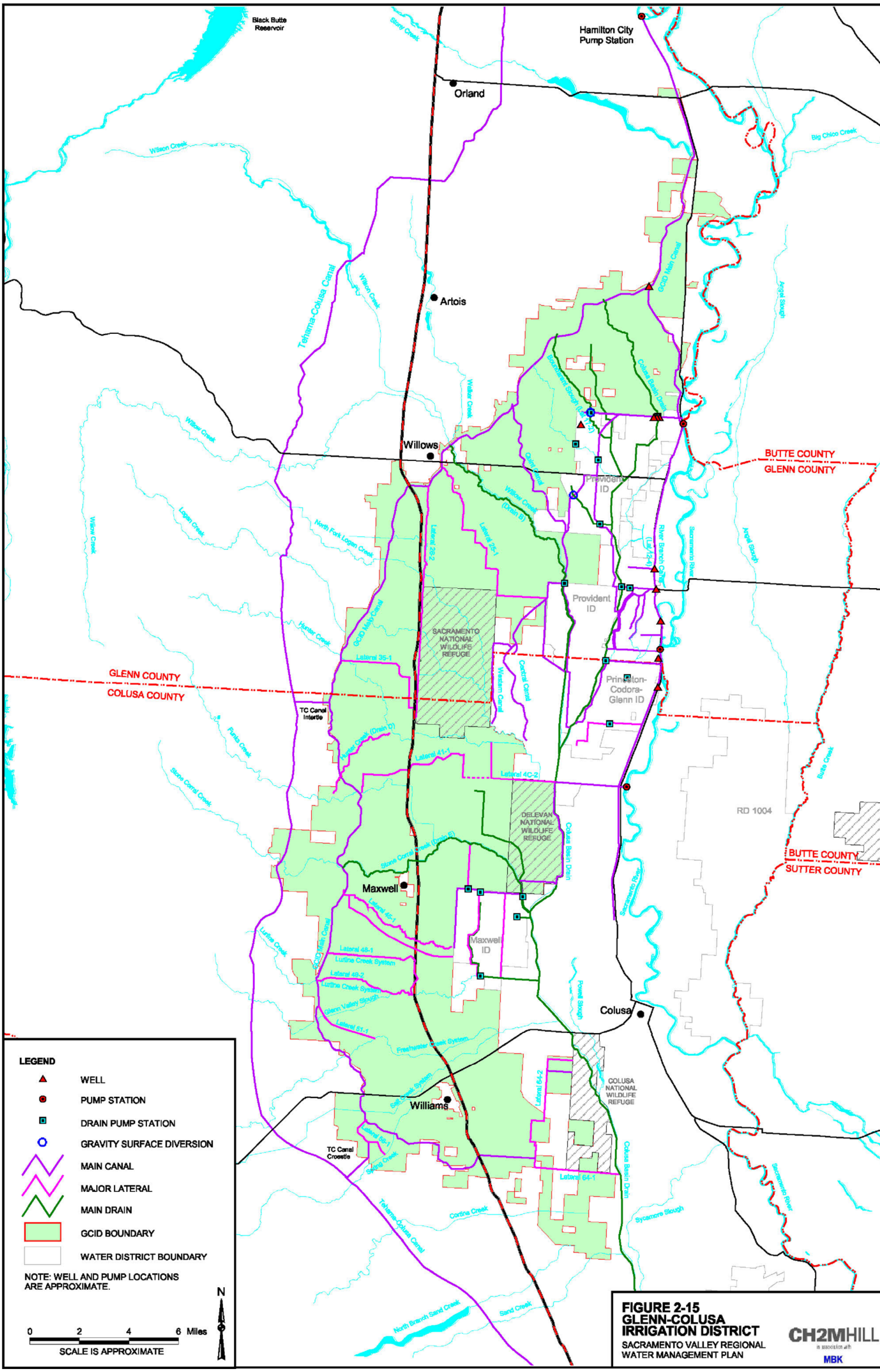


FIGURE 2-15
GLENN-COLUSA IRRIGATION DISTRICT
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2M HILL RDD \\LOKI\projects\rddgis\SacBWMP\gisdata\newhydro3_0805.apr gcid.pdf 08/18/2005

Provident Irrigation District

2.2.4 Provident Irrigation District

2.2.4.1 History

PID (or the District) was formed on April 27, 1918. A small part of the land in what is now PID was once within the old Central Irrigation District. In 1931, when PID was reorganized and refinanced, certain lands were excluded. Some of the lands that were excluded were later organized into the Willow Creek Mutual Water Company. In 1964, PID and Reclamation entered into a negotiated agreement quantifying the amount of water PID could divert from the Sacramento River. The negotiated agreement recognized PID's annual entitlement to a Base Supply of 49,730 ac-ft/yr from the Sacramento River and also provided for a 5,000 ac-ft allocation of Project Supply, resulting in a total contract entitlement for 54,730 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Exhibit A for PID is included in Table 2-15. The Settlement Contract negotiated in 1964 remains in effect until March 2006. PID is working with Reclamation and counsel to finalize environmental documentation for contract renewal.

TABLE 2-15
Schedule of Monthly Water Diversions – PID
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	7,210	0	7,210
May	10,830	0	10,830
June	12,920	0	12,920
July	6,300	3,500	10,000
August	2,500	1,000	35,000
September	7,400	500	7,900
October	2,570	0	2,570
Total	**49,730**	**5,000**	**54,730**

Notes:

Contract No. 14-06-200-856A-R-1

Points of Diversion: 123.9R, 154.8R

2.2.4.2 Service Area and Distribution System

PID lies to the west of the Sacramento River in the Colusa Basin in the Counties of Glenn and Colusa, approximately 7 miles east of the City of Willows. The District encompasses approximately 15,965 acres (including 800 acres recently annexed into the District) and serves 120 landowners. Rice is the predominant crop accounting for approximately 98 percent of irrigated acreage in the District. Many of PID's operations are coordinated with the PCGID, located directly adjacent and east of the District.

2.2.4.3 Water Supply

The Sacramento River serves as the principal water source for the District, although the District also uses tailwater from both inside and outside of the District. The District has water rights to the Sacramento River and several other surface water sources as shown in Table 2-16. The following discussion describes these sources and their historical use.

TABLE 2-16
PID: Water Rights
Sacramento Valley Regional Water Management Plan

Source	Water Rights[a,b] Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River, Colusa Basin Drain, Willow Creek, Unnamed Drain[d]	A000462 (9/15/16)	000303 (7/12/17)	007205 (3/30/65)	Apr 1 to Oct 1	250 cfs
Sacramento River, Colusa Basin Drain, Willow Creek, Unnamed Drains[d]	A000640 (4/9/17)	000304 (7/12/17)	007206 (3/30/65)	Apr 1 to Oct 1	100 cfs
Sacramento River, Colusa Basin Drain, Drain 13, Drain 55, Unnamed Drain, Willow Creek	A000892 (1/18/18)	000416 (3/28/18)	007207 (3/30/65)	Apr 1 to Oct 1	110 cfs
Colusa Basin Drain	A001422 (9/2/19)	000847 (3/4/21)	001109 (9/15/31)	Apr 15 to Oct 1	10 cfs
Colusa Basin Drain	A013452 (11/9/49)	008290 (12/20/50)	004364 (5/21/56)	Apr 1 to Oct 1	3.25 cfs
Sacramento River, Colusa Basin Drain, Drain 13, Drain 55, Unnamed Drain, Willow Creek	A030813 (1995 or later)	Pending	Pending	Oct 1 to Mar 31	483.25 cfs 26,747 ac-ft/yr
Colusa Basin Drain	A010595 (1/27/43)	6210	4331 (4/24/56)	Apr 15 to Oct 1	10 cfs

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).
[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.
[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings
[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.
[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Surface Water. PID holds water rights to divert water from the natural flow of the Sacramento River. The PID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-16-200-0856A (Contract No. 0856A). This contract provides for an agreement between PID and the United States on PID's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract was set to expire March 31, 2004. However, Congress granted a 2-year extension and therefore the contract will remain in effect until March 31, 2006. PID is working with Reclamation and counsel to finalize environmental documentation for the proposed contract renewal, expected to take effect for another 40-years at the end of the 2-year extension. Contract No. 0856A provides for a maximum total of 54,730 ac-ft/yr, of which 49,730 ac-ft is considered to be Base Supply and 5,000 ac-ft is CVP water (Project Supply), as shown in Table 2-17. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-17
PID: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	16,200	5,000
Non-critical Months	33,530	0
Total Annual	**49,730**	**5,000**

The contract specifies the total quantity of water that may be diverted by PID each month during the period April through October each year. The monthly distribution of the Base Supply and Project Supply is shown on Figure 2-16. The monthly Base Supply ranges from a minimum of 2,500 ac-ft in August to a maximum of 12,920 ac-ft in June. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 3,500, 1,000, and 500 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 16,200 ac-ft, and the total Project Supply is 5,000 ac-ft, as shown in Table 2-17.

Settlement Contract Historical Diversions. PID's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 2-17. From 1964 to the mid-1970s, diversions typically increased from one year to the next. The increase in diversions during this period is attributed to an increase in rice acreage. During the early 1960s, government programs limited rice production within the District. Wheat and safflower, crops with lower water requirements compared to rice, were planted in place of rice. Total annual diversions in 1964 were only 16,000 ac-ft in comparison to 56,000 ac-ft in 1975 when the District purchased water in addition to Base Supply and Project Supply entitlements. Between 1975 and 1986, diversions fluctuated between 35,000 and 51,000 ac-ft/yr. During drought conditions in the late 1980s and early 1990s, annual diversions declined. The decrease in diversion during this period is associated with the management philosophy to reduce river diversions. In addition, several years were classified as "critical years," and contract supplies were reduced to 75 percent of contract entitlements. During 1991, a critically dry year, annual diversion only totaled 23,000 ac-ft when 75 percent allocation was 41,048 ac-ft. During the past several years, annual diversions have dramatically increased, as diversions for 1996 and 1997 were 54,300 and 53,000 ac-ft, respectively.

Figure 2-16 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- Due to the relatively small, 3,500 ac-ft, Base Supply and Project Supply entitlement for August, the average diversions for the District are well above this amount, nearly 6,000 ac-ft on average (1977 to 1991).
- During the 1980s and in the last several years, PID has used nearly all of its entitlement water (Base Supply and Project Supply) during the critical months (also see Figure 2-17).
- During the recent period (1992 to 1997), the average monthly diversions have been greater than long-term averages (1964 to 1991).
- During the period (1992 to 1997), the average monthly diversion in the month of October was approximately 6,900 ac-ft, an increase of over 5,000 ac-ft in relation to the other two period averages. Increased diversions during the month of October (1992 to 1997) are attributed to increased rice straw decomposition acreage.

Non-contract Period (November – March). Contract No. 0856A does not limit PID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. Recently, PID has filed for a water right permit for non-contract-period diversions in the amount of approximately 26,700 ac-ft, as shown in Table 2-16. Relatively little pre-irrigation occurs within the District, and therefore, non-contract-period diversions are predominantly used for rice straw decomposition. In response to increasingly stringent limitations on burning, many of the District’s landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 4,000 to 8,000 acres have been flooded in the past; however, acreage is expected to increase over the next few years.

Other Surface Water Sources. PID has water rights to several surface water sources within or bordering the District’s service area. As shown in Table 2-16, PID holds water rights to Willow Creek, Colusa Basin Drain, Drain 13, Drain 55, and several other unnamed drains.

Groundwater. The PID boundary overlies the Colusa Sub-basin (Department groundwater basin number 5-21.52) of the Sacramento Valley Groundwater Basin. Groundwater throughout the Sacramento Groundwater Basin, and therefore within PID, occurs in a broad alluvial basin and is therefore not confined to any well-defined subsurface stream channels.

PID lies within the northeastern portion of the Colusa Sub-basin. The area is located on recent alluvial sediments including: channel, floodplain, basin, and alluvial deposits. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities. Stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeabilities. Underlying these recent fluvial deposits are the Tehama and Tuscan Formations (Department 1978; Department, 2003c).

Beneath the alluvial fan deposits are the deposits of the Tehama Formation. Although the Tehama Formation is mostly fine-grained, it contains sufficient sand and gravel zones in many areas to provide large quantities of groundwater. In the northern portion of the Colusa Sub-basin the Tehama Formation contains extensive deposits of interbedded gravel from the ancestral Stony Creek (the Stony Creek Member). The Stony Creek Member of the

Tehama Formation is typically very productive, yielding large quantity of water to wells. In the central and southern portion of the Colusa Sub-basin, between Willows and Williams, the Tehama Formation is predominately clayey and wells in this area are generally less productive than those in the northern portion of the sub-basin (Department, 1978).

The Tuscan Formation is an important water-bearing unit in the northeastern portion of the Sacramento Valley (Department, 2003a). Deposited during the same period as the Tehama Formation, the Tuscan Formation consists of interbedded volcanic deposits (Department, 1978). The unit grades from tuff breccias along the eastern margin of the Sacramento Valley to volcanic sands, gravels, and clays to the west. In the Colusa Sub-basin, the Tuscan Formations is found at depths of 300-1,000 feet bgs, where it interfingers with the Tehama Formation (Department, 2003a). Volcanic sands and gravels can provide high yields to domestic and irrigation wells; however, the unit is generally too deep to be tapped by wells west of Chico (Department, 1978).

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for agricultural, domestic, and M&I uses. In general, natural groundwater quality is influenced by streamflow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada Mountains is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range. The total depth of fresh water in PID is approximately 1,200 feet bgs (Berkstresser, 1973). The fresh water is underlain by saline water.

In the northern portion of PID, near the town of Glenn, groundwater movement is generally to the southeast, towards the Sacramento River, at a gradient of 5 feet per mile (Department, 2003c). In the southern portion of the District the flow changes to a more southerly direction with a gradient of about 2.5 feet per mile. Seasonal fluctuations in groundwater level are generally less than about 5 feet, but can be up to 10 feet in drought years (Department, 2003b). Wells located near recharge sources typically show less of an annual change in groundwater levels.

Past pumping and drought conditions have not historically negatively affected the overall long-term groundwater level trends in PID. Based on the spring to spring water level information of Department monitoring wells in the PID area that date back to the 1940s, there has been little significant change in groundwater levels over time (Department, 2003b). Groundwater level data since 1980 from over 2,300 wells in the Sacramento Valley were reviewed and the historical trends show that groundwater levels in the PID area are generally stable over the long term, although short-term fluctuations in groundwater levels are observed that can be correlated with precipitation trends.

Approximately 15 to 20 privately owned wells and four District-owned wells are located within the District’s boundaries. During the drought years of 1976 to 1977, PID installed three agricultural groundwater wells to supplement its water supply. An additional well was installed in 1991. During the drought of 1986 to 1993, several private groundwater wells were installed. The total capacity of the District-owned wells is approximately 3,000 to 4,000 ac-ft/yr. Groundwater is used to help with initial flooding of the rice fields and to increase flexibility during the peak demand periods (Department, 1978).

Other Water Supplies. In recent years, PID has relied heavily upon tailwater, approximately 45,000 to 55,000 ac-ft/yr, from both inside and outside of the District's service area to supplement its Sacramento River entitlement. PID operates two gravity surface diversions on Drain 13 and Drain 55. These two drains primarily convey tailwater from GCID. In addition, Colusa Basin Drain, Quint Canal, and Willow Creek also convey tailwater from GCID and other sources. Approximately 25,000 to 30,000 ac-ft annually have been used in the past from these sources. PID meters water pumped from these drains.

In the past, PID has recycled internally about 20,000 to 25,000 ac-ft annually. Water recirculated within PID is metered. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability.

2.2.4.4 Water Use

District Water Requirements. Rice is the overwhelmingly predominant crop grown within PID's service area, due to the presence of clayey soils within the majority of the District. Other crops include a small amount of pasture and grains. Rice accounts for more than 98 percent of the District's irrigated acreage on an annual basis (Department, Northern District).

As is the case with most of the other districts, water requirements are typically highest during the summer months (June, July, and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. The vast majority of irrigation water requirements are met through the contract surface water supply, although groundwater is used in drought years on an individual grower basis and as per agreements with the District.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 2-18 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

Figure 2-18 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

TABLE 2-18
PID Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Rice	14,600 (± 10%)[c]	14,600 (± 10%)[c]
Other Crops	200 (± 10%)[c]	400 (± 10%)[c]
Total Irrigated Acreage	**14,800 (± 10%)[c]**	**15,000 (± 10%)[c]**

[a] Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Northern District.

[b] Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Northern District.

[c] Percentages obtained from PID.

Urban. PID does not overlay any municipal or industrial centers and does not currently have plans to provide water for these uses other than continuing to pump and deliver water to the Willow Creek Mutual Water Company, which is an agricultural user. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 5,000 ac-ft compared to 1995 estimated levels (Department, Northern District). Future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the District does not preclude the possibility of serving such needs in the future.

Environmental. Approximately 50 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. PID contributes varying levels of flow depending on year type to the Delevan National Wildlife Refuge through Willow Creek during the irrigation season. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

Up to 8,500 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. Additionally, the District serves approximately 1,000 acres of privately owned duck clubs. No managed designated environmental or wetlands areas are within the District.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the District. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Glenn County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage of each individual soil association and soil profile within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Glenn and Colusa Counties.

Soil associations in the Glenn County area of PID are as follows (Appendix C):

- Zamora-Marvin: Silt to silty clay loam, well-drained to somewhat poorly drained, moderately fine-textured and fine-textured soils on floodplains.
- Tehama-Plaza: Silt loam, deep, well-drained to somewhat poorly drained soils mainly on alluvial fans.
- Willows-Plaza-Castro: Clay loam, somewhat poorly drained and poorly drained, medium- to fine-textured soils.

Soil profile characteristics in the Colusa County area of PID are as follows (Appendix C):

- Older alluvial fan and basin soils with moderately compacted subsoils.

Transfers and Exchanges. PID is involved with several water transfer agreements. Several of the irrigation and reclamation districts adjacent to the Colusa Basin Drain have agreed to provide additional flow, when possible, to the drain for use by the Colusa Basin Drain Mutual Water Company. The districts are compensated by Colusa Basin Drain Mutual Water Company for this water. In addition, PID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share O&M of the drains within their respective service areas and to share the right to recirculate the water in those drains. PID also diverts water to Willow Creek Mutual Water Company via a transfer agreement.

Other Uses. No other significant water uses other than those discussed above occur within PID.

2.2.4.5 District Facilities

Diversion Facilities. PID's primary water supply facility is a surface water diversion on the Sacramento River at Sidds Landing Pump Station. The District operates Sidds Landing Pump Station in cooperation with PCGID. The District also operates two gravity surface diversions on adjacent drainage channels that convey return flows from GCID lands to the west of PID. Table 2-19 summarizes PID's surface water supply facilities. See Figure 2-19 for a map of PID's major conveyance facilities.

TABLE 2-19
PID Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Sidds Landing Pump Station	Sacramento River	Pump	300	58,000
Drain 13 Gravity Surface Diversion	Drain 13	Gravity	100	9,500
Drain 55 Gravity Surface Diversion	Drain 55	Gravity	100	30,000

During the 1976 to 1977 drought, PID installed three groundwater wells to supplement its water supply. An additional well was installed in 1991. Table 2-20 summarizes the District's groundwater well data. During the drought of 1986 to 1993, several private groundwater wells were installed. There is no formal agreement between the District and the landowners regarding pumping of private wells. Approximately 7,200 ac-ft/yr can currently be pumped from the groundwater wells within the District.

TABLE 2-20
PID Groundwater Wells
Sacramento Valley Regional Water Management Plan

Map ID	Capacity (cfs)	Historical Pumping (ac-ft/yr)	Water Quality
AG Well No. 1	4.5	534	Good
AG Well No. 2	10.7	280	Good
AG Well No. 3	12.9	207	Good
AG Well No. 4	11.1	302	Good

Conveyance System. PID's distribution and conveyance system includes approximately 58 miles of unlined canals and main laterals. The Main Canal runs from Sidds Landing Pump Station through the northern portion of the District. The PID main canal also supplies other canals in the Willow Creek Mutual Water Company to the west of PID's southern service area. Table 2-21 summarizes PID's distribution facilities.

TABLE 2-21
PID Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Provident Main Canal	Sidds Pump Station	400	No	NA	15
Quint Canal	GCID Main Canal	80	No	Colusa Drain	15
Wylie Canal	Provident Main Canal	60	No	Quint Canal	15
Unnamed Lateral	Provident Main Canal and possibly groundwater pump No. 1	100	No	Unnamed Creek to Colusa Drain	15
North Lateral	Provident Main Canal	300	No	Colusa Basin Drain	15

Storage Facilities. PID currently has no storage facilities.

Spill Recovery. PID has a network of unlined drainage ditches for conveying irrigation return flows. The drains generally empty into the Colusa Basin Drain. The District operates six pumping plants that recapture return flows. Table 2-22 summarizes the drain recapture facilities, and Table 2-23 summarizes the main drain laterals.

TABLE 2-22
PID Drain Pump Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Colusa Drain Pump	Colusa Basin Drain	Provident Main Canal	53	5,700
Sprague Drain Pump	Unnamed Creek	Booster Ditch	18	2,100
Willow Creek Drain Pump	Willow Creek	Quint Canal/ Provident Main Canal	40	2,200
Green Camp Pump	Unnamed Creek	Provident Main Canal	16	680
57 Pumps	Colusa Drain	N Lateral	39	8,300
Drain 13 Booster Pump	Drain 13	Booster Ditch	48	10,400

TABLE 2-23
PID Drainage Laterals
Sacramento Valley Regional Water Management Plan

Name	End Spill	Downstream Diverters/Recapture
Colusa Basin Drain	Sacramento River	Downstream diversions outside District
Willow Creek Drain	Colusa Basin Drain	Downstream diversions outside District
Drain 55	Colusa Basin Drain	Downstream diversions outside District
Drain 13	Colusa Basin Drain	Downstream diversions outside District

2.2.4.6 District Operating Rules and Regulations

PID was formed under Chapter 11 of the California Water Code. As such, the District is subject to the rules and regulations of this code including governing its actions through an elected Board of Directors and is required to keep a minimum amount in financial reserves.

Water rotation, apportionment, and shortage allocation:

> According to Rule 5 of PID Rules and Regulations: *All requests for water service must be made in writing and must be delivered at the District's office at least three days before the water is needed. Effort will be made to make delivery in less than three days, and where possible, delivery will be made within twenty-four hours.*
>
> According to Rule 13 of PID Rules and Regulations: *When, through lack of water, lack of ditch capacity, or for any other reason, it is not possible to delver throughout the District or any portion thereof, the full supply of water required by the water users, such supply as can be delivered will be pro rated until such time as delivery of a full supply can be given.*

Use of drainage waters:

> *District landowner(s) are advised that drain water in the District is considered water supplied by the District, and any such water recaptured by the landowner(s) or user(s) may not be used to increase irrigated acreage.*

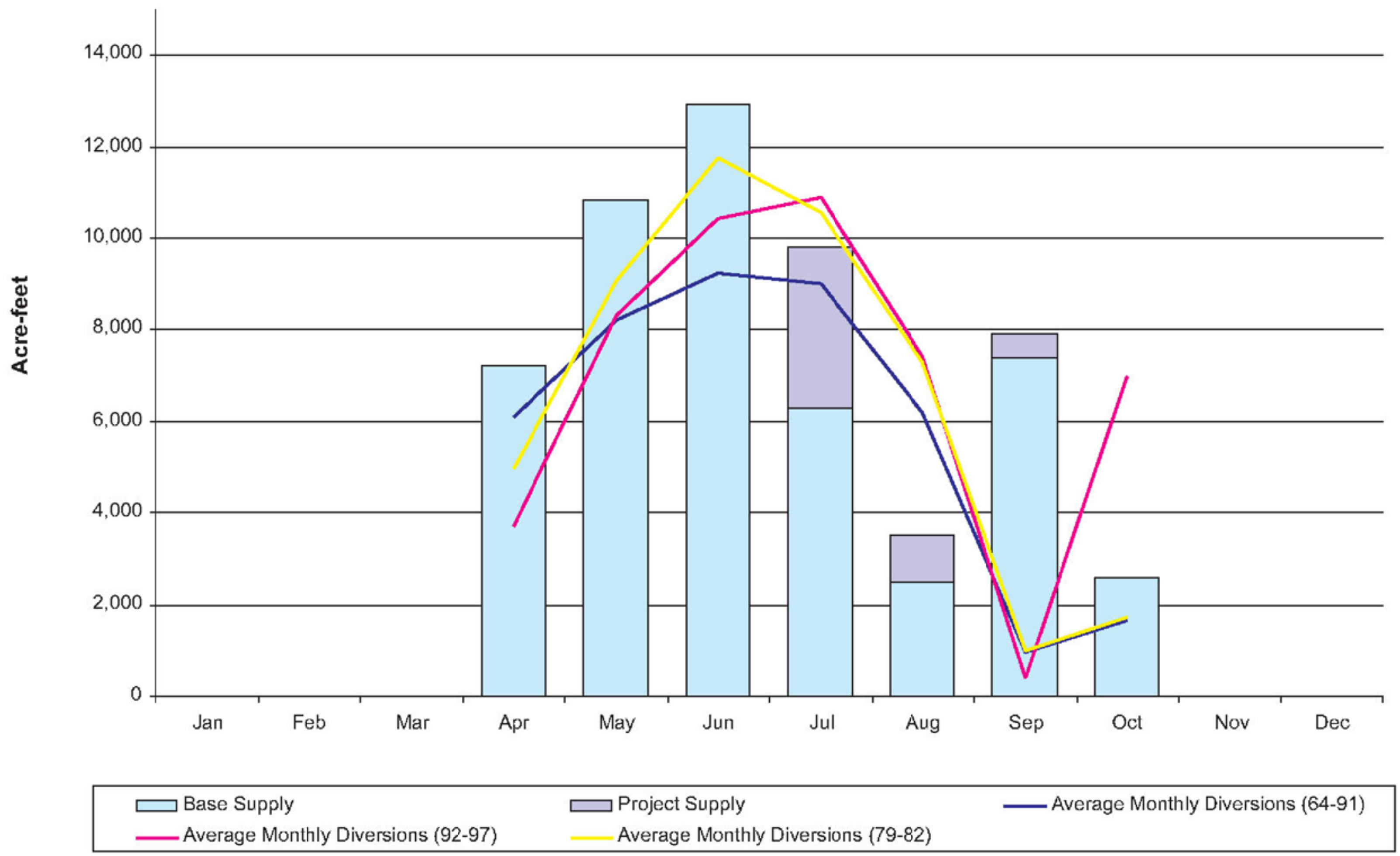
Policies for wasteful use of water:

> According to Rule 12 of PID Rules and Regulations: Any consumer wasting water on roads, or vacant land, or land previously irrigated either willfully, carelessly, or on account of defective ditches, or who shall flood certain portions or the land to an unreasonable depth, or use an unreasonable amount of water in order to properly irrigate other portions or whose land has been improperly checked for the economical use of water or allows an unnecessary amount of water to escape from any tailgate, will be refused the use of water until such conditions are remedied.

2.2.4.7 Water Measurement, Pricing, and Billing

PID currently measures flows at the main pump stations with flowmeters. District wells and drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts. Minor increases in conveyance efficiency could be achieved by improved operations measurement, with installation of measuring facilities at intermediate points along the main canal, and improved measuring at the heads of laterals. These new measurement facilitates would be integrated with the operations automation program described above to increase overall distribution system efficiency.

PID does not currently meter field turnouts. Flow rates at turnouts are estimated based on head-flow relationships for the turnout orifices or weirs. The District does not record total delivery to each customer. The average on-farm efficiency for the District is approximately 64 percent, which is near the assumed practical upper limit of around 70 percent. Field-level metering in combination with incentive pricing and on-farm improvements may potentially increase the average on-farm efficiency and provide a relatively minor quantity of conserved water.



Notes:

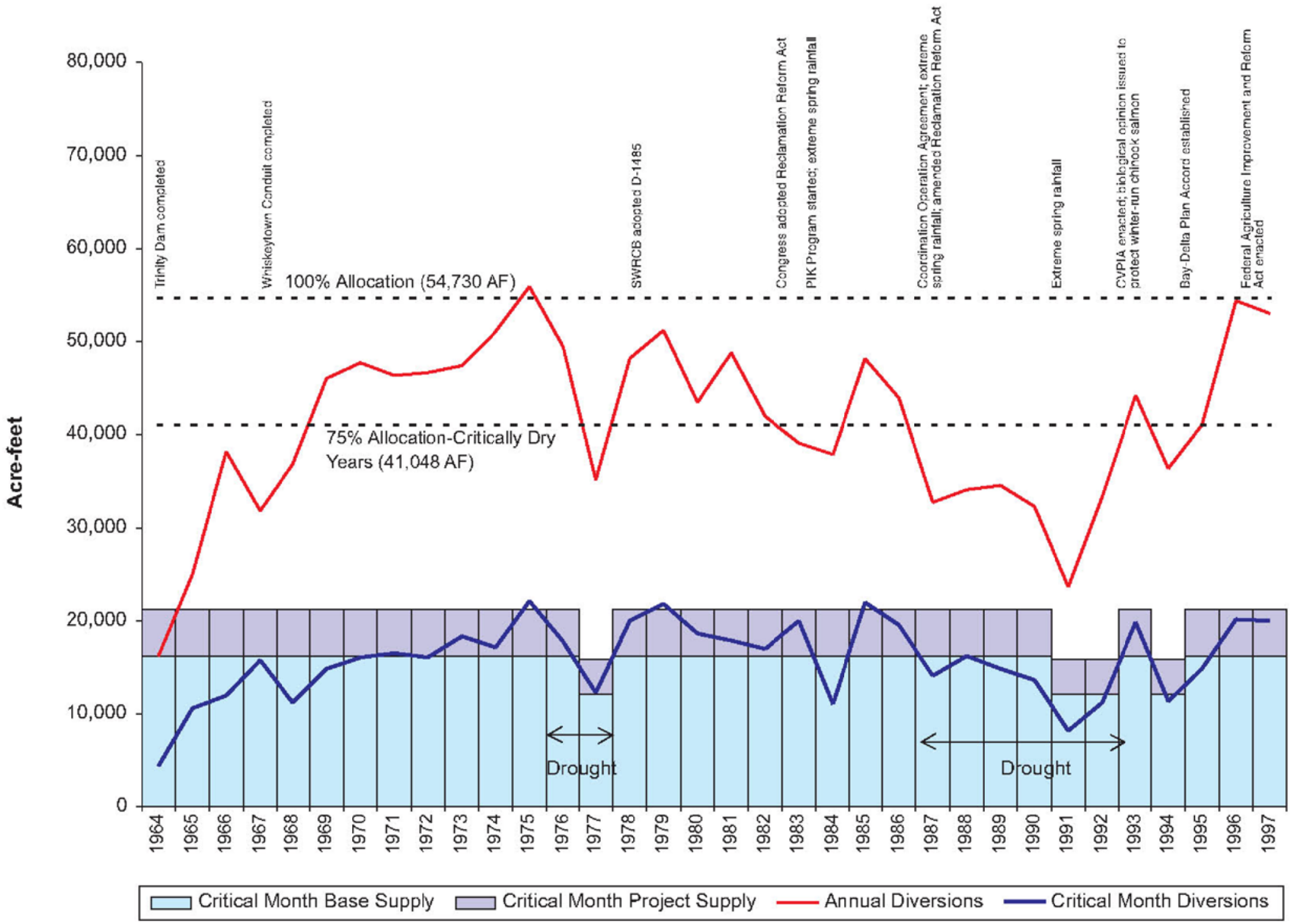
1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-16
PROVIDENT IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS

SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032003010RDD_853 (8/17/05)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-17
PROVIDENT IRRIGATION DISTRICT
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

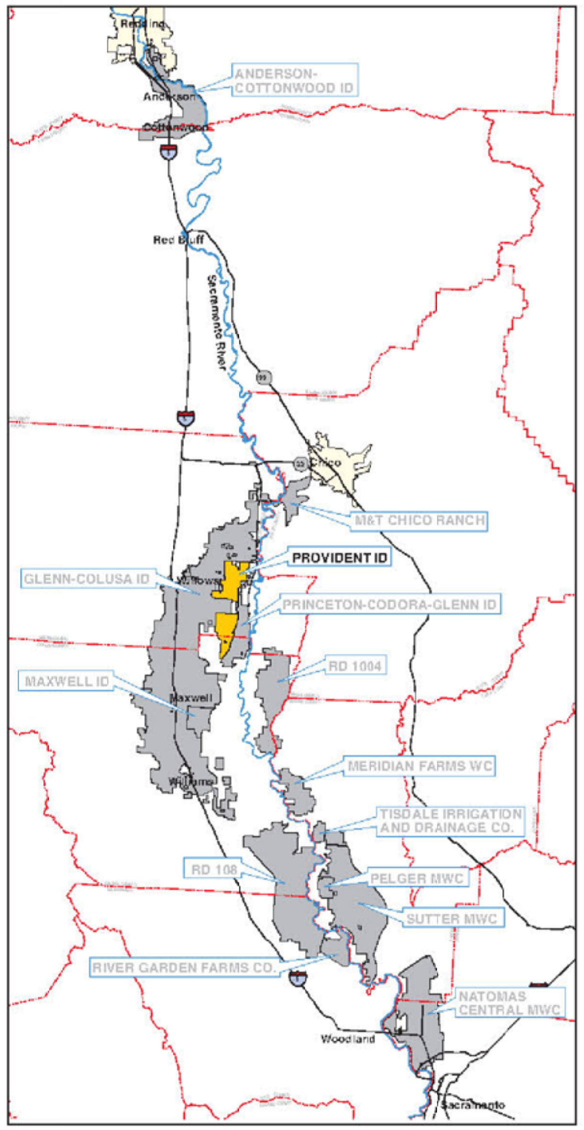
W032005010RDD_63 (8/17/05)

Provident Irrigation District

Manager: Lance Boyd • 258 South Butte Street • Willows, CA 95988 • (530) 934-4801

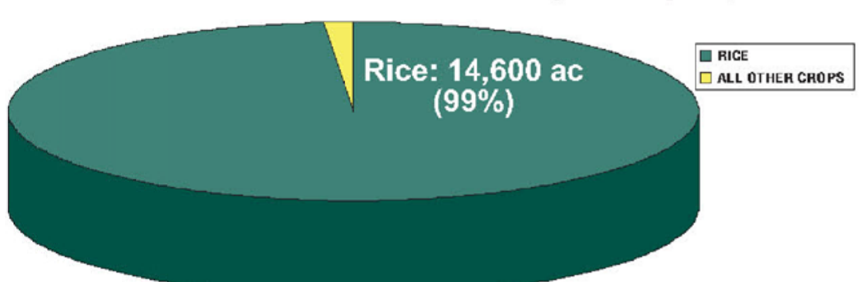
Settlement Contract:	54,730 af
Base Supply:	49,730 af
Project Supply:	5,000 af

Location Map



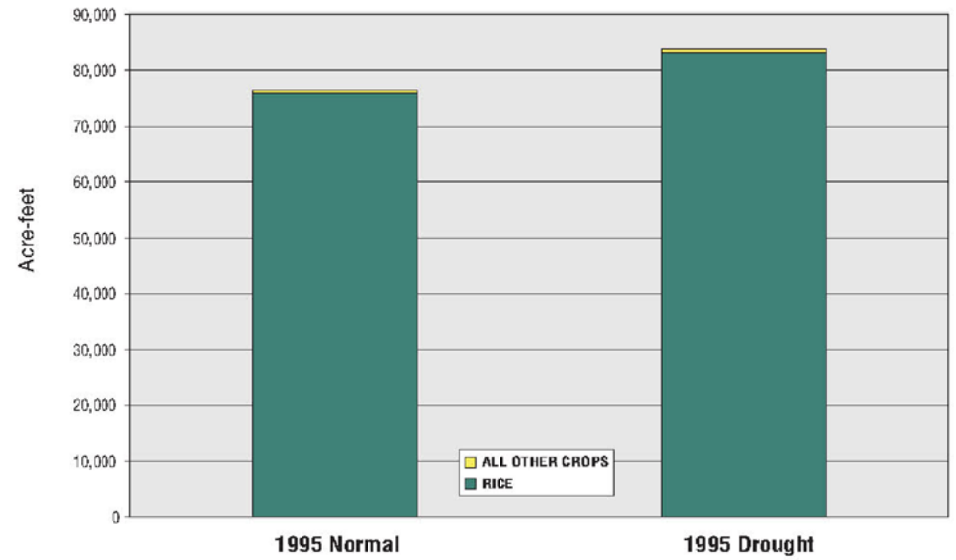
Irrigated Acreage by Crop

Total District Area: 15,965 ac
Net Irrigated Acreage[a] : 14,800 ac

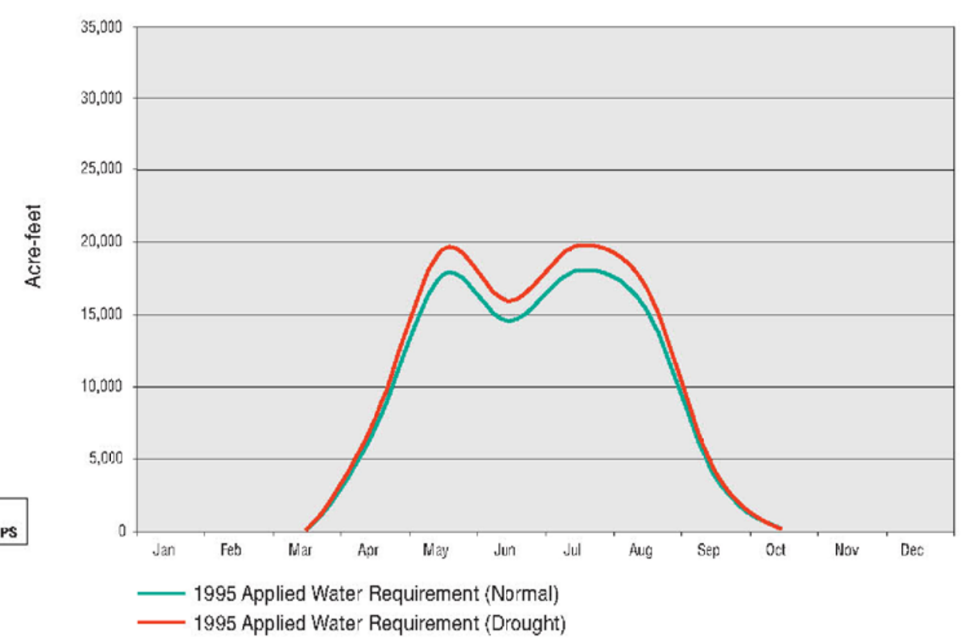


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

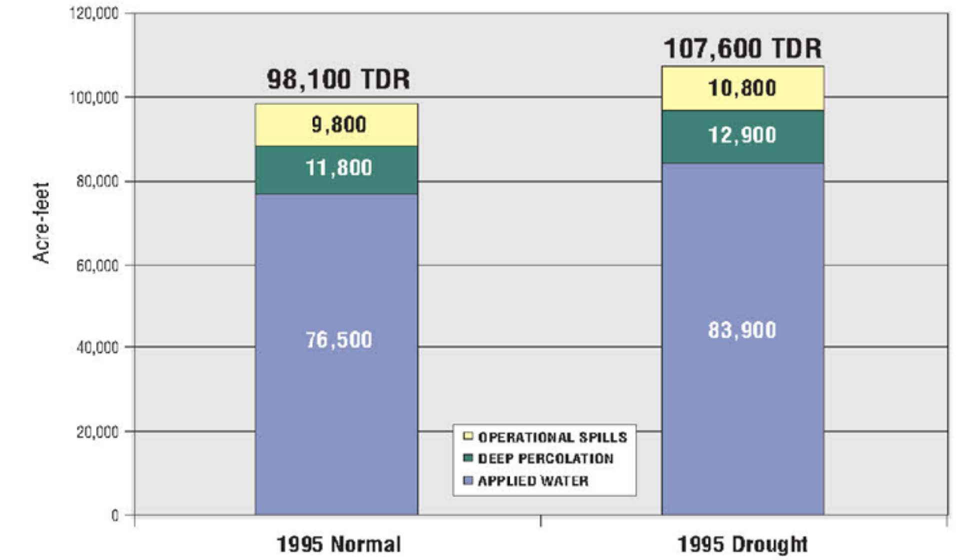


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

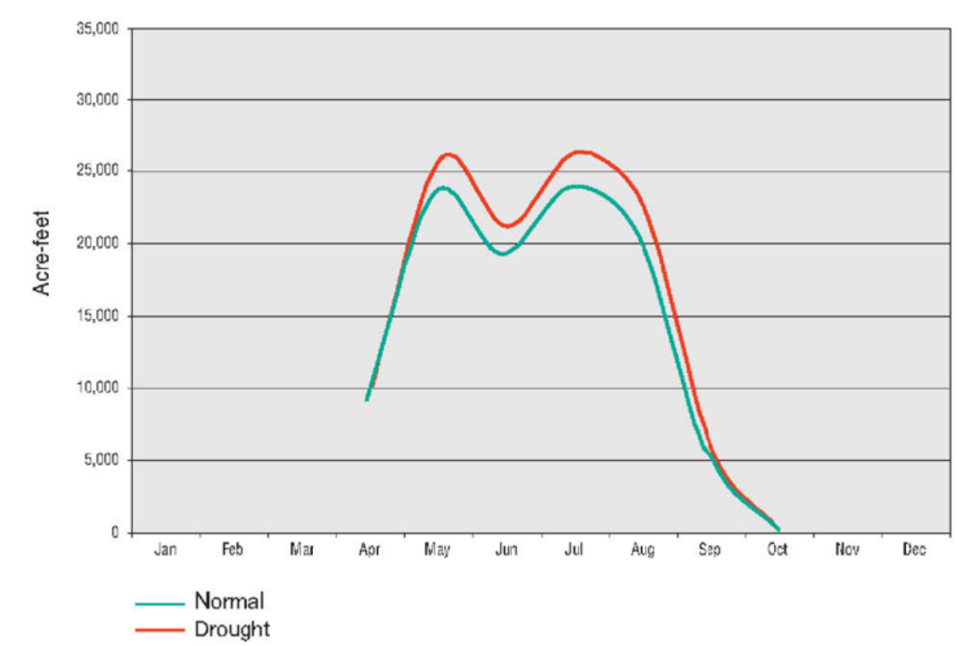


District Water Requirements

Annual Total District Water Requirement
(Includes 10% Operational Spills and 12% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 12% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 2-18
PROVIDENT
IRRIGATION DISTRICT IRRIGATED ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W032005010RDD_104 (8/17/05)

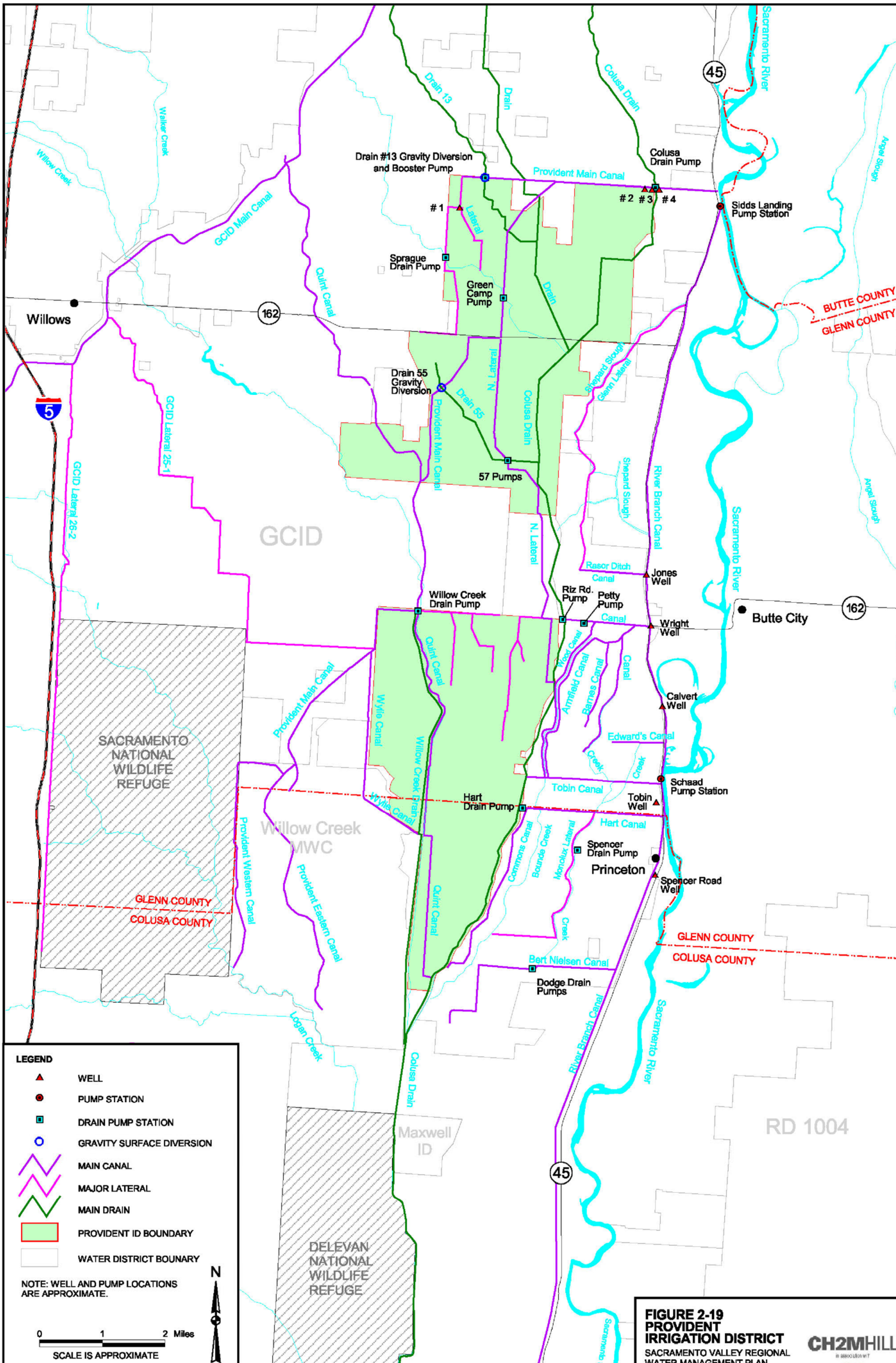


FIGURE 2-19
PROVIDENT IRRIGATION DISTRICT
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

Princeton-Codora-Glenn Irrigation District

2.2.5 Princeton-Codora-Glenn Irrigation District

2.2.5.1 History

PCGID (or the District) was organized on December 9, 1916, under the California Irrigation District Act of 1897. The District was organized to take over from the receiver of the Sacramento Valley West Side Canal Company a portion of the River Branch canal system.

In 1964, the District entered into a negotiated agreement with Reclamation quantifying the amount of water PCGID could divert from the Sacramento River. The resulting negotiated agreement recognized PCGID's annual entitlement to a Base Supply of 52,810 ac-ft/yr of flows from the Sacramento River and also provided for a 15,000 ac-ft allocation of Project Supply, resulting in a total contract entitlement of 67,810 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Exhibit A to the Settlement Contract for PCGID and are included in Table 2-24. The Settlement Contract negotiated in 1964 remains in effect until March 2006. PCGID is working with Reclamation and counsel to finalize environmental documentation for contract renewal.

TABLE 2-24
Schedule of Monthly Water Diversions – PCGID
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	10,800	0	10,800
May	13,500	0	13,500
June	12,790	400	13,190
July	6,740	6,000	12,740
August	2,780	8,400	11,180
September	480	200	5,000
October	1,400	0	1,400
Total	**52,810**	**15,000**	**67,810**

Notes:

Contract No. 14-06-200-849A-R-1

Points of Diversion: 123.9R, 154.8R

2.2.5.2 Service Area and Distribution System

PCGID is located west of the Sacramento Valley adjacent to the Sacramento River, in Glenn and Colusa Counties. The Colusa Basin Drain runs along most of PCGID's western boundary, beyond which lies PID. The community of Princeton lies within PCGID's boundaries. The District encompasses approximately 11,700 acres and serves 125 landowners. Rice is the primary crop grown within the District. The balance of irrigable acreage consists of orchards and row crops. PCGID does not supply M&I water to any entity. District operations are coordinated with PID, located directly adjacent and west of the District.

2.2.5.3 Water Supply

PCGID holds water rights to divert water from the natural flow of the Sacramento River as well as the Colusa Basin Drain. These diversions differ in the quantity and timing in which they can be used, as indicated in Table 2-25.

TABLE 2-25
PCGID: Water Rights
Sacramento Valley Regional Water Management Plan

Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A000244 (2/3/16)	00463 (8/15/18)	002646 (4/10/44)	Apr 1 to Oct 31	120 cfs
Sacramento River	A000770 (9/5/17)	000464 (8/15/18)	004161 (12/30/55)	Apr 1 to Oct 31	120 cfs
Colusa Basin Drain	A017066 (5/2/56)	013869 (2/15/63)	008989 (2/21/69)	Primary: Apr 1 to Jun 30 Secondary: Sep 1 to Oct 31	50 cfs
Sacramento River, Colusa Basin Drain	A030812 (1995 or later)	Pending	Pending	Nov 1 to Mar 31	290 cfs 24, 370 ac-ft /yr

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Surface Water. The PCGID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-16-200- 0849A (Contract No. 0849A). This contract provides for an agreement between PCGID and the United States on PCGID's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract was set to expire March 31, 2004. However, Congress granted a 2-year extension and therefore the contract will remain in effect until March 31, 2006. PID is working with Reclamation and counsel to finalize environmental documentation for the proposed contract renewal, expected to take effect for another 40-years at the end of the 2-year extension.

Contract No. 0849A provides for a maximum total of 67,810 ac-ft/yr, of which 52,810 ac-ft is considered to be Base Supply and 15,000 ac-ft is CVP water (Project Supply), as shown in Table 2-26. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-26
PCGID: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	14,320	14,600
Non-critical Months	38,490	400
Total Annual	**52,810**	**15,000**

The contract specifies the total quantity of water that may be diverted by PCGID each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-20. The monthly Base Supply ranges from a minimum of 1,400 ac-ft in August to a maximum of 13,500 ac-ft in May. CVP water (Project Supply) is available during the months of June, July, August, and September with entitlements of 400, 6,000, 8,400, and 200 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 14,320 ac-ft, and the total Project Supply is 14,600 ac-ft.

Settlement Contract Historical Diversions. PCGID's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 2-21. From 1972 to 1981, except for the 1977, which was designated as a critically dry year, annual diversions consistently approached total contract entitlements. In 1975, 1979, and 1981, PCGID purchased additional CVP water above the 15,000 ac-ft amount provided for in the contract. During drought conditions in the late 1980s and early 1990s, annual diversions declined. Several years were classified as "critical years," and contract supplies were reduced to 75 percent of contract entitlements.

Figure 2-20 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- On average, monthly diversions by PCGID have been similar to their corresponding monthly entitlements. From 1964 to 1991, PCGID diverted over 80 percent of their contract amounts from May through August.
- Every year, from 1964 to 1997, PCGID has diverted some portion of their CVP contract entitlement during critical months. Furthermore, during the 1980s and in the last several years, PCGID has used nearly all of its entitlement water (Base and Project Supply) during the critical months (also see Figure 2-21).
- During the period from 1992 to 1997, the average monthly diversion in the months of April, May, and June declined between 20 and 50 percent in relation to the long-term period of record (1964 to 1991). This trend is attributed to wet hydrologic conditions during the spring months, thereby reducing diversions during this time.

Non-contract Period (November – March). Contract No. 0849A does not limit PCGID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. Recently, PCGID has filed for a water right permit for non-contract-period diversions in the amount of approximately 24,400 ac-ft. Non-contract-period diversions are predominantly used for rice straw decomposition and pre-irrigation. PCGID has historically irrigated in months prior to April (pre-irrigation), especially for orchards, tomatoes, and sugar beets. In response to increasingly stringent limitations on burning, some of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 1,200 to 2,500 acres have been flooded in the past. A lower percentage of rice acreage is flooded in PCGID compared to other adjacent districts because of the high cost of decomposition water (relative to other districts).

Other Surface Water Sources. Several minor creeks are located within PCGID boundaries, including Canal Creek and Bounde Creek. Canal and Bounde Creeks are seasonal and provide no additional surface water source during the irrigation season. However, these waterways are used as conveyance facilities for tailwater and/or recirculation purposes. PCGID has permits to pump water from the Colusa Basin Drain. PCGID may divert up to approximately 50 cfs from the Drain from April 1 to June 30.

Groundwater. The PCGID boundary overlies the Colusa Sub-basin (Department groundwater basin No. 5-21.52) of the Sacramento Valley Groundwater Basin, and therefore within PCGID, occurs in a broad alluvial basin and is therefore not confined to any well-defined subsurface stream channels.

PCGID lies within the north-central portion of the eastern Colusa Sub-basin. Groundwater occurs in a broad alluvial basin and is not confined to subsurface stream channels. The area is located on recent alluvial sediments including: channel, floodplain, basin, and alluvial deposits. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities. Stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeabilities. Underlying these recent fluvial deposits are the Tehama and Tuscan Formations (Department 1978; Department, 2003c).

Although the Tehama Formation is mostly fine-grained, it contains sufficient sand and gravel zones in many areas to provide large quantities of groundwater. In the northern portion of the Colusa Sub-basin the Tehama Formation contains extensive deposits of interbedded gravel from the ancestral Stony Creek (the Stony Creek Member). The Stony Creek Member of the Tehama Formation is typically very productive, yielding large quantity of water to wells. In the central and southern portion of the Colusa Sub-basin, between Willows and Williams, the Tehama Formation is predominately clayey and wells in this area are generally less productive than those in the northern portion of the sub-basin (Department, 1978). The most productive aquifers in the Colusa Sub-basin are associated with the Stony Creek Member of the Tehama Formation.

The Tuscan Formation is an important water-bearing unit in the northeastern portion of the Sacramento Valley (Department, 2003a). Deposited during the same period as the Tehama Formation, the Tuscan Formation consists of interbedded volcanic deposits (Department, 1978). The unit grades from tuff breccias along the eastern margin of the Sacramento Valley to volcanic sands, gravels, and clays to the west. In the Colusa Sub-basin, the Tuscan Formations is found at depths of 300 to 1,000 feet bgs, where it interfingers with the Tehama Formation (Department, 2003a). Volcanic sands and gravels can provide high yields to domestic and irrigation wells; however, the unit is generally too deep to be tapped by wells west of Chico (Department, 1978).

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for agricultural, domestic, and M&I uses. In general, natural groundwater quality is influenced by streamflow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range (Department, 2003c). The total depth of fresh water in PCGID is approximately 1,400 feet bgs (Berkstresser, 1973). The fresh water is underlain by saline water.

In the northern portion of PCGID groundwater movement is generally to the southeast, towards the Sacramento River, at a gradient of 5 feet per mile. In the southern portion of the District the flow changes to a more southerly direction with a gradient of about 2.3 feet per mile (Department, 2003c) Seasonal fluctuations in groundwater level in the PCGID area show an atypical trend. During years of normal precipitation, groundwater levels have been shown to fluctuate up to 10 feet seasonally. During drought years, seasonal fluctuations are generally less than about 5 feet (Department, 2003b). The trend is interpreted as being a result of lower recovery of spring water levels during drought years, resulting in an overall decrease in groundwater levels during consecutive drought years. Wells located near recharge sources typically show less of an annual change in groundwater levels. (Department, 2003b).

Past pumping and drought conditions have not historically negatively affected the overall long-term groundwater level trends in PCGID. Based on the long term spring to spring water level information of Department monitoring wells in the PCGID area that date back to the 1930s, there has been little significant change in groundwater levels over time. Groundwater level data since 1980 from over 2,300 wells in the Sacramento Valley were reviewed and the historical trends show that groundwater levels in the PCGID area are generally stable over the long term, although short-term fluctuations in groundwater levels are observed that can be correlated with precipitation trends.

Approximately 20 privately owned wells and 5 District-owned wells are located within the District’s boundaries. The total capacity of the District-owned wells is approximately 3,000 to 4,000 ac-ft/yr. Groundwater is used to help with the initial flooding of the rice fields and to increase flexibility during the peak demand periods. Operations of these wells are coordinated with the river pumps to maximize flexibility and serve those within the District during times of short water supplies (e.g., drought conditions).

Although PCGID has no formal agreement with private well owners, in the past, the District has established seasonal agreements (one irrigation season duration). In 1994, PCGID developed a conjunctive water management program with landowners that encouraged landowners to pump groundwater to supplement Sacramento River diversions (Department, 1978).

Other Water Supplies. In recent years, PCGID has relied heavily upon tailwater to supplement its Sacramento River entitlement. GCID has been the primary source of this tailwater. As discussed above, PCGID has water rights to tailwater in Colusa Basin Drain. Water pumped from this and other drains is metered by PCGID.

PCGID has initiated a Recapture Plan for recirculating water through the District. Currently, four recapture plants are located within PCGID. In the past, PCGID has recycled about 20,000 to 25,000 ac-ft annually. Water recirculated within PCGID is metered. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability. PCGID is involved with several water transfer agreements. Several of the irrigation and reclamation districts adjacent to the Colusa Basin Drain have agreed to provide additional flow, when possible, to the drain for use by Colusa Basin Drain Mutual Water Company. The districts are compensated by Colusa Basin Drain Mutual Water Company for this water. In addition, PCGID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share O&M of the drains within their respective service areas and to share the right to recirculate the water in those drains.

2.2.5.4 Water Use

District Water Requirements. Rice is the major crop grown within PCGID's service area, in addition to orchard and row crops. Class I soils (i.e., sandy and gravelly soils) are generally present in the portions of the District directly adjacent to the river, which allow for orchards, but in turn result in greater seepage from the laterals and canals throughout the District. Rice accounts for approximately 75 percent of the District's irrigated acreage on an annual basis. As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Water application requirements for orchards are typically greatest in June, July, and August.

The vast majority of irrigation water requirements are met through the contract surface water supply, although groundwater is used in drought years on an individual grower basis and as per agreements with the District. Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 2-27 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

Figure 2-22 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

TABLE 2-27
PCGID Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Rice	7,700 (± 20%)[c]	7,700 (± 30%)[c]
Other Deciduous	700 (± 20%)[c]	700 (± 30%)[c]
Alfalfa	200 (± 10%)[c]	500 (± 10%)[c]
Other Crops	1,400 (± 10%)[c]	1,400 (± 10%)[c]
Total Irrigated Acreage	**10,000 (± 10%)[c,d]**	**10,300 (± 10%)[c,d]**

[a]Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Northern District.

[b]Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Northern District.

[c]Percentages obtained from PCGID.

[d]Includes 100 double-cropped acres for 1995 and 2020.

Future irrigation season cropping patterns and crops will likely shift, but overall associated water requirements are anticipated to remain relatively the same as current conditions.

Urban. PCGID does not serve any municipal or industrial centers, including Princeton, and does not currently have plans to provide water for these uses. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 5,000 ac-ft compared to 1995 estimated levels (Department, Northern District). Future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the District does not preclude the possibility of serving such needs in the future.

Environmental. Approximately 50 acres of riparian vegetation are estimated to be incidentally supplied by irrigation including vegetation directly adjacent to delivery laterals or influenced through leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

Up to 2,500 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. Future estimates indicate that up to 4,000 acres may eventually be flooded. No managed designated environmental or wetlands areas are within the District.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the District. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Glenn County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Glenn and Colusa Counties.

Soil associations in the Glenn County area of PCGID are as follows (Appendix C):

- Zamora-Marvin: Well-drained to somewhat poorly drained silt to silty clay loam, moderately fine-textured and fine-textured soils on floodplains.
- Willows-Plaza-Castro: Somewhat poorly drained and poorly drained clay loam, medium- to fine-textured soils.

Soil profile characteristics in the Colusa County area of PCGID are as follows (Appendix C):

- Recent alluvial fan and floodplain soils with deep permeable profiles.
- Older alluvial fan and basin soils with moderately compacted subsoils.

Transfers and Exchanges. PCGID is one of 34 SRSCs that currently participate in the Pool program. Since 1974 the Pool has been the forum to move available Project Supply supplies within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool rather than for diversion. PCGID also has an ongoing agreement to transfer water directly to the Colusa Basin Mutual Water Company via a “sub-pool” administered by the SWRCA. In general, the water transferred to the Colusa Basin Mutual Water Company is made available through the Colusa Basin Drain for Colusa Basin Mutual Water Company use. In addition, PCGID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share O&M of the drains within their respective service areas and to share the right to recirculate the water in those drains. PCGID has also transferred water when available to the state during dry periods.

Other Uses. No other significant water uses other than those discussed above occur within PCGID.

2.2.5.5 District Facilities

Diversion Facilities. PCGID operates two pumping plants on the Sacramento River. The Sidds Pumping Plant is located north of the community of Glenn at Sidds Landing and includes five pump/motor units of various horsepower ratings and a combined capacity of approximately 210 cfs. The Schaad Plant is similar to the Sidds facility in design and construction and is located 1 mile north of the Town of Princeton. The Schaad Plant includes three pump/motor units and has a capacity of approximately 130 cfs. Table 2-28 summarizes PCGID’s surface water supply facilities. See Figure 2-23 for a map of PCGID’s major conveyance facilities.

TABLE 2-28
PCGID Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Sidds Landing Pump Station	Sacramento River	Pump	300	42,000
Schaad Pump Station	Sacramento River	Pump	130	22,000

PCGID operates five District-owned wells. Operation of these wells is coordinated with the Sacramento River pump stations to maximize flexibility and provide additional supplies during drought periods. Table 2-29 summarizes the District-owned groundwater wells. In addition, approximately 15 private wells are located within the District boundary. The District has no formal agreement with growers with regard to pumping private wells. Approximately 3,000 ac-ft/yr are available for pumping from the wells that are currently developed.

TABLE 2-29
PCGID Groundwater Wells
Sacramento Valley Regional Water Management Plan

Map ID	Capacity (cfs)	Water Quality	Notes
Wright Well	4.5	Good	Little use–for an orchard only
Jones Well	8.2	Good	Drought/Supplemental
Calvert Well	7.8	Good	Drought/Supplemental
Tobin Well	8	Good	Drought/Supplemental
Spencer Road Well[a]	5.6	Good	Drought/Supplemental

[a]Well construction in progress.

Conveyance System. The District's distribution and conveyance system includes approximately 63 miles of canals and laterals, including the 15 miles of main canal from the Sacramento River diversion point.

PCGID's distribution system includes approximately 63 miles of unlined canals and main laterals. The River Branch Canal conveys water from Sidds Landing Pump Station at the northern end of the District down to the Armfield, Barnes, and four laterals in the central and southern portions of the District. The Schaad Pump Station supplies the Tobin Canal, Hart Canal, and the southern end of the River Branch Canal. Based on testing conducted in 1997, main canal seepage has been found to be approximately 20 percent. Due to the proximity of the river and associated soils, seepage among the other District canals is assumed to vary from 15 to 25 percent. Table 2-30 summarizes PCGID's main canal and irrigation lateral features.

TABLE 2-30
PCGID Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
River Branch Canal	Sidds Landing Pumping Plant	350	No	None	25
Glenn Lateral	Sidds Landing Pumping Plant	100	No	Colusa Drain	15
Rasor Ditch Canal	River Branch Canal	60	No	Colusa Drain	15
Wood Canal	River Branch Canal	60	No	Tobin Canal	15
Armfield Canal	River Branch Canal	75	No	Tobin Canal	15
Edwards Canal	River Branch Canal	50	No	None	15
Tobin Canal	River Branch Canal	100	No	Colusa Drain	15
Commons Canal	Hart Canal	150	No	None	15
Hart Canal	River Branch Canal	200	No	Colusa Drain	15
Barnes Canal	River Branch Canal	60	No	Colusa Drain	15
Bert Nielsen Canal	River Branch Canal	150	No	Colusa Drain	15
Monolux Lateral	Hart Canal	75	No	Colusa Drain	15

Storage Facilities. PCGID currently has no storage facilities.

Spill Recovery. PCGID has a network of unlined drainage ditches for conveying irrigation return flows. Some of the water in PCGID's drains comes from GCID via the Colusa Basin Drain; the rest is made up of internal District drainage. PCGID currently operates four drain pumps for recapturing and recirculating the water from the drains. The District has flow-meters with totalizers on each of the drain pumps, which allows them to keep records of their total drain pumpage. Approximately 25,000 ac-ft/yr are recycled from the drains within PCGID. Drains within the District generally empty into the Colusa Basin Drain, which flows south along the western boundary of the District. Table 2-31 summarizes PCGID's major drainage facilities.

TABLE 2-31
PCGID Drain Pump Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Hart Drain Pump	Hart Canal	Hart Canal	70	18,900
Spencer Drain Pump	Inter-district drains	Monolux Lateral	21	2,200
Dodge Drain Pumps	Inter-district drains	Bert Nielson Canal	29	7,300
Riz Road Pump[a]	Colusa Drain	Riz Lateral	35	Not known
Petty Pump	Local Drain	Wood Canal	10	2,000

[a]Currently down. Will be back in operation soon. Was not used in last couple of years.

2.2.5.6 District Operating Rules and Regulations

PCGID was formed under Chapter 11 of the California Water Code. As such, the District is subject to the rules and regulations of this code including governing its actions through an elected Board of Directors and is required to keep a minimum amount in financial reserves.

Water rotation, apportionment, and shortage allocation:

> According to Rule 5 of PCGID Rules and Regulations: *All requests for water service must be made in writing and must be delivered at the District's office at least three days before the water is needed. Effort will be made to make delivery in less than three days, and where possible, delivery will be made within twenty-four hours.*
>
> According to Rule 13 of PCGID Rules and Regulations: *When, through lack of water, lack of ditch capacity, or for any other reason, it is not possible to delver throughout the District or any portion thereof, the full supply of water required by the water users, such supply as can be delivered will be pro rated until such time as delivery of a full supply can be given.*

Use of drainage waters:

> *District landowner(s) are advised that drain water in the District is considered water supplied by the District, and any such water recaptured by the landowner(s) or user(s) may not be used to increase irrigated acreage.*

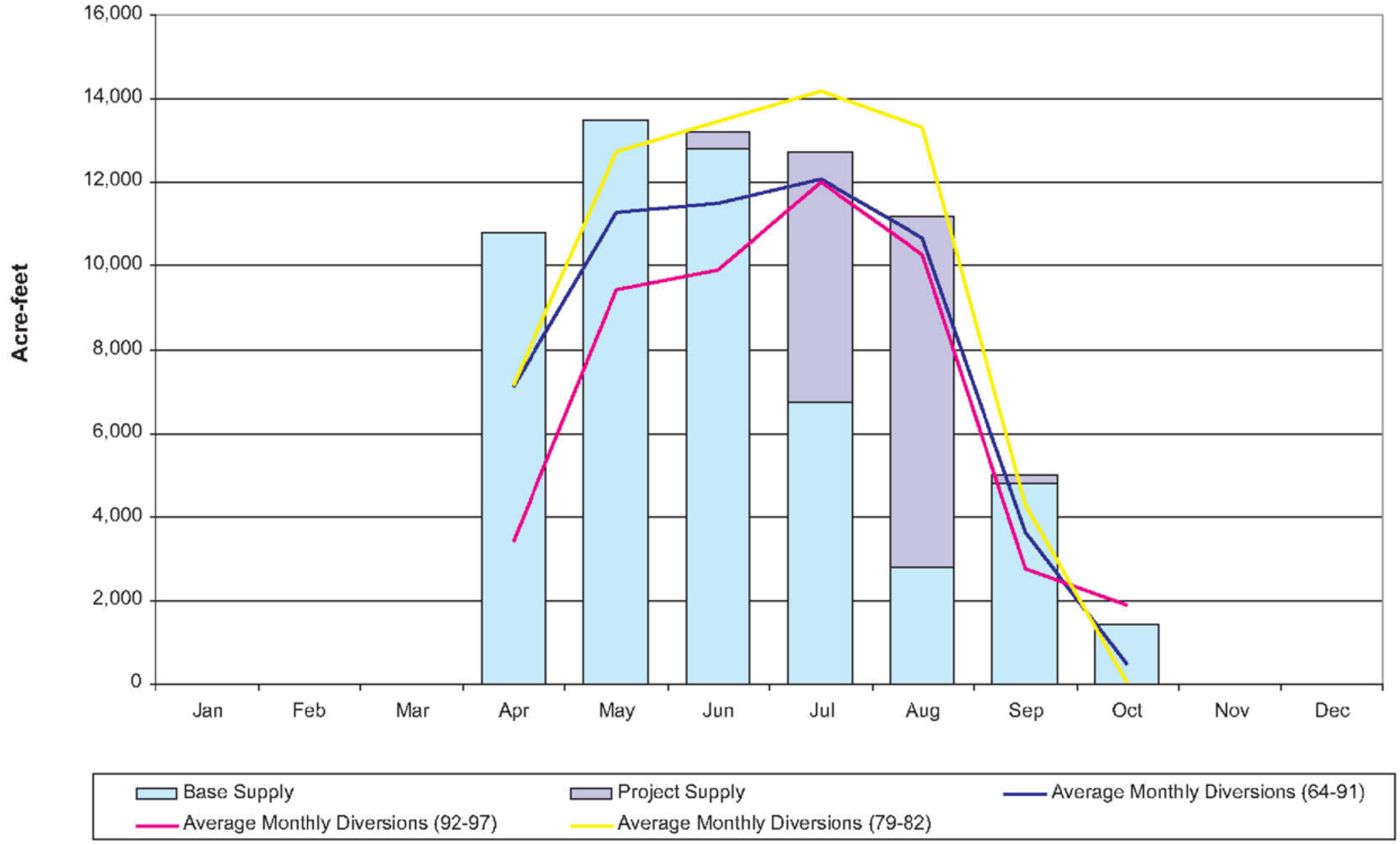
Policies for wasteful use of water:

> According to Rule 12 of PCGID Rules and Regulations: *Any consumer wasting water on roads, or vacant land, or land previously irrigated either willfully, carelessly, or on account of defective ditches, or who shall flood certain portions or the land to an unreasonable depth, or use an unreasonable amount of water in order to properly irrigate other portions or whose land has been improperly checked for the economical use of water or allows an unnecessary amount of water to escape from any tailgate, will be refused the use of water until such conditions are remedied.*

2.2.5.7 Water Measurement, Pricing, and Billing

PCGID currently measures flows at the main pump stations with flowmeters. District wells and all drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts. Minor increases in conveyance efficiency could be achieved by improved operations measurement, with installation of measuring facilities at intermediate points along the main canal and improved measuring at the heads of laterals. These new operations measurement facilitates would be integrated with the operations automation program described above to increase overall distribution system efficiency.

PCGID does not currently meter field turnouts. Flow rates at turnouts are estimated based on head-flow relationships for the turnout orifices. The District does not record total delivery to each customer. The District has installed flowmeters on field turnouts in the past and experienced clogging by the debris that is common in earthen canals. The frequent clogging required cleaning of meters and resulted in poor accuracy. The average on-farm efficiency for the District is approximately 64 percent, which is near the assumed practical upper limit of around 70 percent (Reclamation). Field-level metering in combination with incentive pricing and on-farm improvements may potentially increase the average on-farm efficiency and provide a significant quantity of conserved water. The associated capital and O&M costs for metering would likely result in significant rate increases to District customers.



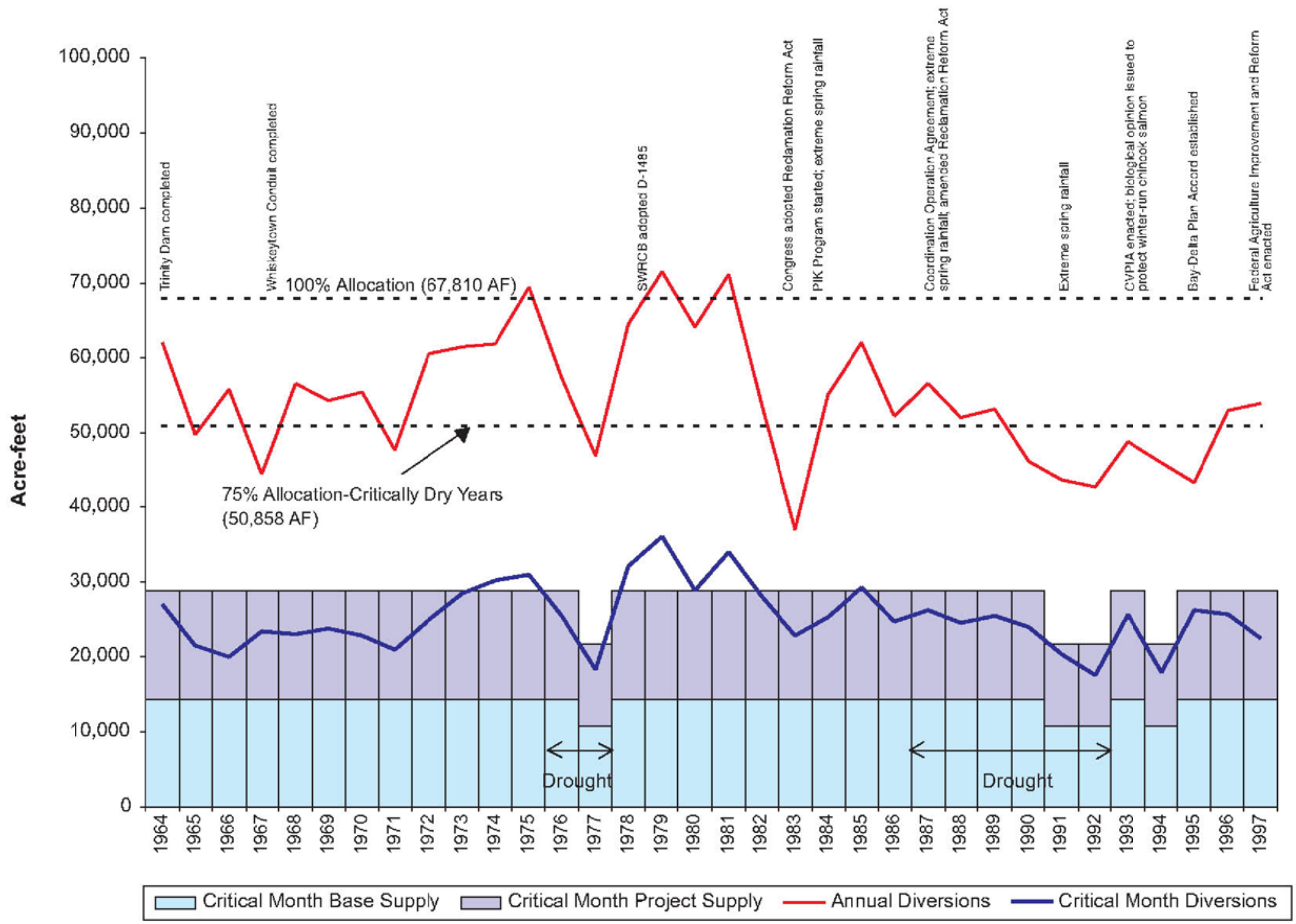
Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

W032005010RDD_106 (8/17/05)

FIGURE 2-20
PRINCETON-CODORA-GLENN IRRIGATION DISTRICT MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-21
PRINCETON-CODORA-GLENN IRRIGATION DISTRICT ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGMENT PLAN

CH2MHILL in association with MBK

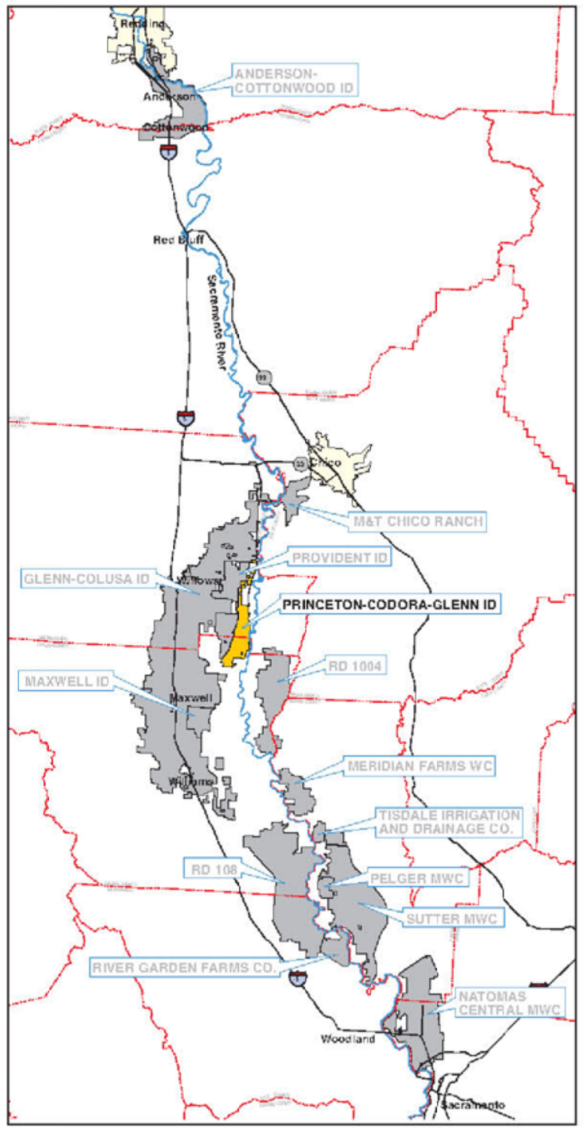
W032005010RDD_107 (8/17/05)

Princeton-Codora-Glenn Irrigation District

Manager: Lance Boyd • P.O. Box 98 • Princeton, CA 95970 • (530) 439-2248

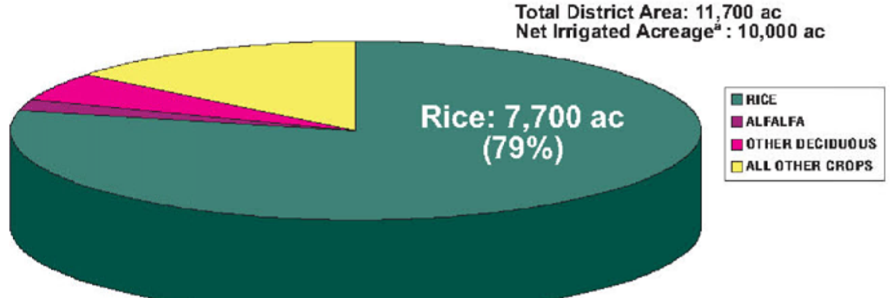
Settlement Contract:	67,810 af
Base Supply:	52,810 af
Project Supply:	15,000 af

Location Map



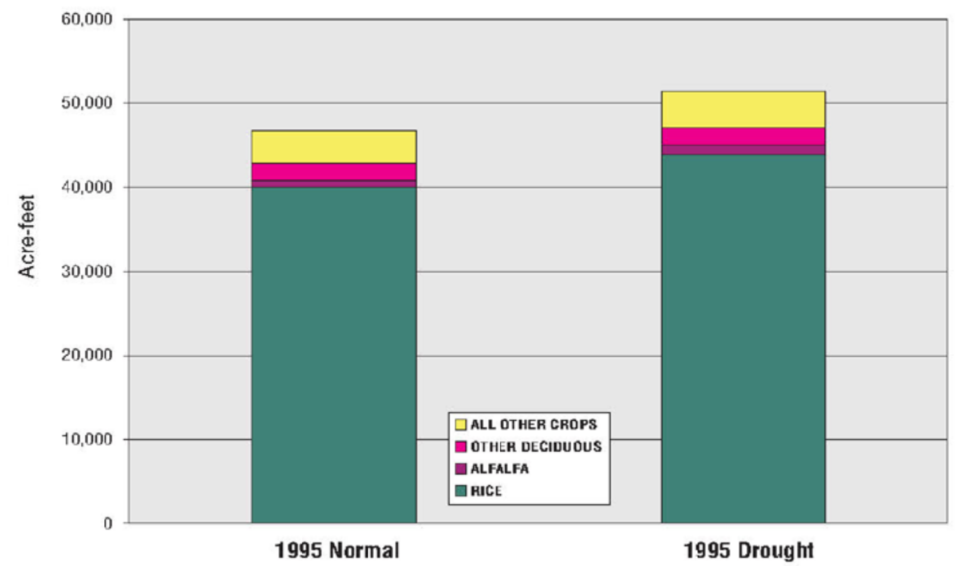
Irrigated Acreage by Crop

Total District Area: 11,700 ac
Net Irrigated Acreage[a] : 10,000 ac

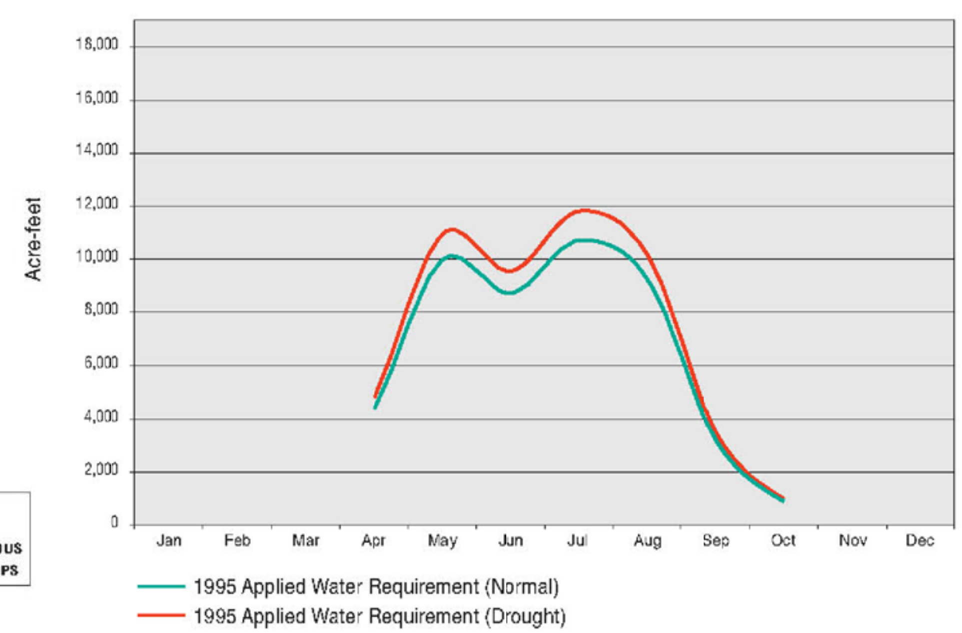


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



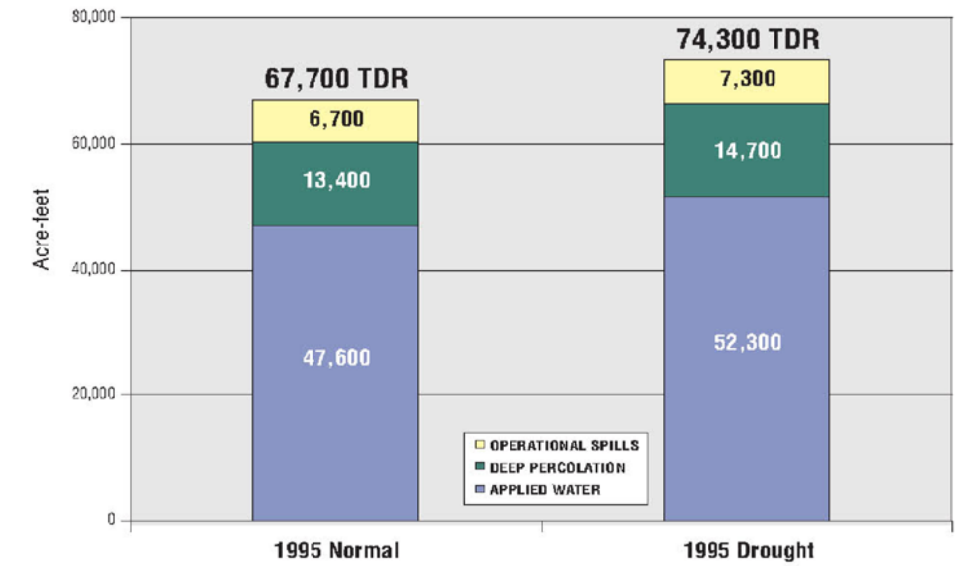
Monthly Applied On-field Water Requirement[b]
(Normal and Drought)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 10% Operational Spills and 20% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 20% Deep Percolation Estimates)

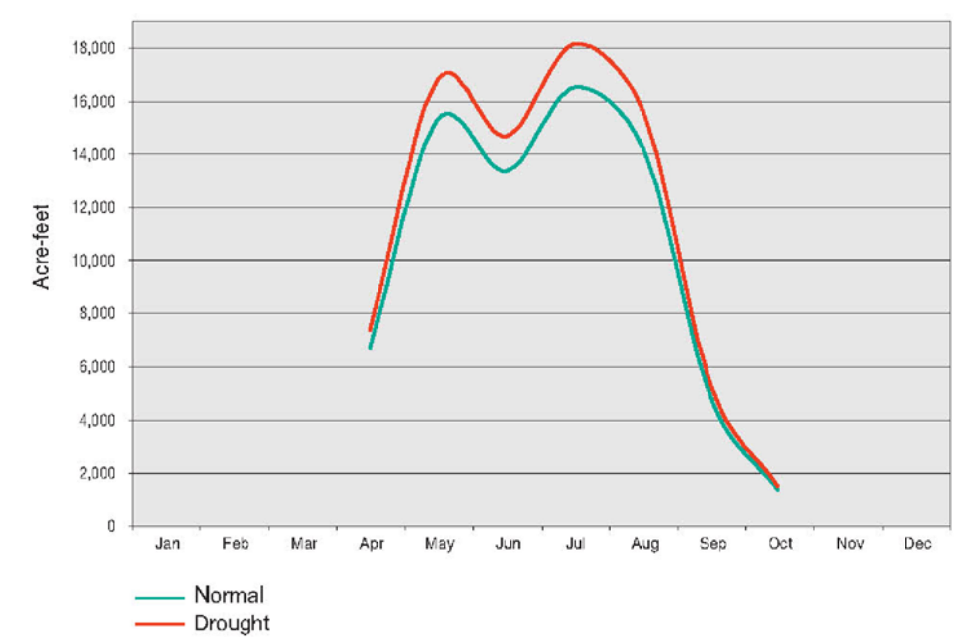


FIGURE 2-22
PRINCETON-CODORA-GLENN
IRRIGATION DISTRICT IRRIGATED ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W032005010RDD_108 (8/17/05)

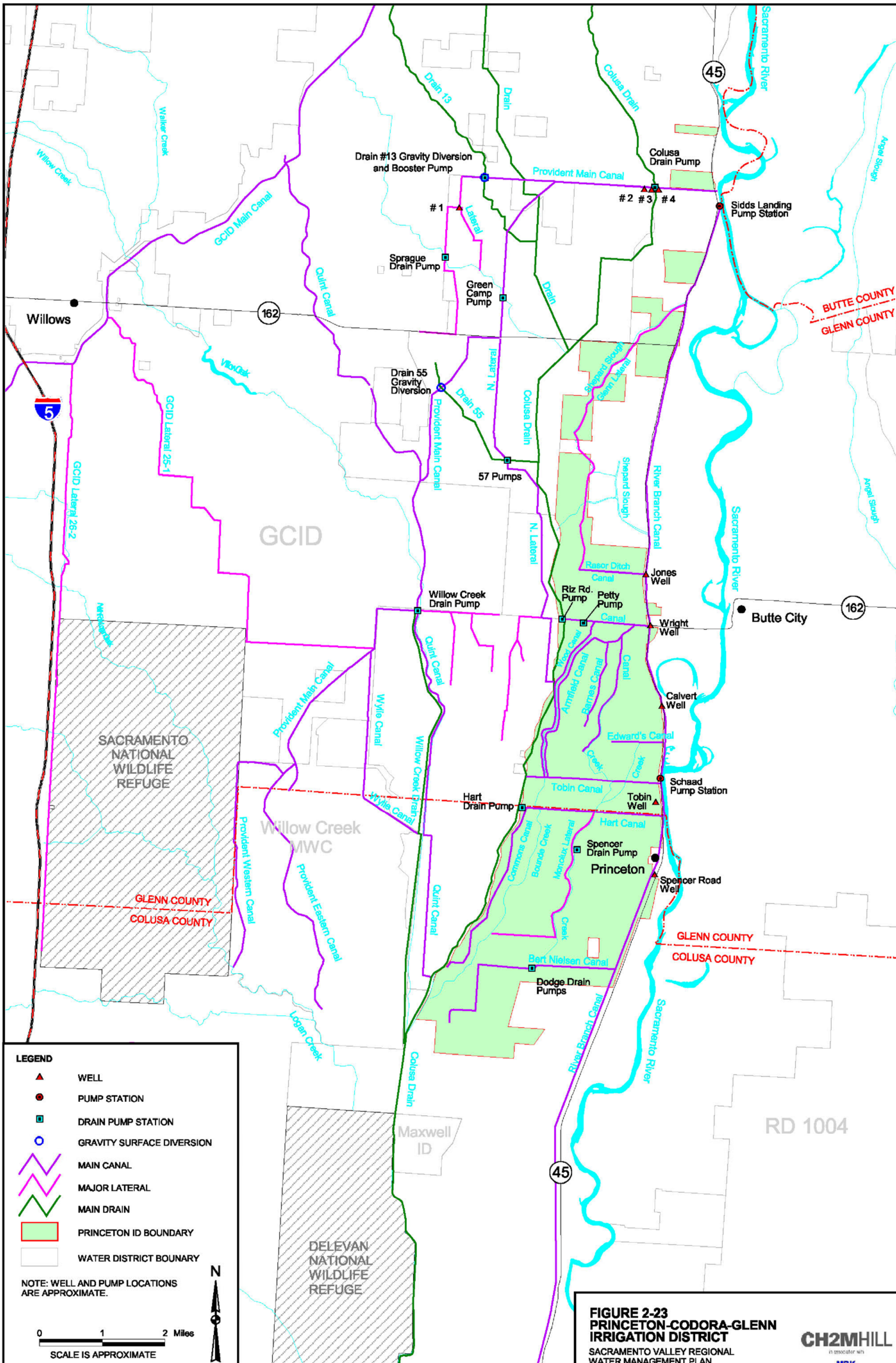


FIGURE 2-23
PRINCETON-CODORA-GLENN IRRIGATION DISTRICT
SACRAMENTO VALLEY REGIONAL
WATER MANAGEMENT PLAN

CH2M HILL RDD \\LOKI\projects\rddgis\SacBWMP\gisdata\newhydro3_0605.apr princeton.pdf 08/18/2005

Reclamation District No. 108

2.2.6 Reclamation District No. 108

2.2.6.1 History

RD 108 (or the District) was formed in 1870 under the general Reclamation District Law of 1868 for the purpose of constructing levees to provide flood protection to over 100,000 acres of farmland along the west side of the Sacramento River from north of Colusa to Knights Landing. In the early 1900s, RD 108 was consolidated to approximately 58,000 acres to provide irrigation water service, flood control, and drainage for lands within its service area. In 1917, the District began construction of major irrigation distribution system facilities for delivery of water from the Sacramento River to approximately 48,000 acres. RD 108 entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water RD 108 could divert from the Sacramento River. The resulting negotiated agreement recognized RD 108's annual entitlement of Base Supply of 199,000 ac-ft/yr of flows from the Sacramento River and also provided for a 54,500 ac-ft allocation of Project Supply. In 1974, the District reduced its Project Supply allocation to 33,000 ac-ft with the expectation that conservation efforts including canal lining and recirculation of drainage water by the District would reduce diversion requirements from the Sacramento River. The subsequent contract entitlement is for a total of 232,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Table 2-32 to the Settlement Contract.

TABLE 2-32
Schedule of Monthly Water Diversions – RD 108
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	34,000	0	34,000
May	50,500	0	50,500
June	49,000	0	49,000
July	31,500	16,000	47,500
August	16,500	15,000	31,500
September	16,000	2,000	18,000
October	1,500	0	1,500
Total	**199,000**	**33,000**	**232,000**

Notes:

Contract No. 14-06-200-876A-R-1

Points of Diversion: 43.1R, 43.3R, 51.1R, 56.4R, 59.1R, 61.05R, 61.2R, 62.3R, 63.2R, 70.4R

2.2.6.2 Service Area and Distribution System

The District's 48,000-acre service area is located within southern Colusa County and northern Yolo County along the west side of the Sacramento River, between the towns of Grimes and Knights Landing. The service area is surrounded on three sides by flood control levees, i.e., on the east by the westerly levee of the Sacramento River, on the west and southwest by the Colusa Basin Drain (commonly referred to as the "Back Levee"), and on the southeast by the northerly levee of RD 787. RD 108 obtains its water supply from the Sacramento River under its riparian water rights and licenses for appropriation of surface waters. This water supply is supplemented when necessary from groundwater, using the District's three wells and several privately owned wells, and by diversion of water from the Colusa Basin Drain under the District's appropriative license. Approximately 130 land-owners and water users grow a wide variety of crops including rice, wheat, corn, safflower, sugar beets, tomatoes, beans, vineseeds, fruits, and nuts. Rice is the predominant crop.

2.2.6.3 Water Supply

Surface Water. RD 108 holds a water right, primarily under 1917 and 1918 priority dates, to divert water from the natural flow of the Sacramento River. The RD 108 surface water supply entitlement was initially addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0876A (Contract No. 0876A). This contract provided for an agreement between RD 108 and the United States on RD 108's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. The length of this contract is 40 years and will remain in effect until March 31, 2006. The various RD 108 water right maximum quantities and sources are summarized in Table 2-33.

TABLE 2-33
RD 108: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A000576 (1/25/17)	000315 (7/24/17)	003065 (2/24/50)	Feb 1 to Oct 31	180
Sacramento River	A000763 (8/27/17)	000388 (1/16/18)	003066 (2/24/50)	Feb 1 to Oct 31	500
Sacramento River	A001589 (12/26/19)	001885 (11/22/24)	003067 (2/24/50)	May 1 to Oct 1	255.25
RD 108 Back Levee Borrow Pit (Colusa Basin Drain)	A011899 (5/26/47)	008251	(12/20/50)	Apr 1 to Oct 1	75

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

A – Appropriative right

J – Adjudication

S – Statement of Water Diversion and Use

Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Contract No. 0876A provided for a maximum total of 253,500 ac-ft/yr, of which 199,000 ac-ft was considered to be Base Supply and 54,500 ac-ft was CVP water (Project Supply). In 1974, the District reduced its Project Supply allocation to 33,000 ac-ft with the expectation that conservation efforts including canal lining and recirculation of drainage water by the District would reduce diversion requirements. Thus, the current contract provides for a maximum total of 232,000 ac-ft/yr, of which 199,000 ac-ft is considered to be Base Supply, and 33,000 ac-ft is CVP water (Project Supply), as shown in Table 2-34. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-34
RD 108: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Months	64,000	33,000
Non-critical Months	135,000	0
Total Annual	**199,000**	**33,000**

The contract specifies the total quantity of water that may be diverted by RD 108 each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-24. The monthly Base Supply ranges from a minimum of 1,500 ac-ft in October to a maximum of 50,500 ac-ft in May. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 16,000, 15,000, and 2,000 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 64,000 ac-ft, and the total Project Supply is 33,000 ac-ft.

Settlement Contract Historical Diversions. RD 108's total annual diversions from the Sacramento River can be characterized into two time periods, 1964 to 1982 and 1983 to 1997 (shown on Figure 2-25). From 1964 to 1982, annual diversions fluctuated between a maximum of 214,700 ac-ft in 1968 to a minimum of 140,400 ac-ft in 1977 (critically dry year). During the early 1980s, RD 108 slowly phased in a "lock-up" program to control rice pesticides. This lock-up program was in effect from approximately 1983 until 1997. This lock-up program provided for complete recycling of, as no was discharged into the Sacramento River during the lock-up period. Due to the recycling effects of this program, diversions from the Sacramento River were reduced. From 1983 to 1997, annual diversions fluctuated between a maximum of 143,900 ac-ft in 1992 (critically dry year) to a minimum of 93,900 ac-ft in 1983.

Similar to trends in annual diversions, RD 108 diverted a portion of their Project Supply every year during the period of 1964 to 1982. In critical months during 1982 to 1990, RD 108 diverted a portion of their Project Supply during only one year. Since 1991, RD 108 has increased their diversions during critical months and has diverted a portion of their Project Supply.

Figure 2-24 shows the historical monthly average diversions for the following three periods:

- 1964 to 1982: Beginning of recording period to prior to start-up of the lock-up program.
- 1983 to 1990: Period when the lock-up program was active and minimal diversion of Project Supply entitlements occurred.
- 1991 to 1997: Similar to 1982 to 1990 period, except increased diversions of Project Supply entitlements occurred.

The following observations are noted:

- Since the beginning of the water recycling program in 1983, Base Supply diversions decreased most significantly in April, May, and June. On average, these diversions were cut nearly in half. These reductions in diversions are attributed to the implementation of the lock-up program, as the lock up period was typically from May 1 to early July.
- Between 1983 and about 1990, less than 20 percent of the total Project Supply entitlements were diverted. A majority of the Project Supply diversions occurred during the critical month of August.
- Beginning in 1991, average monthly diversions of Project Supply in July and August increased to nearly 50 percent of the Project Supply entitlement.

Non-contract Period (November – March). Contract No. 0876A does not limit RD 108 from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. As previously discussed, RD 108 also has riparian water rights to the Sacramento River, which allow for diversion during the entire water year (October through September). RD 108 has historically irrigated in months prior to April (pre-irrigation), especially for tomatoes and grain crops. With the phase-out of rice straw burning over the past several years, there has been an increased interest by rice growers in fall and winter flooding of rice fields to enhance decomposition of rice straw and stubble. Approximately 6,000 acres were flooded each of the past 4 years.

Other Surface Water Sources. No creeks or other surface water sources, excluding the Sacramento River and the Colusa Basin Drain, are available to RD 108.

Groundwater. Irrigation water requirements are met through the contract surface water supply, although groundwater is used by a few individual growers to supplement the surface supply, particularly in dry years. Approximately 12 privately owned wells and three District-owned wells are located within the District's boundaries. During some dry years or peak demand periods, RD 108 uses groundwater to increase system flexibility and responsiveness to grower water needs (i.e., increase speed of water deliveries). The District's three groundwater wells have a total capacity of approximately 20 cfs (Department, 1978).

RD 108 lies within the southern portion of the Colusa Sub-basin. The area is located on recent alluvial sediments including: channel, floodplain, basin, and alluvial deposits. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeability. Stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeability.

Underlying these recent fluvial deposits are the Tehama and Tuscan Formations (Department 1978; Department, 2003c).

Although the Tehama Formation is mostly fine-grained, it contains sufficient sand and gravel zones in many areas to provide large quantities of groundwater. In the northern portion of the Colusa Sub-basin the Tehama Formation contains extensive deposits of interbedded gravel from the ancestral Stony Creek (the Stony Creek Member). The Stony Creek Member of the Tehama Formation is typically very productive, yielding large quantity of water to wells. In the central and southern portion of the Colusa Sub-basin, between Willows and Williams, the Tehama Formation is predominately clayey and wells in this area are generally less productive than those in the northern portion of the sub-basin (Department, 1978).

The Tuscan Formation is an important water-bearing unit in the northeastern portion of the Sacramento Valley (Department, 2003a). Deposited during the same period as the Tehama Formation, the Tuscan Formation consists of interbedded volcanic deposits (Department, 1978). The unit grades from tuff breccias along the eastern margin of the Sacramento Valley to volcanic sands, gravels, and clays to the west. In the Colusa Sub-basin, the Tuscan Formations is found at approximate depths of 300-1,000 feet bgs, where it inter-fingers with the Tehama Formation (Department, 2003a). Volcanic sands and gravels can provide high yields to domestic and irrigation wells; however, the unit is generally too deep to be tapped by wells west of Chico (Department, 1978).

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for agricultural, domestic, and M&I uses. In general, natural groundwater quality is influenced by streamflow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range. The total depth of fresh water in RD 108 is approximately 1,200 feet bgs (Berkstresser, 1973). The fresh water is underlain by saline water.

Throughout RD 108, groundwater movement is generally to the southeast, towards the Sacramento River. In the northern portion of the District, the gradient is slightly greater than 2 feet per mile. In the southern portion of the District the gradient is less than 2 feet per mile (Department, 2003c). Limited recent groundwater data is available for the RD 108 area because the Department monitors only one well in the region. Historically (from the 1940s through the late 1970s), four additional wells have been monitored. Examination of data from additional monitoring wells within 2 miles of the RD 108 boundary indicates that during years of normal precipitation, groundwater levels in the unconfined portion of the aquifer fluctuate between 2 and 5 feet seasonally; while during drought years, groundwater levels have been shown to fluctuate up to 13 feet (Department, 2003b). Groundwater levels in the confined portion of the aquifer system fluctuate between 8 and 35 feet during years of normal precipitation, and up to 40 feet under drought conditions. Historical trends show that groundwater levels in the RD 108 area are generally stable over the long term, although short-term fluctuations in groundwater levels are observed that can be correlated with precipitation trends.

Other Water Supplies. In recent years, RD 108 has relied heavily upon tailwater and reuse/recirculation to supplement its Sacramento River entitlement. The Colusa Basin Drain has been the primary source of tailwater, as this canal flows along the western edge of the District. However, the tailwater supply from the Colusa Basin Drain is primarily used as an alternative supply. RD 108 holds a permit to pump 75 cfs from the Colusa Basin Drain (RD 108 Back Levee Borrow Pit).

Because a large portion of RD 108 lies within an area of relatively little slope, the District has a unique capability of recirculating drainage water so that no drainage is pumped into the Sacramento River. As previously discussed, this lock-up capability allowed the District to control rice pesticide-contaminated water within its drainage and irrigation systems for the prescribed holding period, thereby permitting early release of pesticide water from rice fields. Typically, the lock-up period was an 8 to 10 week period, approximately from May 1 to early July. In addition, RD 108 has recirculated a certain amount of drainage water beyond the normal 2-month lock-up period as a water management practice. Approximately 60,000 ac-ft was recycled annually during the lock-up program. However, after about 15 years of recycling water during the peak irrigation season, it was found that continued recycling of drainage water detrimentally affected crop production within certain areas of the District because of salt buildup in the soil. Therefore, in 1997, RD 108 suspended the lock-up program and has curtailed its recirculation of drainage water.

2.2.6.4 Water Use

District Water Requirements. Rice is the predominant crop grown within RD 108's service area. Other key crops include tomatoes, safflower, wheat, alfalfa, corn, and vineseed. Rice accounts for approximately 40 to 50 percent of the District's irrigated acreage on an annual basis. As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. Irrigation water requirements are met through the contract surface water supply, although groundwater is used by a few individual growers to supplement the surface supply, particularly in dry years.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 2-35 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

Figure 2-26 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

TABLE 2-35
RD 108 Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Rice	21,500 (± 10%)[c]	21,600 (± 10%)[c]
Grain	8,200 (± 45%)[c]	8,100 (± 45%)[c]
Safflower	5,500 (± 35%)[c]	5,100 (± 35%)[c]
Tomatoes	5,400 (± 70%)[c]	6,600 (± 70%)[c]
Other Crops	10,400 (± 30%)[c]	9,300 (± 30%)[c]
Total Irrigated Acreage	**51,000 (± 5%)[c,d]**	**52,500 (±5%)[c,d]**

[a]Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Northern and Central Districts.

[b]Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Northern and Central Districts.

[c]Percentages obtained from RD 108.

[d]Includes 1,400 double-cropped acres for 1995, and 1,800 double-cropped acres for 2020.

With the phase-out of rice straw burning over the past several years, there has been an increased interest by rice growers in fall and winter flooding of rice fields to enhance decomposition of rice straw and stubble. Approximately 6,000 acres were flooded during each of the past 3 years. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture. The District is actively working with Yolo County Resource Conservation District and Reclamation on a demonstration program of planting native vegetation along the District's irrigation and drainage canals to prevent erosion of levee slopes, to improve water quality, and to enhance wildlife habitat.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Urban. RD 108 does not currently serve water to any municipal or industrial users. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by approximately 2,500 ac-ft compared to 1995 estimated levels (Department, Central and Northern Districts). Future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the District does not preclude the possibility of serving such needs in the future.

Environmental. Approximately 100 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

As described above, up to 6,000 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. No managed designated environmental or wetlands areas are within the District.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the District. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The District's topography generally consists of nearly level to gently sloping terrain. Because the District has relatively high groundwater levels and primarily silty clay soils seepage occurs into several canals and ditches. This makes lining of open canals and ditches difficult due to pressure exerted from groundwater.

Soil associations for the Yolo County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Yolo and Colusa Counties.

Soil associations in the Yolo County area of RD 108 are as follows (Appendix C):

- Sycamore-Tyndall: Somewhat poorly drained, nearly level, very fine sandy loams to silty clay loams on alluvial fans.
- Sacramento: Poorly drained, nearly level silty clay loams and clays in basins.
- Capay-Sacramento: Moderately well-drained to poorly drained, nearly level, silty clay loams to clays in basins.

Soil profile characteristics in the Colusa County area of RD 108 are as follows (Appendix C):

- Young alluvial fan and basin soils with moderately compacted subsoils.
- Recent alluvial fan and floodplain soils with deep permeable profiles.
- Older alluvial fan and basin soils with moderately compacted subsoils.

Transfers and Exchanges. RD 108 is one of 34 SRSCs that currently participate in the Pool program. Since 1974 the Pool has been the forum to move available Project Supply supplies within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool rather than for diversion. RD 108 also has an ongoing agreement to transfer water directly to the Colusa Basin Mutual Water Company via a "sub-pool" administered by the SWRCA. In general, the water transferred to the Colusa Basin Mutual Water Company is made available through the Colusa Basin Drain for Colusa Basin Mutual Water Company use. RD 108 recently participated in a successful transfer to the Contra Costa Water District.

Other Uses. No other significant water uses other than those discussed above occur within RD 108.

2.2.6.5 District Facilities

RD 108 uses an arranged schedule to deliver irrigation water to District customers. RD 108 owns and operates an irrigation system that includes 11 pumping plants, 7 of which are located along the Sacramento River (Figure 2-27). Irrigation canals totaling about 120 miles convey the river water to farms within the District's service area. The District also owns and operates a drainage system used for removing drainage water and winter storm runoff. Because the District has no natural drainage outlet, excess drainage water and rainfall runoff, which accumulate in over 300 miles of District drains, are channeled to the Rough and Ready Pumping Plant (850-cfs capacity) near the southeast corner of the District where the water is pumped into the Sacramento River for use downstream. The Riggs Pumping Plant on the northwest side of the District, adjacent to the Colusa Basin Drain, is a multi-purpose facility. Drainage of water from the north can be discharged into the Colusa Basin Drain or pumped into the irrigation canal system for reuse. The plant is also used to divert water from the Colusa Basin Drain for irrigation of District lands as a supplemental supply.

Because a large portion of RD 108 lies within an area of relatively little slope, the District has a unique capability of recirculating drainage water so that no drainage is pumped into the Sacramento River. This “lock-up” capability allows the District to control rice pesticide-contaminated water within its drainage and irrigation systems for the prescribed holding period, thereby permitting early release of pesticide water from rice fields. In addition, RD 108 has recirculated a certain amount of drainage water beyond the normal 2-month lock-up period as a water management practice. However, after about 15 years of water reuse during the peak irrigation season, it was found that continued recycling of drainage water created a detrimental effect on crop production within certain areas of the District caused by the build-up of salts in the soil. As a result, in 1997, RD 108 suspended the lock-up program and has curtailed its recirculation of drainage water.

The District is responsible for maintaining the integrity of the Back Levee, the primary flood control feature along the Colusa Basin Drain. The eastern boundary portion of the levee of the Sacramento River is maintained by the Sacramento River West Side Levee District, a sister district to RD 108. Flood maintenance involves patrolling the levee and making repairs as necessary during high water condition, which have occurred in 3 of the last 5 years, in the Colusa Basin Drain. More substantial repairs were subsequently made by the U.S. Army Corps of Engineers.

Diversion Facilities. RD 108's primary water supply facilities include seven pumping plants along the Sacramento River for diversion of water. The largest of these is the Wilkins Slough Pumping Plant and Fish Screen Structure near the northeast boundary of the District, which supplies the Wilkins Slough Main Canal. Table 2-36 summarizes RD 108's surface water supply facilities. See Figure 2-27 for a map of RD 108's major conveyance facilities. The District is finalizing plans for a new 300-cfs pumping plant and fish screen facility that would result in combining service to the Boyer's Bend, Howell's Landing, and Tyndall Mound service areas. There would be new and modified conveyance facilities associated with this new diversion and the three existing diversions would be either abandoned or removed.

Conveyance System. RD 108's distribution and conveyance system includes approximately 84 miles of earthen canals and 35 miles of concrete-lined canals. The Wilkins Slough Main Canal serves laterals in the northern and western portions of the District, and is supplied from the Wilkins Slough Pumping Plant. Irrigation Canals 12, 13, and 15 serve the central portion with water from Boyers Bend, Howells Landing, and Tyndall Mound pump stations. Irrigation Canal 10P and 14 serve the western and southern boundary of the

District, and are supplied from the Wilkins Slough Pump Station via the Main Canal and the El Dorado Bend Pump Station. Several of these canals can also be supplied by the District's drain recapture pumps, as described below. Table 2-37 summarizes RD 108's primary distribution facilities.

TABLE 2-36
RD 108 Surface Water Pumping Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Wilkins Slough Pumping Plant	Sacramento River	Pump/Gravity	700	95,000
Steiner Bend – N Pump Station	Sacramento River	Pump	8	350
Steiner Bend – S Pump Station	Sacramento River	Pump	30	1,600
Boyer's Bend Pump Station	Sacramento River	Pump	116	14,100
Howell's Landing Pump Station	Sacramento River	Pump	71	6,300
Tyndall Mound Pump Station	Sacramento River	Pump/Gravity	190	18,500
El Dorado Bend Pump Station	Sacramento River	Pump/Gravity	80	6,400

TABLE 2-37
RD 108 Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Wilkins Slough Main Canal	Wilkins Slough Pumping Plant	800	Earth	None	[a]
Irrigation Canal No. 12	Boyer's Bend Pumping Plant	100	Concrete	Main Drainage Canal	[a]
Irrigation Canal No. 13	Tyndall Mound Pumping Plant	130	Concrete	Main Drainage Canal	[a]
Irrigation Canal No. 14	El Dorado Pumping Plant	300	Earth	Main Drainage Canal	[a]
Irrigation Canal No. 15	Howell's Landing Pumping Plant	70	Concrete	Main Drainage Canal	[a]
Irrigation Canal No. 10P	Riggs Ranch Drain Pump	500	Earth	Main Drainage Canal	[a]
Lateral No. 10-S	Wilkins Slough Main Canal	250	Earth	Main Drainage Canal	[a]

[a]Varies. See District deep percolation studies.

In 1997, RD 108 began upgrading and automating major supply and canal control facilities. Currently over 50 percent of the District's distribution and drainage system pumping and control structure facilities are linked via a centralized SCADA system. The District is continuing this program with the goal of automating major canal and lateral control structures. Operational spills are currently at the lower practical amount for an open-channel irrigation system, and further significant reductions are limited. Conveyance system automation, when essentially completed over the next few years, will be fully developed as a management option for RD 108 and does not offer significant potential for new water conservation.

Storage Facilities. As noted previously, RD 108 has the ability to retain its drainage for reuse. This resulted in average annual savings of 60,000 ac-ft. Recently this has been found to reduce water quality and therefore some drainage is now pumped out of the District to control salinity levels within the soil.

Spill Recovery. RD 108 has an extensive network of drainage facilities, including over 300 miles of drains and five major drain pump stations for removal or reuse of irrigation return flows and winter stormwater runoff. Because of the topography and the surrounding levees, drainage must be pumped out of the District. The drainage is generally conveyed to the southeast corner of the District where the Rough and Ready, El Dorado Bend, and Sycamore Slough pumping plants are used to convey the drainage either through the flood control levees and into the Sacramento River or back into the distribution laterals for reuse. Sycamore Slough lifts drainage water into Lateral 14A, which conveys water to El Dorado for removal or to the irrigation system for reuse. The Riggs Ranch Pumping Plant conveys drainage from the northern portion of the District into either the Colusa Basin Drain or back into the supply conveyance system (Irrigation Canal 10P) for reuse. The Lateral 8 Pumping Plant lifts drainage water into Wilkins Slough Main Canal for reuse. The Rough and Ready Drain Pump Station shown on Figure 2-27 is not used for irrigation. The pump discharges regional drainage into the Sacramento River when a gravity discharge is prevented by a high river stage. Tables 2-38 and 2-39 summarize the main RD 108 drainage facilities.

TABLE 2-38
RD 108 Drain Pump and Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Sycamore Slough	Main Drainage Canal	Irrigation Canal 14	170	10,000
Riggs Ranch	Drain No. 9	Irrigation Canal 10P/Colusa Basin Drainage Canal	150	5,000
Lateral 8	Drain No. 8	Wilkins Slough Main Canal	200	4,000

TABLE 2-39
RD 108 Drainage Laterals
Sacramento Valley Regional Water Management Plan

Name	End Spill	Downstream Diverters/Recapture
Main Drainage Canal	Rough and Ready Drain Pump/Sycamore Slough Drain Pump	No
Drain No. 8	Main Drainage Canal	No
Drain No. 9	Main Drainage Canal	No

2.2.6.6 District Operating Rules and Regulations

RD 108, pursuant to Section 50911 (a) of the Water Code of the State of California, has produced rules and regulations covering the distribution of water within their District. The following list contains the headings of the 22 rules and regulations that RD 108 adopted on November 8, 1989. The headings include, control of system, employees, distribution of water, applications for water, charges for water, time of payment, shortage of water, waste of water, measurement of water, determination of acreage irrigated, access to land, control of regulation structures, condition of private ditches, delivery gates or turnouts, responsibility of the District, liability of irrigators, encroachments, abatement of nuisance, drainage water from sources outside the District system, enforcement of rules, complaints, and amendments and other changes.

Water rotation, apportionment, and shortage allocation:

> Water is ordered 24 hours prior to necessary delivery date. Rule 7 of RD 108 Rules and Regulations states: *Whenever a general shortage of water appears imminent, the Board of Trustees shall so find by resolution duly passed and recorded in its minutes. The resolution shall incorporate special rules and regulations to cover the distribution of the available water supply during the period of the shortage. In the event of temporary, local or similar shortages, the Manager is authorized to place in effect such variations in service as in his judgement the occasions requires.*

Use of drainage waters:

> Rule 19 of RD 108 Rules and Regulations states: *A charge will be made to cover the cost of conveying and disposing of drainage water from each tract of land situated outside the District. This charge shall be established annually by the Board of Trustees*

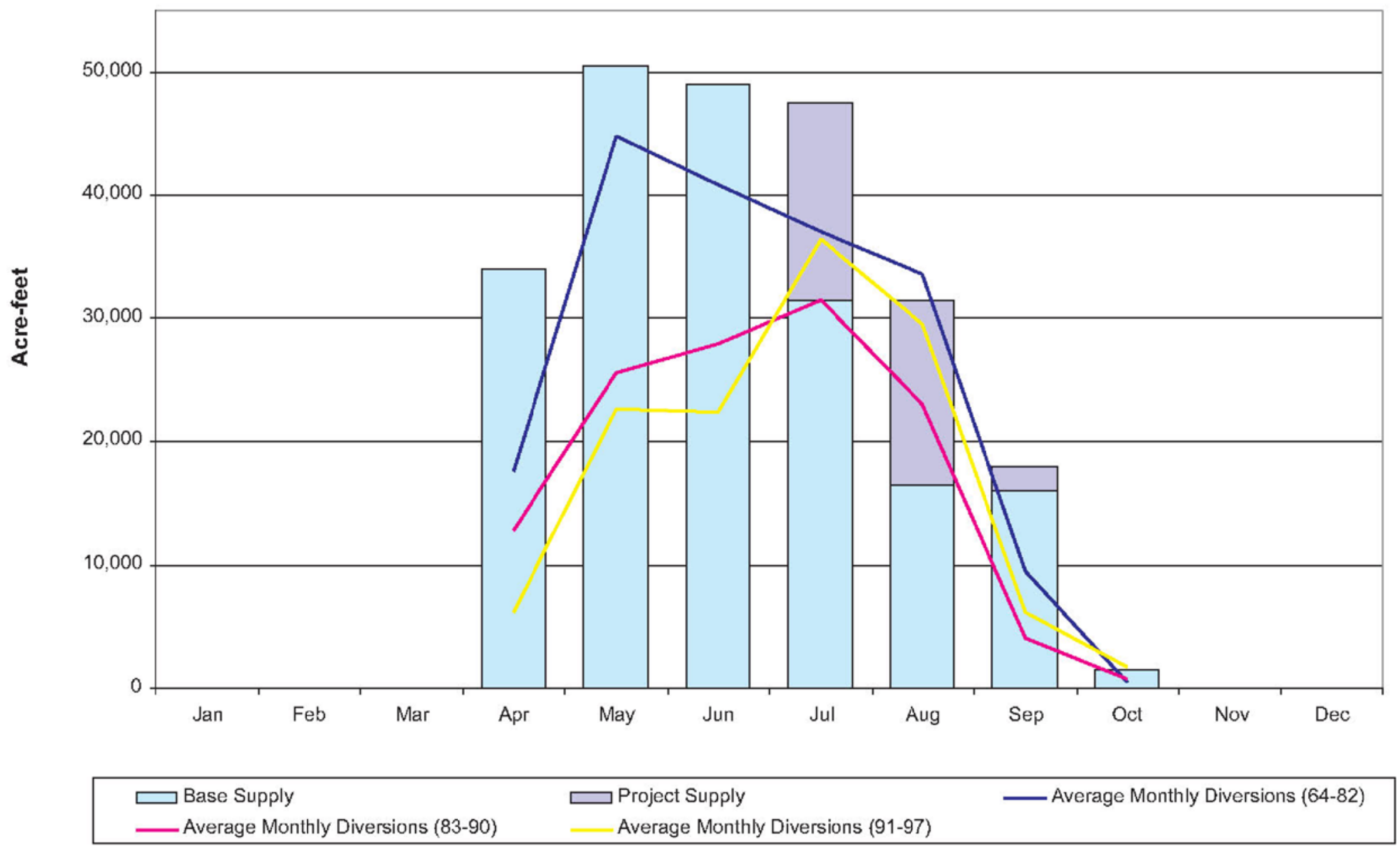
Policies for wasteful use of water:

> Rule 8 of RD 108 Rules and Regulations states: *Any water user who deliberately, carelessly or otherwise wastes water on roads, vacant land or land previously irrigated or who floods certain portions of the land to an unreasonable depth or who uses an unreasonable amount of water in order to irrigate properly other portions or who irrigates land which has been improperly checked for the economical use of water or who allows an unnecessary amount of water to escape from any field will be refused the use of water until such conditions are remedied or will have his use curtailed by the amount of waste, as the Manager may determine.*
>
> *The District reserves the right to refuse delivery of water to any lands when it appears to the satisfaction of the Manager that its proposed use or method of use would require such excessive quantities of water as would constitute waste.*

2.2.6.7 Water Measurement, Pricing, and Billing

Reclamation currently measures water at each of the seven Sacramento River pump stations using flowmeters. RD 108 measures drain pump and relift pump flows using pump efficiency curves and power use records. Drain flows leaving the District service area are also metered at the pump stations that are used to discharge the drainage into the Sacramento River. Flows in canals and laterals are measured using head measurements at gates and weirs. Some improvement in water measurement could be achieved along main canals and laterals with the installation of low-headloss flow measurement devices such as long-throated flumes and water level monitoring devices to quantify flows delivered to specific water service areas.

RD 108 measures flow rate at turnouts using head-discharge relationships for orifices and gates. Flow rates are set to match the field demand based on the irrigation method and field conditions. The total quantity of water delivered to each turnout is not recorded. The average on-farm efficiency for the District is approximately 66 percent, which is near the practical upper limit of around 70 percent. Operating conditions such as minimal head differential between supply laterals and fields and canal debris make widespread use of flowmeters impractical for nearly all turnouts. The most practical method for quantifying delivery at turnouts may involve improved water level recording and control in the laterals, combined with recording of delivery times and flow rates at each turnout. Some method of quantification, along with field-level improvements and appropriate price incentives, may provide improved field-level efficiency.



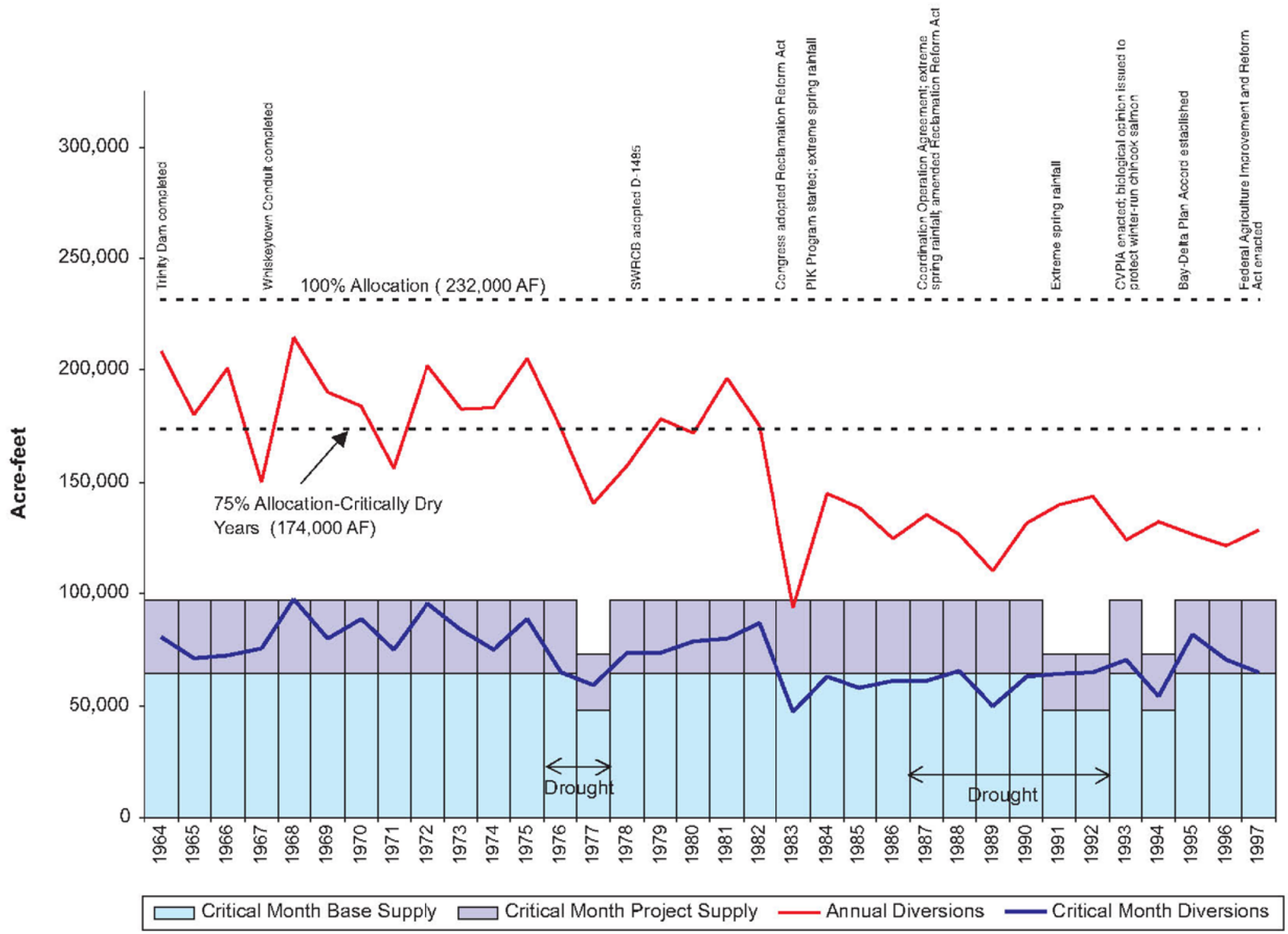
Notes:

1. Critically dry years 1977, 1991, 1992, and 1994 are omitted from Average Monthly Diversions.
2. Monthly diversions based on contract period for April to October.

FIGURE 2-24
RECLAMATION DISTRICT NO. 108
MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W032005010RDD_126 (8/17/05)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-25
RECLAMATION DISTRICT NO. 108
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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in association with
MBK

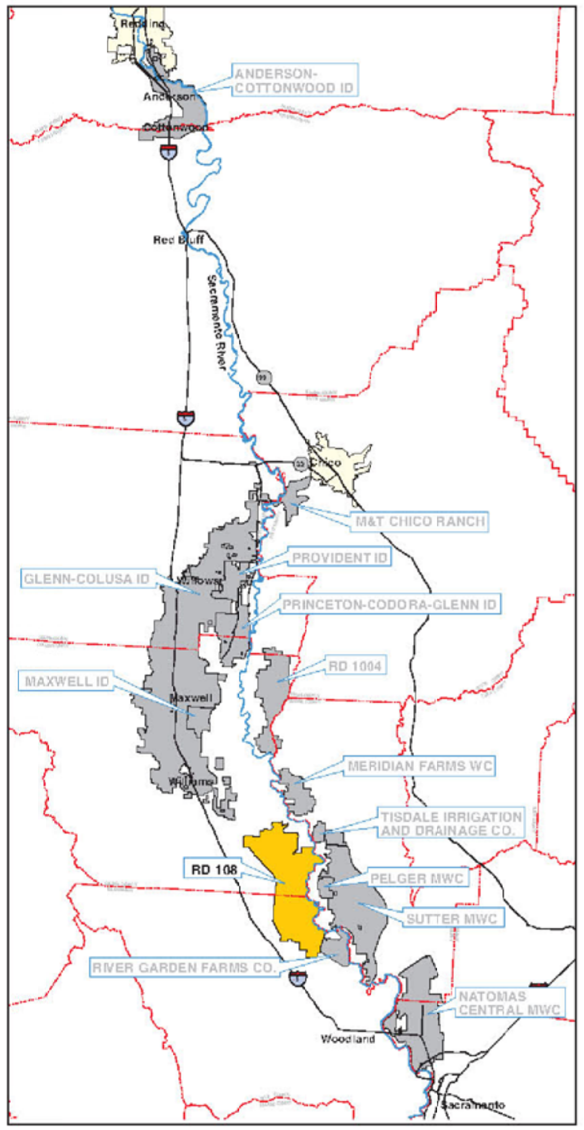
Reclamation District No. 108

General Manager: Luther P. Hintz • P.O. Box 50 • Grimes, CA 95920 • (530) 437-2221

Settlement Contract:	232,000 af
Base Supply:	199,000 af
Project Supply:	33,000 af

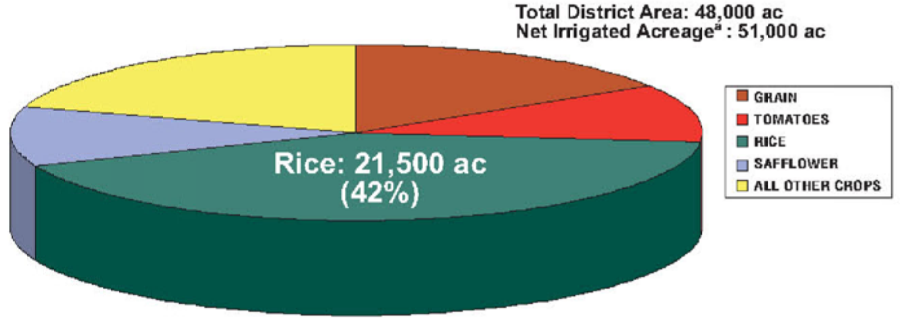
RECLAMATION DISTRICT 108

Location Map



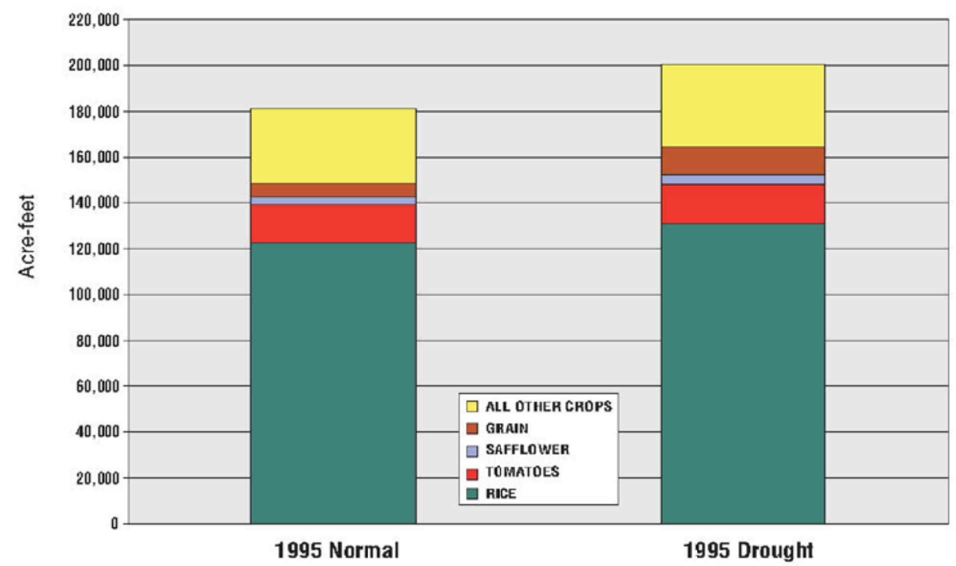
Irrigated Acreage by Crop

Total District Area: 48,000 ac
Net Irrigated Acreage[a] : 51,000 ac

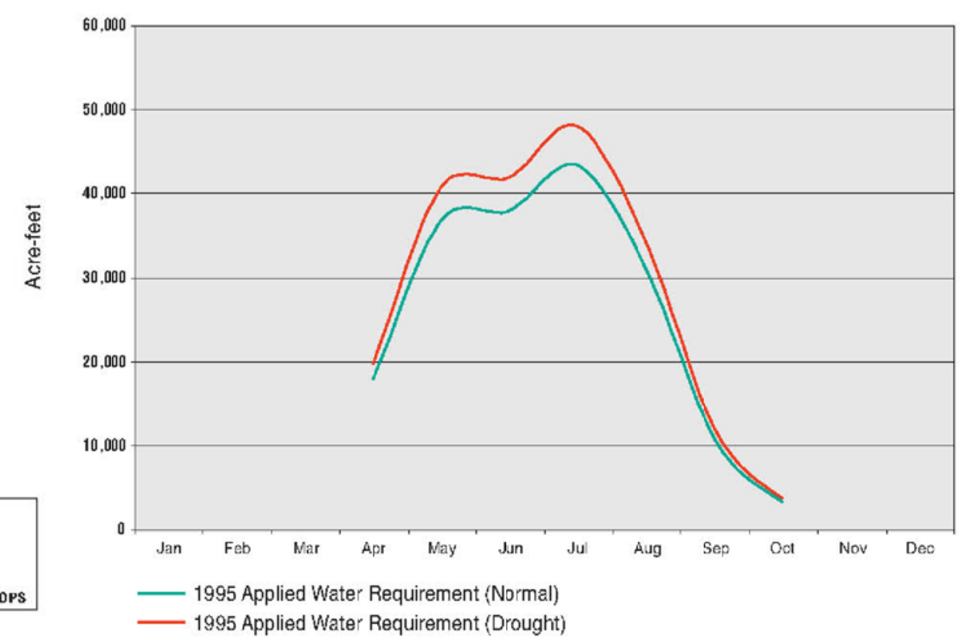


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

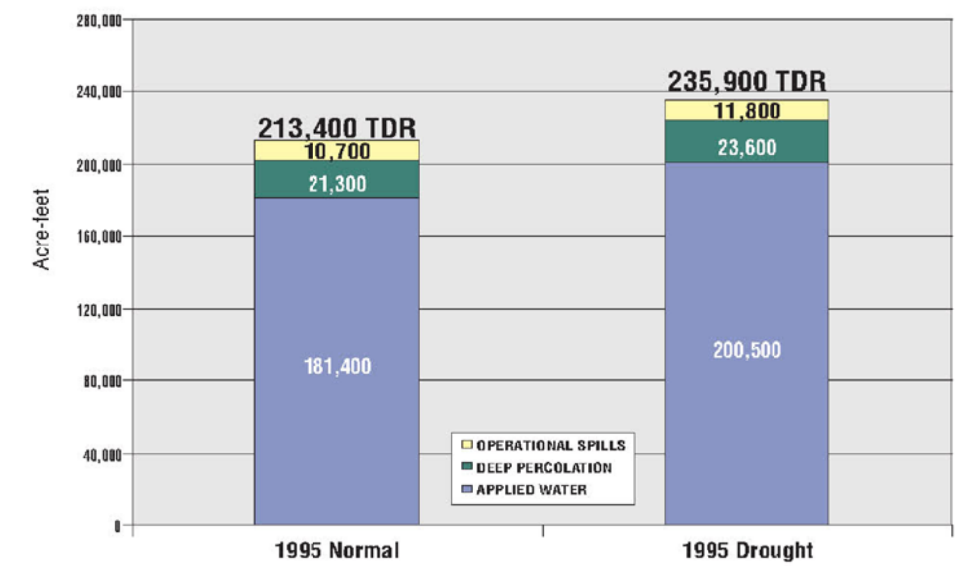


NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates. Includes 1,400 double-cropped acres for 1995.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)

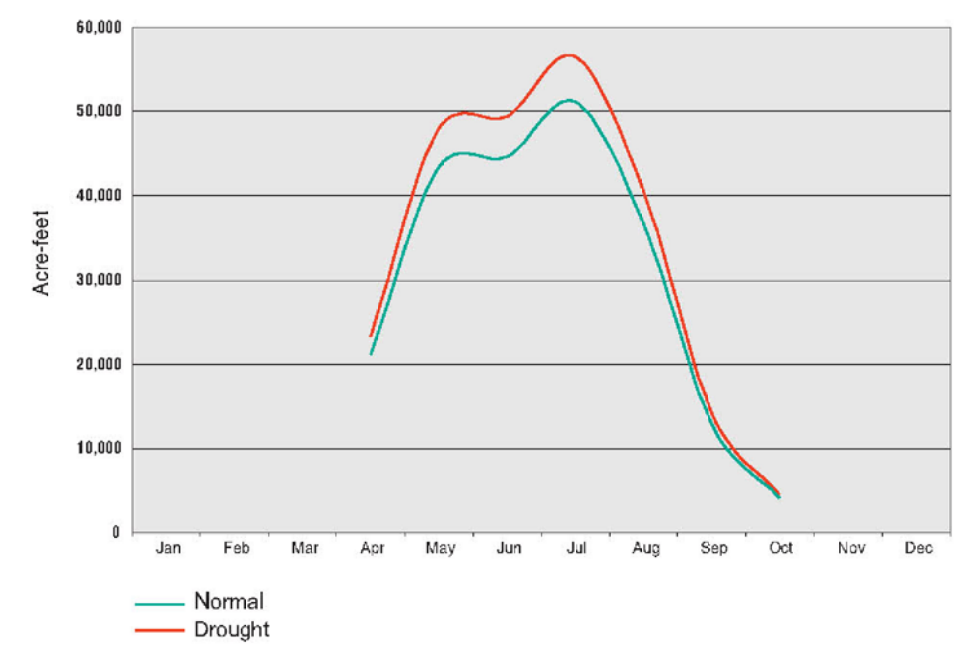


FIGURE 2-26
RECLAMATION DISTRICT NO. 108
IRRIGATED ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_110 (8/17/05)

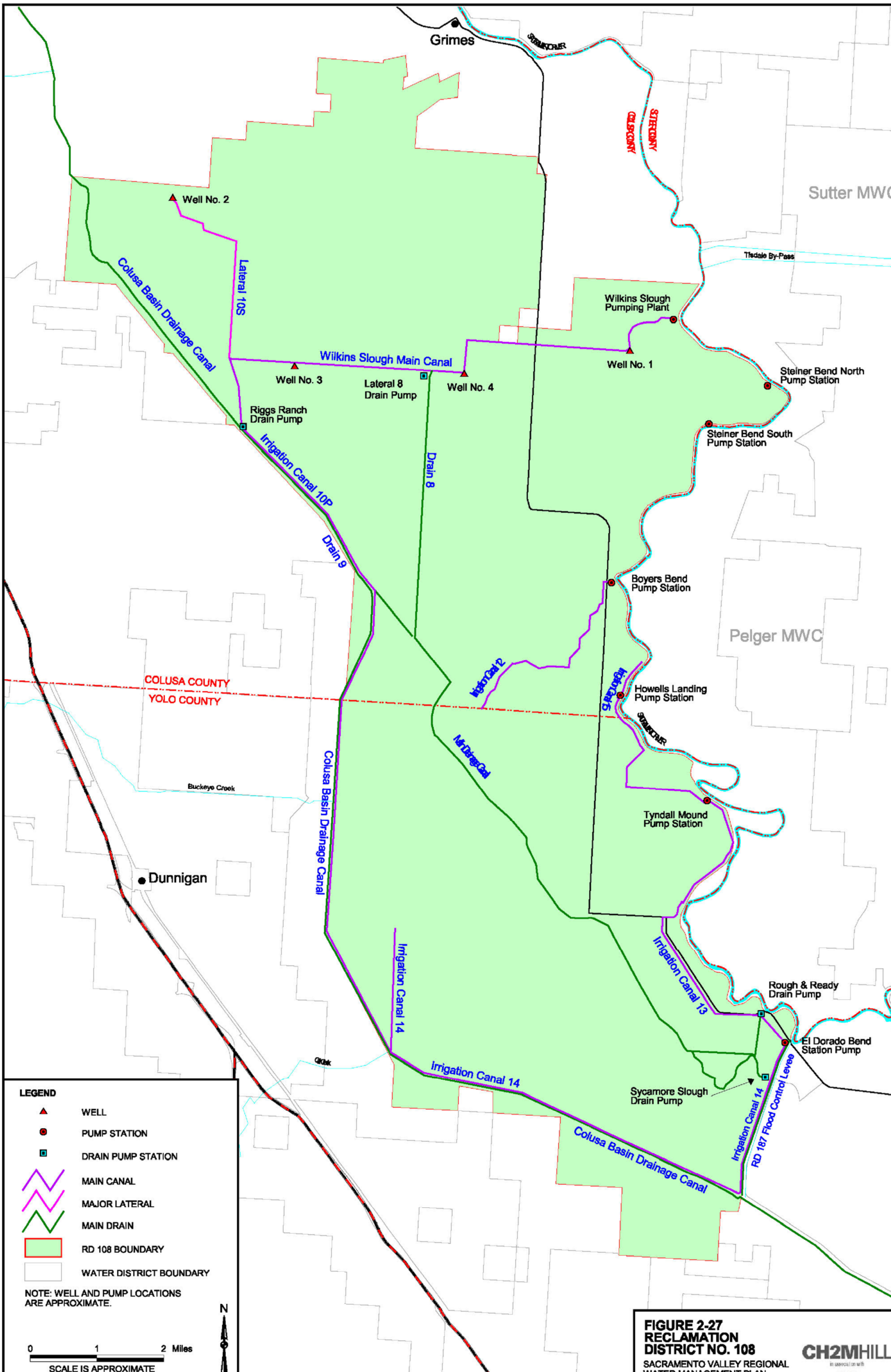


FIGURE 2-27
RECLAMATION DISTRICT NO. 108
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
MBK

CH2M HILL RDD \\LOKI\projects\rddgis\SacBWMP\gisdata\newhydro3_0805.apr RD108.pdf 08/18/2005

Butte Sub-basin

2.3 Butte Sub-basin

The Butte Sub-basin, shown on Figure 2-28, is located on the east side of the Sacramento Valley floor and is bounded on the west by the Sacramento River, on the north by Big Chico Creek, on the east by Butte Creek and Butte Slough, and the south by the Sacramento River and Butte Slough. RD 1004 is the only participating SRSC within this sub-basin.

Other water users within the sub-basin include other SRSCs, riparian rights holders, groundwater users, and Feather River diverters (e.g., Western Canal Water District). SRSCs account for approximately 50 percent of the water usage within the sub-basin. Inflows to the sub-basin include diversions from the east bank of the Sacramento River, Butte Creek, and Big Chico Creek. Outflows occur either through Butte Slough to Sutter Bypass or RD 1004's pumping plants to Sacramento River. Surplus water from precipitation and return flows from irrigation flow to Butte Slough. This surplus water can be rediverted for irrigation before leaving the basin as outflow (BWMP TM 3; see Appendix D).

2.3.1 Water Supply within the Butte Sub-basin

2.3.1.1 Surface Water

On average surface water provides 50 percent of the Butte Sub-basin total water supply (BWMP TM 4; see Appendix D). Agricultural needs account for approximately 98 percent of the demand in the sub-basin, over 725 taf/yr, depending on hydrology and other factors. Surface water is diverted from the following sources: East bank of the Sacramento River, Big Chico Creek and Butte Creek. Use is an important water supply component to the sub-basin. Use is highly variable and not measured regionally; however, estimates suggest that approximately 80 to 100 taf/yr is reused. This accounts for approximately 10 to 15 percent of the total supply. (BWMP TM 6; see Appendix D).

Water availability during critical or shortage years varies by contract type and water right. As dictated by the CVP Settlement contracts, surface water allocations can be reduced up to twenty-five percent of contract total in years determined to be "critical" by Reclamation per the Shasta Index criteria referred to in the contracts. While SRSCs represent 50 percent of the total water supplied to the Butte Sub-basin, other users such as those with riparian rights and groundwater users are not subject to contract-related reductions. Additional information related to water shortage allocation policies is provided in Section 1, Regional Description (BWMP TM 6; see Appendix D).

2.3.1.2 Groundwater

The Butte Sub-basin covers about 284 square miles in the north-central Sacramento Valley and overlies the Sacramento Valley Groundwater Basin. Surface water use is widespread in the southern portion of the basin, and groundwater use is prevalent along the Sacramento River and the central to northern portions of the sub-basin (Department, 2003a). The Sacramento Valley Groundwater Basin is divided into sub-basins of which the East Butte Sub-basin (groundwater basin number 5-21.59) and the West Butte Sub-basin (groundwater basin number 5-21.58) are relevant to this section. These groundwater sub-basins are defined and described in more detail in the Department's Groundwater Bulletin 118 individual basin descriptions. The basin descriptions include details regarding local hydrogeology, groundwater level trends, and groundwater quality.

The aquifer system of the basin is composed of late Tertiary to Quaternary Age deposits. Tertiary deposits are poorly sorted fluvial material of the Tehama Formation and volcanic deposits of the Tuscan Formation. The Tehama Formation consists of locally cemented silt, gravel, sand, and clay of fluvial origin deposited from the Coast Ranges. The Tuscan Formation consists of volcanic gravel and tuff breccia, coarse to fine grained volcanic sandstone, conglomerate and tuff, tuffaceous silt, and clay derived mainly from andesitic and basaltic source rocks. Tertiary deposits are the primary source of groundwater for most irrigation and municipal wells in the sub-basin.

Overlying the Tuscan Formation are alluvium, floodplain, and terrace deposits of Quaternary age. Quaternary deposits can provide moderate to large quantities of water to shallow irrigation and domestic wells in the sub-basin (Department, 2003a).

Groundwater currently contributes approximately 30 percent to 40 percent of total water supply used in the Butte Sub-basin, and the Department has identified the Butte Sub-basin as suitable for potential conjunctive use opportunities. To this effect, districts in coordination with the Department have been collecting important data to allow further evaluation of groundwater management options. During periods of drought there has been an estimated maximum of 100,000 ac-ft of groundwater storage deficit (late 1980s), but the basin recovered fairly rapidly within a few years. The estimated storage capacity of the East Butte and West Butte Groundwater Sub-basins, down to 200 feet is on the order of 3 maf (Department, 1978). Groundwater is generally of good quality for agricultural and potable water uses.

Because of the sub-basin’s capacity to provide surface and groundwater, there are potential opportunities for enhancing in-basin management of groundwater supplies. Current management efforts in the Butte Sub-basin include ongoing local water management planning efforts, AB 3030-related actions, and the continued implementation of the Butte County ordinance and Glenn County BMOs.

Other areas where potential improvements could be made include the groundwater recovery, distribution, and recharge network. Some groundwater extraction facilities are present, with private pumpers supplying 30 percent of the sub-basin’s needs. Further recharge is provided through agricultural cultural practices (e.g., percolation from applied water.) However, an adequate distribution and recharge network is not in place.

2.3.1.3 Reuse and Other Water Supplies

Return flows and diversions are an integral part of the sub-basin hydrology (i.e., along lower Butte Creek and Butte Slough) during much of the year, and play a critical role in both irrigation supply and in-stream flow management. Major entities that use or are involved in its management within the sub-basin include RD 1004, MTCR, Western Canal Water District, Richvale Irrigation District, several reclamation districts, and numerous individual riparian and drain users along Butte Creek and the Butte Sink area. The USFWS and California Department of Fish and Game also rely on to assist in meeting water requirements associated with several wildlife management areas.

Based on the high level of reuse, existing efforts at regional management practices, and the extensive reuse infrastructure, the Butte Sub-basin may have strong potential for effective regional management.

Potential regional management program objectives and benefits could include some or all of the following:

- Modification of Sacramento River and/or Butte Creek diversion patterns in support of short-term in-stream flow targets
- Drought-year increase in reuse together with other supplies such as groundwater to support beneficial intra-basin or out-of-basin transfers to other water users
- Improved monitoring of quality and soil salinity impacts, both by location and season, with increased ability to track soil salinity accumulation and set soil leaching targets
- Improved management of return flow water quality impacts to meet in-stream water quality targets at key downstream points such as the Butte Slough Outfall gates and the East-West Diversion Weir at the head of the Sutter Bypass
- Increased supply reliability to users with few or no alternative supplies (BWMP TM 6; see Appendix D)

No other significant sources of supply are used in the sub-basin.

2.3.2 Water Use within the Butte Sub-basin

2.3.2.1 Agricultural

Within the Butte Sub-basin agricultural needs account for approximately 98 percent of the demand in the sub-basin, over 725 taf/yr, depending on hydrology and other factors. Agricultural land use within Butte Sub-basin is primarily rice, due to the presence of fine-textured and poorly drained soils. This crop composes over 80 percent of the total crops served by the sub-basin (BWMP TM 2; see Appendix D). Water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area’s hot, dry climate.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and diversions have therefore been more a function of water-year type and climate than changes in cropping. Table 2-40 presents total irrigated acreage by crop for RD 1004, which is the only participating SRSC in the Butte Sub-basin; it encompasses the majority of the irrigated agricultural acreage in the sub-basin. Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current needs in terms of crop mix.

2.3.2.2 Urban

M&I requirements within the Butte Sub-basin account for less than 2 percent of current use. M&I water requirements are currently met by groundwater supply. M&I water use is anticipated to increase only slightly by 2020 (BWMP TM 2; see Appendix D). It should be noted that the majority of the City of Chico does not fall within the boundaries of this sub-basin and therefore its predominately groundwater supply is not accounted for in this write up.

TABLE 2-40
RD 1004 Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Rice	12,800 (± 10%)[c]	11,600 (± 10%)[c]
Dry Beans	1,400 (± 10%)[c]	1,200 (± 15%)[c]
Cotton	500 (±10%)[c]	1,500 (± 10%)[c]
Tomatoes	300 (±5%)[c]	300 (± 5%)[c]
Cucurbits	200 (±10%)[c]	600 (± 10%)[c]
Other Crops	500 (±5%)[c]	500 (± 5%)[c]
Total Irrigated Acreage	**15,700 (±10%)[c]**	**15,700 (± 10%)[c]**

[a]Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Northern District.

[b]Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Northern District.

[c]Percentages obtained from RD 1004.

2.3.2.3 Environmental

Managed environmental water supply requirements (i.e., wildlife refuge demands) are not a significant demand on the sub-basin. Butte Creek remains a focus of restoration efforts given its importance in providing valuable salmonid habitat, particularly to spring-run salmon. The Lower Butte Creek Project, which was begun in 1997, is a major effort by local stakeholders to develop regional alternatives for improved fish passage, agricultural water supply, and seasonal wetlands and other habitat management. The project evaluated a wide range of structural and institutional alternatives to meet these objectives, and implemented several capital projects along lower Butte Creek to improve flow control and fish passage. Projects associated with the Lower Butte Creek Project included improvements at the Butte Creek/Sanborn Slough Bifurcation Structure, White Mallard Dam, White Mallard Outfall, and Drumheller Slough Outfall. These projects are directly adjacent to RD 1004.

Other environmentally beneficial actions include rice lands farming methods that provide habitat for waterfowl, and important water transfer and in-stream flow management agreements that have been made to help meet in-stream flow objectives (BWMP TM 6; see Appendix D).

2.3.2.4 Transfers and Exchanges

Both MTCR and RD 1004 have in the past and continue to participate in the Sacramento River Water Contractors Association Project Supply Pool. In addition, the Western Canal Water District, which is a State Water Contractor, transferred water through the State Water Bank in the early 1990s.

Neither MTCR nor RD 1004 would typically have large supplies of water available for transfer, particularly in dry years, due to the sub-basin's use of and reliance on from upstream users. Accordingly, the sub-basin should be viewed as one that would likely be seeking to transfer water in rather than having supplies available for transfer out (assuming current cropping patterns).

Short-term or temporary transfers into the sub-basin could be initiated during drought/ critical years when some water purveyors have their surface water supplies reduced sharply, or long-term transfers could be made to permanently reallocate supplies in a beneficial manner. Similar to other basins, the potential to accomplish substantial transfers of water is constrained by existing regulations and policy.

2.3.2.5 Other Uses

Beyond M&I and agricultural use, there are no other significant water uses within the Butte Sub-basin. Reservoirs, such as Oroville, are outside of the sub-basin boundaries.

2.3.2.6 Sub-basin Water Budget

The Butte Sub-basin, shown on Figure 2-28, is located on the east side of the Sacramento Valley floor and is bounded on the west by the Sacramento River, on the north by Big Butte Creek, on the east by Butte Creek and Butte Slough, and on the south by the Sacramento River and Butte Slough. The participating SRSCs within this sub-basin include M & T Chico Ranch and RD 1004. Several short-form SRSCs and numerous small riparian diverters are also located in the Butte Sub-basin. No SWP contractors are in the sub-basin.

A water use balance for Butte Sub-basin for 2020 average-year conditions is presented on Figure 2-29. Under 2020 average conditions for this sub-basin, the following projections are made:

- On average, surface water will provide for approximately 50 percent of the total water supply. Groundwater pumping will represent 30 percent of the total water supply, and reuse of agricultural drainage flow originating from outside the sub-basin will account for 20 percent of the total water supply.
- The participating SRSCs' Base and Project Supplies will make up approximately 25 percent of the surface water supply, and just 15 percent of the total water supply.
- Portions of surplus water from precipitation and drainage flows from irrigation flow to Butte Slough are typically rediverted for irrigation before leaving the basin. The sub-basin water balance shows the portion of drainage flow that originates outside the sub-basin, hence providing an additional supply to area. For 2020 average conditions, this supply is approximately 90 taf/yr or approximately 30 percent of the total supply to the region.

Figure 2-30 presents a water use balance for Butte Sub-basin under 2020 critical-year conditions.

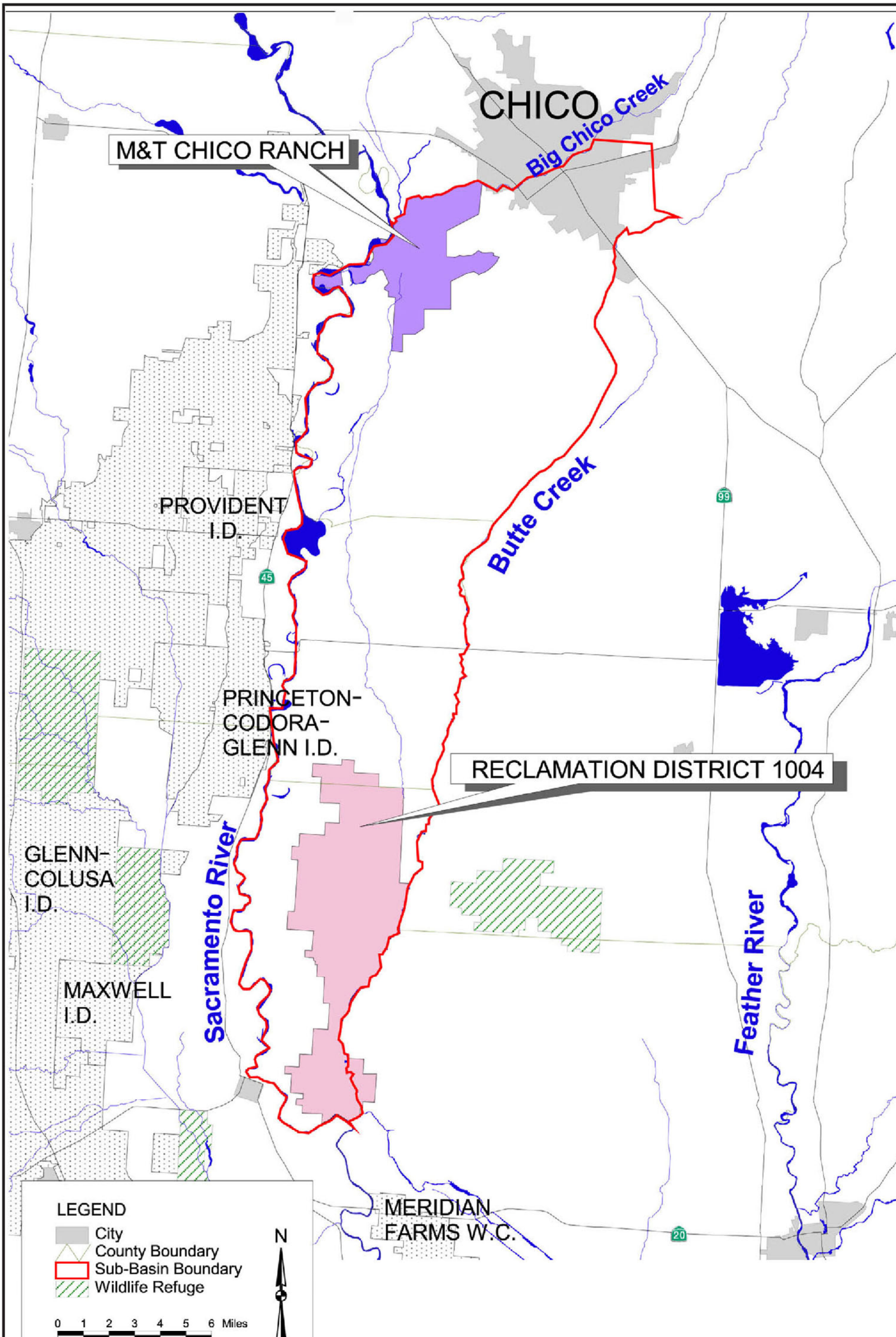


FIGURE 2-28
BUTTE SUB-BASIN
AND PARTICIPATING SACRAMENTO
RIVER SETTLEMENT CONTRACTORS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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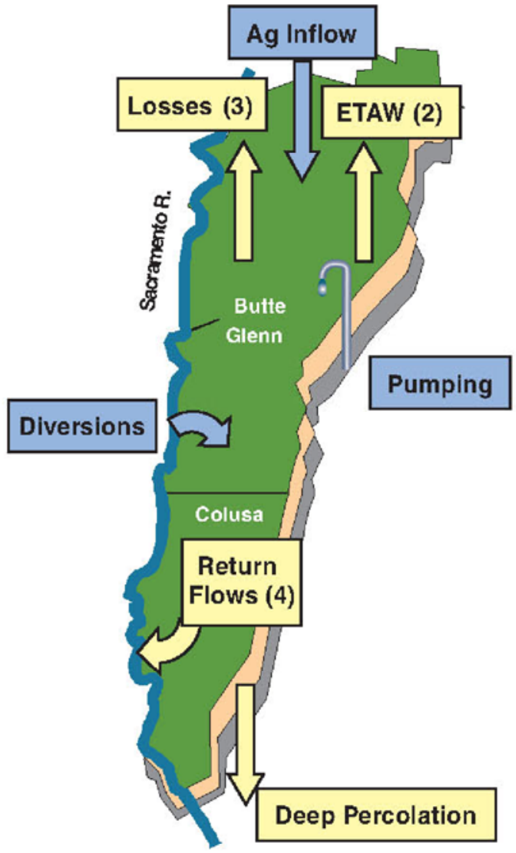
W032005010RDD_128 (8/17/05)



WATER USE (1)

ETAW (2):	Agricultural	=	423
	M&I	=	8
Fall Flooding		=	53
Wildlife Refuges		=	0
SUBTOTAL		=	484
Other:	Losses (3)	=	46
	Deep Perc	=	49
	Return Flows (4)	=	143
TOTAL		=	722

WATER SUPPLY

Surface Water Diversions:		
Riparian	=	38
Settlement Contracts:		
Base Supply	=	91
Project Supply	=	16
CVP Water Service Contracts	=	0
Local Surface Water	=	272
SUBTOTAL	=	417
Agricultural Drainage Inflow	=	70
Groundwater Pumping	=	228
TOTAL	=	715

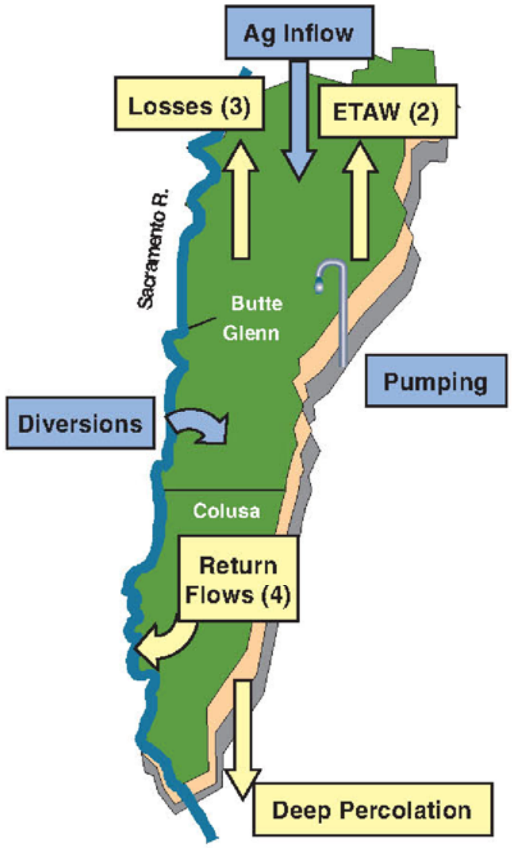
(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 20 percent of TOTAL water supply).

Includes Detailed Analysis Unit 167 (Butte, Colusa, and Glenn Counties) and Butte County Detailed Analysis Unit 166.

FIGURE 2-29
BUTTE SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
In association with
MBK

W032005010RDD_113 (6/8/05)



WATER USE (1)

ETAW (2):	Agricultural	=	471
	M&I	=	8
Fall Flooding		=	53
Wildlife Refuges		=	0
SUBTOTAL		=	532
Other:	Losses (3)	=	41
	Deep Perc	=	47
	Return Flows (4)	=	68
TOTAL		=	690

WATER SUPPLY

Surface Water Diversions:		
Riparian	=	36
Settlement Contracts:		
Base Supply	=	67
Project Supply	=	12
CVP Water Service Contracts	=	0
Local Surface Water	=	252
SUBTOTAL	=	367
Agricultural Drainage Inflow	=	57
Groundwater Pumping	=	255
TOTAL	=	679

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 10 percent of TOTAL water supply).

Includes Detailed Analysis Unit 167 (Butte, Colusa, and Glenn Counties) and Butte County Detailed Analysis Unit 166.

FIGURE 2-30
BUTTE SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_112 (8/17/05)

Reclamation District No. 1004

2.3.3 Reclamation District No. 1004

2.3.3.1 History

RD 1004 (or the District) entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water RD 1004 could divert from the Sacramento River. The resulting negotiated agreement recognized RD 1004's annual entitlement of a Base Supply of 56,400 ac-ft/yr of flows from the Sacramento River and also provided for a 15,000 ac-ft allocation of Project Supply, resulting in a total contract entitlement of 71,400 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Exhibit A to the Settlement Contract, and are included in Table 2-41 for RD 1004. The Settlement Contract negotiated in 1964 remains in effect until March 2006. RD 1004 is working with Reclamation and counsel to finalize environmental documentation for contract renewal.

TABLE 2-41
Schedule of Monthly Water Diversions – RD 1004
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	6,300	0	6,300
May	14,700	0	14,700
June	12,200	0	12,200
July	6,100	600	12,100
August	3,600	8,400	12,000
September	8,200	600	8,800
October	5,300	0	5,300
Total	**56,400**	**15,000**	**71,400**

Notes:

Contract No. 14-060-200-890A-R-1

Points of Diversion: 84.28L, 85.3L, 89.12R, 111.8L

2.3.3.2 Service Area and Distribution System

RD 1004 is located on the east side of the Sacramento River approximately 2 miles east of the town of Colusa and directly west of the Sutter Buttes. The District is primarily in Colusa County, with the southeastern most portion extending into Sutter County. Butte Creek runs along a portion of the eastern edge of RD 1004. The District's service area encompasses approximately 26,000 acres and includes 48 landowners. Rice is the predominant crop grown within the District.

2.3.3.3 Water Supply

RD 1004 holds water rights to divert water from the natural flow of the Sacramento River, Butte Creek, and the Butte Slough. These diversions differ in the quantity and timing in which they can be used as indicated in Table 2-42.

TABLE 2-42
RD 1004: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A000027 (4/2/15)	000031 (11/1/15)	003165 (4/30/51)	Apr 1 to Oct 15	166 cfs 56,000 ac-ft/yr
Butte Slough, Butte Creek	A023201 (12/26/68)	016771 (10/27/75)	Pending	Apr 1 to Jun 15 (Sep 15 to Jan 31 for recreation purposes)	140 cfs

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Surface Water. The RD 1004 surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0890A (Contract No. 0890A). This contract provides for an agreement between RD 1004 and the United States on RD 1004's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract was set to expire March 31, 2004. However, Congress granted a 2-year extension and therefore the contract will remain in effect until March 31, 2006. PID is working with Reclamation and counsel to finalize environmental documentation for the proposed contract renewal, expected to take effect for another 40-years at the end of the 2-year extension.

Contract No. 0890A provides for a maximum total of 71,400 ac-ft/yr, of which 56,400 ac-ft is considered to be Base Supply and 15,000 ac-ft is CVP water (Project Supply), as shown in Table 2-43. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-43
RD 1004: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Months	17,900	15,000
Non-critical Months	38,500	0
Total Annual	**56,400**	**15,000**

The contract specifies the total quantity of water that may be diverted by RD 1004 each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-31. The monthly Base Supply ranges from a minimum of 3,600 ac-ft in August to a maximum of 14,700 ac-ft in May. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of

6,000, 8,400, and 600 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 17,900 ac-ft, and the total Project Supply is 15,000 ac-ft, as shown in Table 2-43.

Settlement Contract Historical Diversions. RD 1004's total annual diversions from the Sacramento River have fluctuated greatly since the initiation of the entitlement contract, as shown on Figure 2-32. From 1964 to the mid-1970s, diversions fluctuated from a minimum of 42,100 ac-ft in 1964 to a maximum of 54,200 ac-ft in 1973. From the mid-1970s until 1990, total annual diversions continued to fluctuate from year to year; however, an overall increase in diversions occurred over this period. Due to critically dry years and the listing of the winter-run Chinook, diversions decreased in the early 1990s. However, since 1995, diversions have increased each year relative to the previous year.

Referring again to Figure 2-31, average monthly diversions are depicted for the following three periods:

- 1965 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

As shown on Figure 2-31, the average diversions (1965 to 1991) made by the District are less than their contract entitlements during all irrigation months. The largest monthly diversions occur during May and July. However, the District has diverted less than 50 percent of their entitlement during the critical month of September. Even with the relatively small September diversions, RD 1004 has diverted a portion of Project Supply during critical months (July, August, and September) every year since 1965, as shown on Figure 2-32.

Non-contract Period (November – March). In addition to the contract water, RD 1004 has filed for entitlements to pump water during the non-contract period for wetlands and rice straw decomposition. The methods and quantities of diversions in the past have varied.

Other Surface Water Sources. Butte Creek is located along the eastern edge of the RD 1004 service area, and Butte Slough is located on the southwestern edge. RD 1004 has established water rights to both Butte Creek and Butte Slough, and has permits to divert water from these sources, as shown in Table 2-42.

Groundwater. The RD 1004 boundary overlies the West Butte Sub-basin (Department groundwater basin number 5-21.58) of the Sacramento Valley Groundwater Basin, and therefore within RD 1004, occurs in a broad alluvial basin and is therefore not confined to any well-defined subsurface stream channels. RD 1004 is located on recent alluvial sediments including: channel, floodplain, basin, and alluvial fan deposits. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities. Alluvial fan and stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeabilities. These recent sediments are underlain by older deposits of the Tehama, and Tuscan Formations (Department, 2003c).

Beneath the fluvial deposits are the Tehama and Tuscan Formations. In the West Butte Sub-basin, the Tehama Formation is comprised of silts, gravels, sands, and clays deposited by streams draining the Coast Ranges. Although the Tehama Formation is mostly fine-grained, it contains sufficient sand and gravel zones in many areas to provide large quantities of groundwater. Interfingering with the Tehama Formation are the volcanic deposits of the Tuscan Formation. In the vicinity of RD 1004, this unit consists of volcanic sands and gravels as well as layers of finer grained materials such as tuffaceous silts and clays. Maximum thickness of these deposits is approximately 2,500 feet near the western boundary of the District (Department, 2003c; Department, 1978; Page, 1980). The most productive aquifers in RD 1004 are associated with the Tehama and Tuscan Formations.

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for agricultural, domestic, and M&I uses. In general, natural groundwater quality is influenced by streamflow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range. The total depth of fresh water in RD 1004 is 500 to 1,400 feet bgs (Berkstresser, 1973). The fresh water is underlain by saline water.

In the northern portion of RD 1004 groundwater movement is generally to the south/ southeast, away from the Sacramento River. In the southern portion of the District, flow direction is more southerly. The overall gradient of groundwater movement in RD 1004 is approximately 2.3 feet per mile (Department, 2003c). Seasonal fluctuations in groundwater level are minimal and generally less than about 10 feet, but can be up to 18 feet in drought years (Department, 2003b). Wells located near recharge sources typically show less of an annual change in groundwater levels.

Past pumping and drought conditions have not historically negatively affected the overall long-term groundwater level trends in RD 1004. Based on the water level information of eight wells in the RD 1004 area that date back to the 1950s, there has been little significant change in groundwater levels over time (Department, 2003b). Groundwater level data since 1980 from over 2,300 wells in the Sacramento Valley were reviewed and the historical trends show that groundwater levels near the RD 1004 area are generally stable over the long term, although short-term fluctuations in groundwater levels are observed that can be correlated with precipitation trends.

Other Water Supplies. RD 1004 currently uses an average tailwater amount of 20,000 ac-ft/ year. The District relies heavily on to supplement other water sources. During the regular irrigation season, drains are ponded to allow pumping, and essentially no water flows out from the drains.

2.3.3.4 Water Use

District Water Requirements. Land use within RD 1004's service area is primarily rice, due to the presence of fine-textured and poorly drained soils within the majority of the District. Other key crops include cotton and wheat. Rice accounts for over 80 percent of the District's irrigated acreage on an annual basis (Department, Northern District). Water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Although surface water is the primary source of irrigation water, groundwater is used in drought years on an individual grower basis and as per agreements with the District.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 2-40 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation. Figure 2-33 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's land-owners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 12,000 acres have been flooded in the past, a trend that is expected to continue or increase assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Urban. RD 1004 does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 100 ac-ft compared to 1995 estimated levels (Department, Northern District). Future M&I water requirements are assumed to be met by groundwater supplies. Although it is considered unlikely, RD 1004 could provide M&I water, but current estimates of future M&I demand are minimal.

Environmental. Approximately 35 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes elderberry shrubs, which provide habitat for the federally listed valley elderberry longhorn beetle, and habitat used by the giant garter snake.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the District. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Sutter County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Sutter and Colusa Counties.

Soil associations in the Sutter County area of RD 1004 are as follows (Appendix C):

- Zamora-Marvin: Well-drained to somewhat poorly drained silt to silty clay loam, moderately fine-textured and fine-textured soils on floodplains.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.
- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.

Soil profile characteristics in the Colusa County area of RD 1004 are as follows (Appendix C):

- Young alluvial fan and basin soils with moderately compacted subsoils.
- Recent alluvial fan and floodplain soils with deep permeable profiles.
- Older alluvial fan and basin soils with moderately compacted subsoils.

Transfers and Exchanges. RD 1004 is one of 34 SRSCs that currently participate in the Pool program. Since 1974 the Pool has been the forum to move available Project Supply supplies within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool rather than for diversion. RD 1004 typically does not have large supplies of water available for transfer, particularly in dry years, because of the Butte Sub-basin's use and reliance on from upstream users. Accordingly, the sub-basin should be viewed as one that would likely be seeking to transfer water in, rather than having supplies available for transfer out (assuming current cropping patterns).

Other Uses. No other water uses other than those discussed above occur within RD 1004.

2.3.3.5 District Facilities

Diversion Facilities. RD 1004's primary water supply facility is a surface water diversion on the Sacramento River northeast of the Town of Princeton. The RD 1004 Pump Station and flat plate fish screen structure has an approximate capacity of 360 cfs. The eastern portion of the District is also served by the White Mallard Diversion, located on Butte Creek. Table 2-44 summarizes RD 1004's primary surface water supply facilities. See Figure 2-34 for a map of the RD 1004 major conveyance facilities. The District owns one well that is used only in drought years and is not a significant water source. There are private wells owned and operated by growers, independent of District operations.

Conveyance System. The District's distribution and conveyance system includes approximately 50 miles of canals and laterals. Several other main canals are located throughout the District, and generally flow from north to south. These additional canals include the Frog Pond Canal, the Morgan Levee Canal, and the White Mallard Canal. Major laterals include the Terril Highline Lateral, the District Borrow Pit Lateral, and Avis Channel. Table 2-45 summarizes the District's primary distribution facilities. Leakage associated with the operation of the main canal is typically in the range of 15 percent (percentage of diversion water that seeps through the canal wall, and as a result, is unavailable for conveyance).

TABLE 2-44
RD 1004 Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
RD 1004 Pump Station at River Mile 112.1	Sacramento River	Pump	360	49,000
White Mallard Dam/Gravity Surface Diversion	Butte Creek	Gravity	80	3,300
Behring Pump	Butte Creek	Pump	95	600
Butte Creek Farms	Sacramento River	Pump	30	3,000
Rancho Caleta West	Sacramento River	Pump	10	50
Rancho Caleta East (Inactive)	Sacramento River	Pump	0	0

TABLE 2-45
RD 1004 Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Terril Highline	Drumheller Slough	110	No	East Levee Drain	5
Main Canal	RD 1004 Pump Station	360	Partial (1,300 feet)	5-Points Drain	7
White Mallard Canal	White Mallard Diversion Dam	180	No	5-Points Drain	5
Avis Channel	Main Canal	95	No	East Levee Drain	5
Morgan Levee Canal	District Borrow Pit	80	No	Frog Pond Drain	5
Frog Pond Canal	Main Canal	80	No	Frog Pond Drain	5
Boat Canal	Main Canal	100	No	Butte Creek Drain	5
District Borrow Pit Lateral	Felly Pumps No. 119 and No. 120	90	No	5-Points Drain	5

Storage Facilities. RD 1004 currently has no storage facilities.

Spill Recovery. RD 1004 has a network of unlined drainage ditches for conveying irrigation return flows. The East Levee Drain accommodates a majority of the drainage in the eastern portion of the District. The East Levee Drain discharges into Butte Creek via the 5-Points Drain Pump and drain lateral. Several major drain laterals and six drain pump stations are also located in the southern portion of the District. Drainage flows in this portion of the District are pumped to the Sacramento River via the three drain pump stations. In addition, the District operates six pumping plants that recapture return flows within the District. Tables 2-46 and 2-47 summarize the main drainage facilities within RD 1004.

TABLE 2-46
RD 1004 Drain Pump Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
5-Points Drain Pump	East Levee Drain	5-Points Drain to Butte Creek	30	2,000
Pole Line No. 107	Womble Drain	Main Canal	40	1800
Trailer Camp No. 108	Gridley Highway Drain	Terril Highline	25	3,000
Drumheller No. 113	Drumheller Slough	Avis Channel	30	NA
Pearl No. 114	Drumheller Slough	Boat Canal	30	1,700
Butte Lodge	Butte Creek Drain/Butte Lodge Drain	Flyway Ditch	20	1,300

TABLE 2-47
RD 1004 Drainage Laterals
Sacramento Valley Regional Water Management Plan

Name	End Spill	Downstream Diverters/Recapture
Butte Creek Drain	Butte Creek	Butte Slough diverters
Butte Lodge Drain	Butte Creek	Butte Slough diverters
5-Points Drain	Butte Creek	Butte Slough diverters
North Levee Drain	East Levee Drain/5-Points Drain/Butte Creek	Butte Slough diverters
Womble Drain	Drumheller Slough	Butte Slough diverters
Frog Pond Drain	Drumheller Slough	Butte Slough diverters

2.3.3.6 District Operating Rules and Regulations

RD 1004, pursuant to Section 50911 (a) of the Water Code of the State of California, has produced rules and regulations covering the distribution of water within their District. The following are a portion of the topics covered within these rules and regulations.

Water rotation, apportionment, and shortage allocation:

> *Water is ordered 24 hours prior to necessary delivery date. Whenever a general shortage of water appears imminent, the Board of Trustees shall so find by resolution duly passed and recorded in its minutes. The resolution shall incorporate special rules and regulations to cover the distribution of the available water supply during the period of the shortage. In the event of temporary, local or similar shortages, the Manager is authorized to place in effect such variations in service as in his judgment the occasions requires.*

Policies for wasteful use of water:

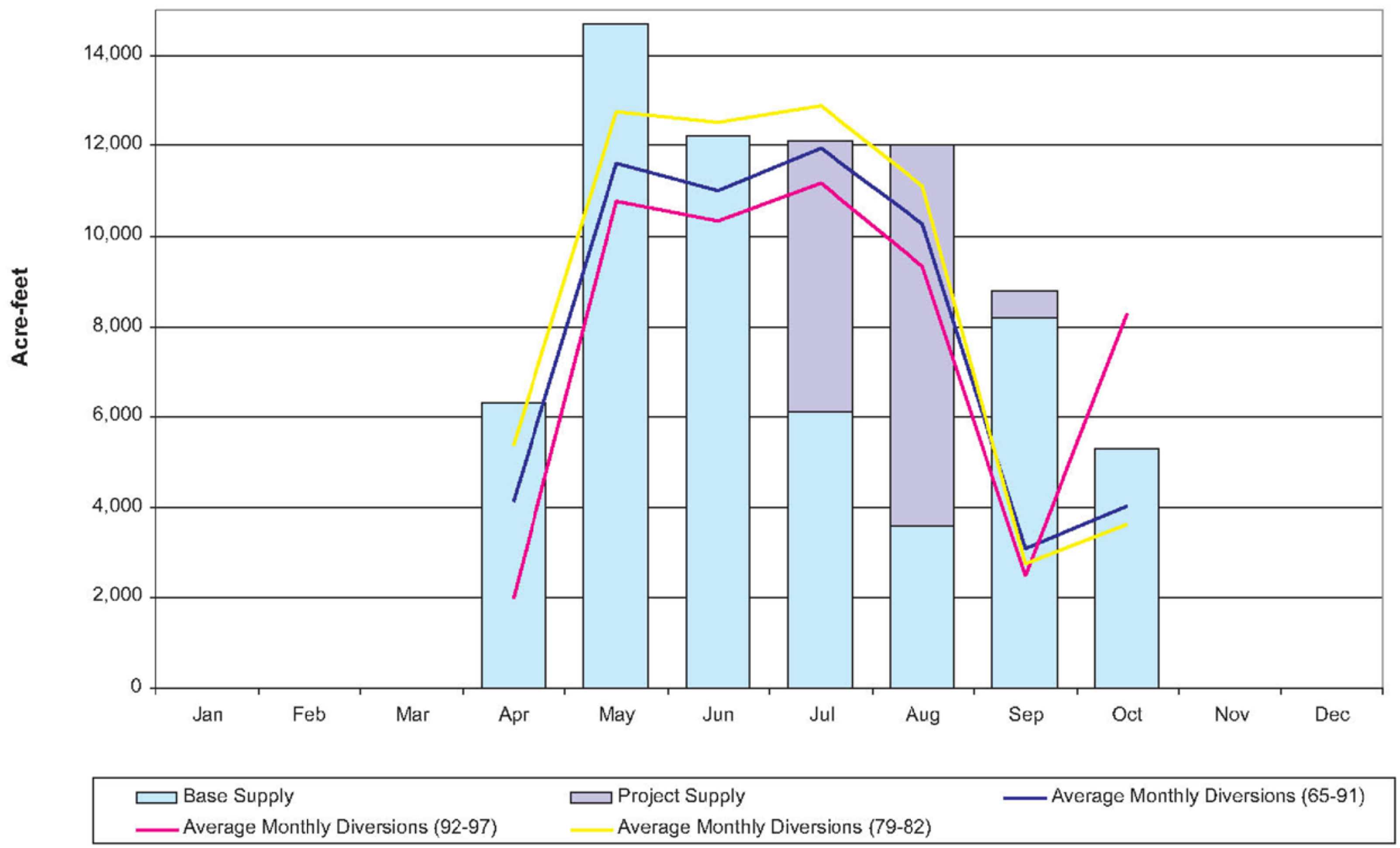
> *Any water user who deliberately, carelessly or otherwise wastes water on roads, vacant land or land previously irrigated or who floods certain portions of the land to an unreasonable*

depth or who uses an unreasonable amount of water in order to irrigate properly other portions or who irrigates land which has been improperly checked for the economical use of water or who allows an unnecessary amount of water to escape from any field will be refused the use of water until such conditions are remedied or will have his use curtailed by the amount of waste, as the Manager may determine.

2.3.3.7 Water Measurement, Pricing, and Billing

Water measurement is considered fully implemented as a conservation measure at RD 1004. The District measures flow and quantity at its river diversion pump stations using flow-meters. Canal and lateral flow rates are measured using meters and totalizers installed at intermediate points such as road culverts. The one District well is metered. Drain pump flows are estimated based on power consumption and pump efficiency data. The only operations level that is not metered is the drain pumps, although the power consumption records and efficiency data provide fairly accurate estimates of total volumes pumped.

RD 1004 has flowmeters installed on its customer turnouts. The meters are read and cleaned regularly, generally every 2 days. The District uses the meter data to record flow rates and total volume delivered at each turnout. These data are then used for the billing, which is based on a dollar-per-ac-ft charge.



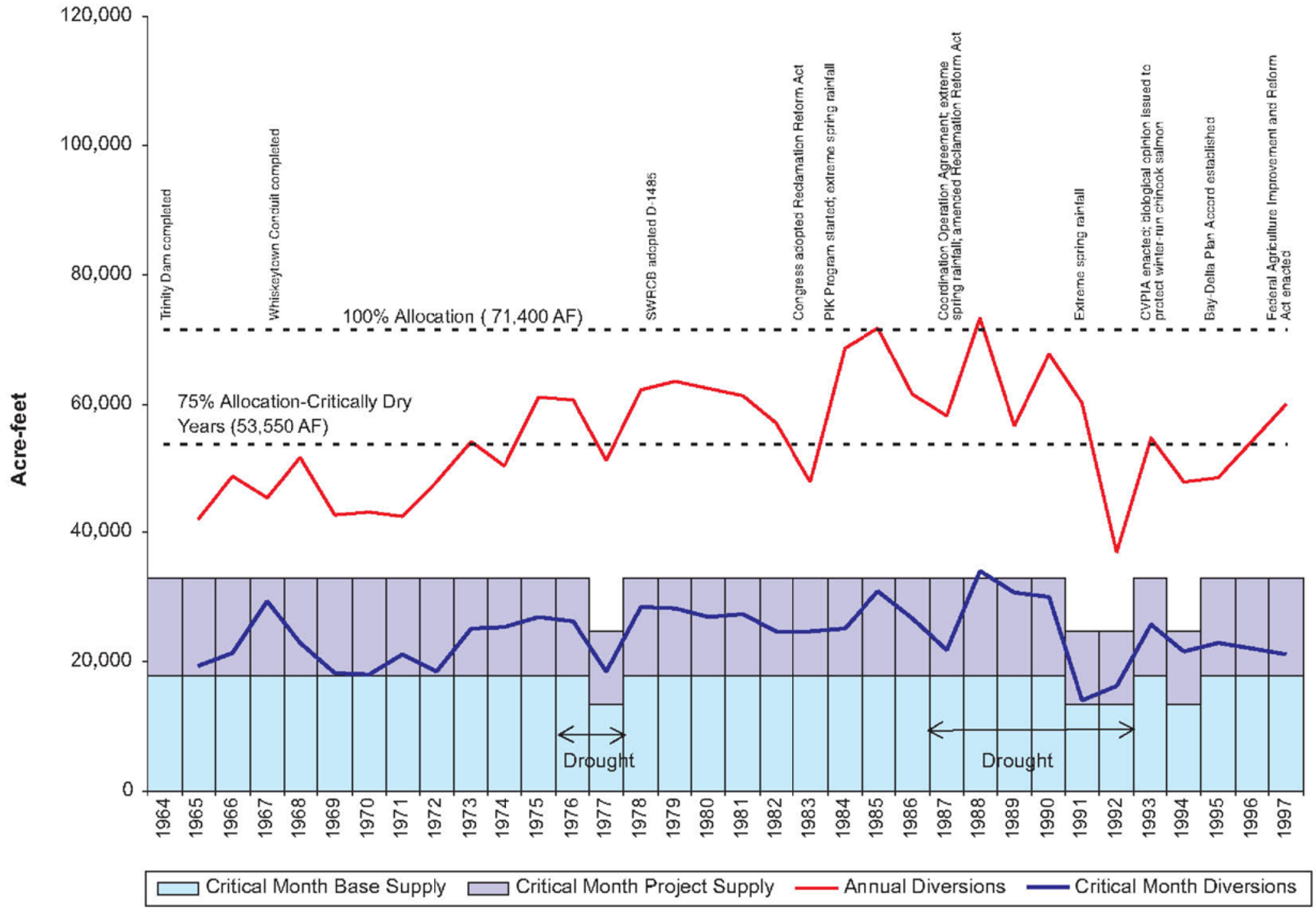
Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (65-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-31
RECLAMATION DISTRICT NO. 1004
MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W032005010RDD_115 (8/17/05)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-32
RECLAMATION DISTRICT NO. 1004
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

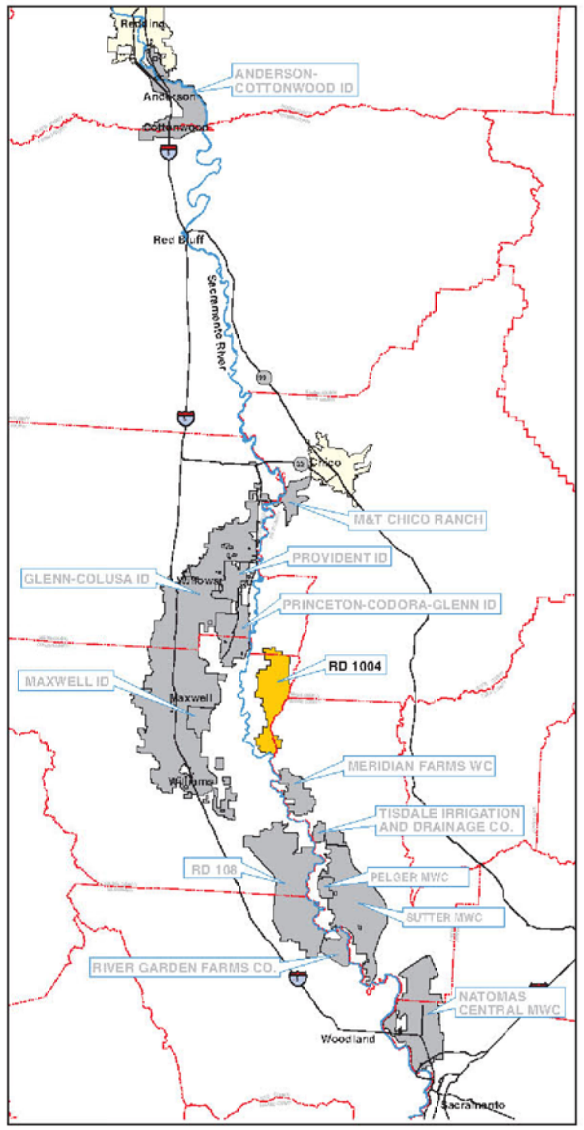
W032005010RDD_116 (8/17/05)

Reclamation District No. 1004

Manager: Kelly Boyd • 134 5th Street • Colusa, CA 95932 • (530) 458-7459

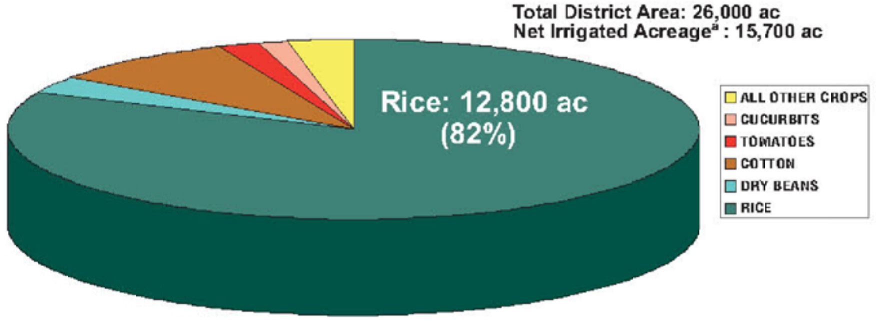
Settlement Contract:	71,400 af
Base Supply:	56,400 af
Project Supply:	15,000 af

Location Map



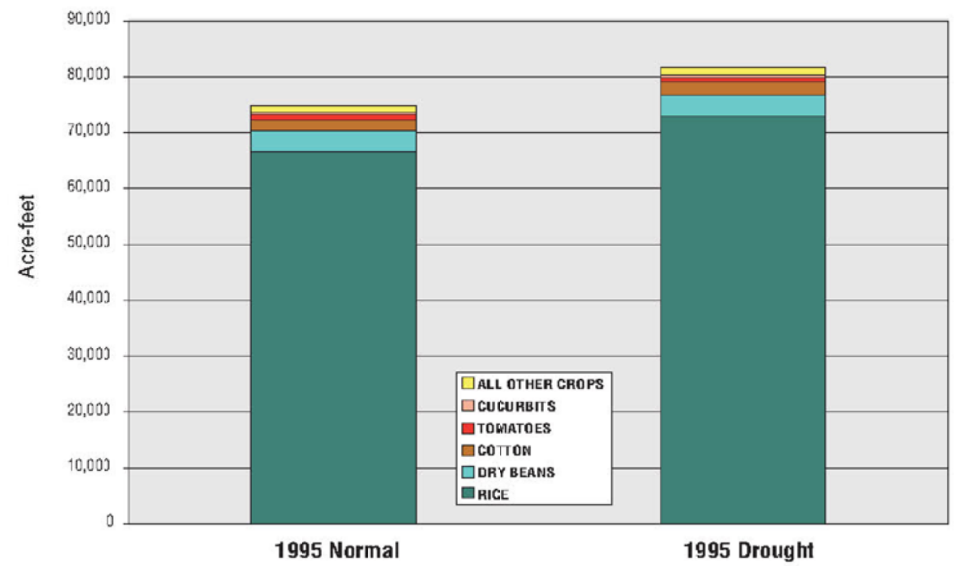
Irrigated Acreage by Crop

Total District Area: 26,000 ac
Net Irrigated Acreage[a] : 15,700 ac

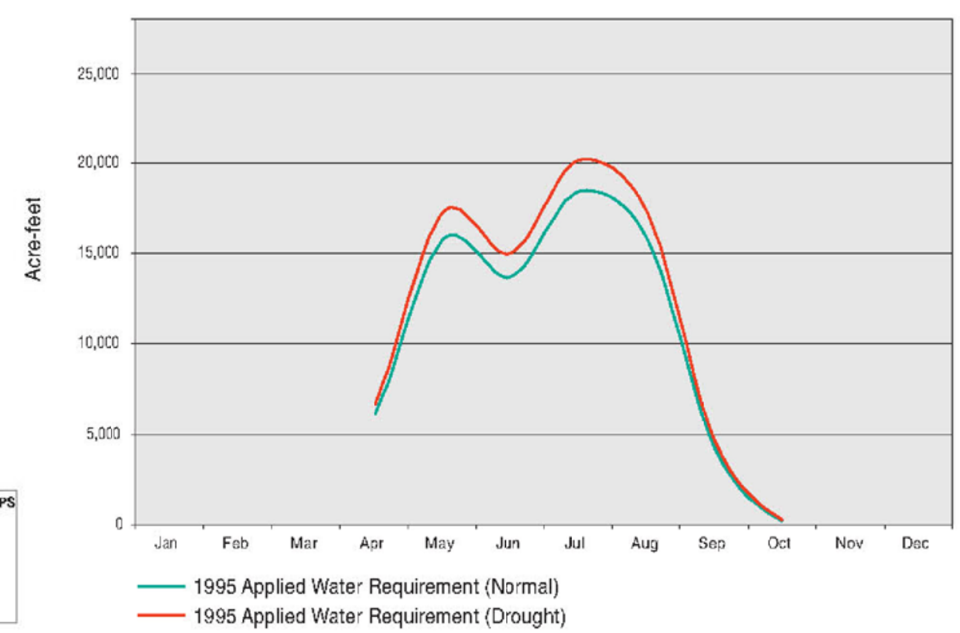


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

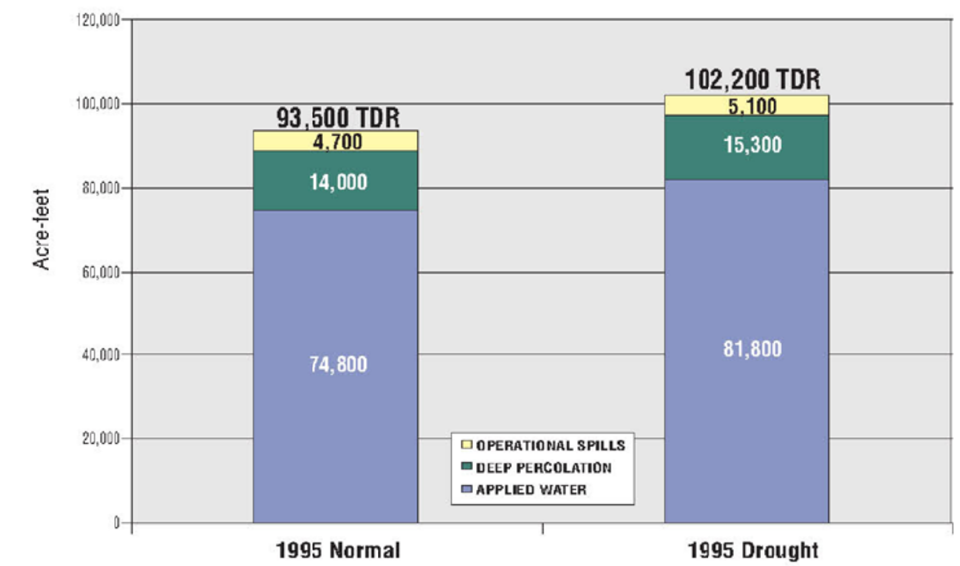


NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)

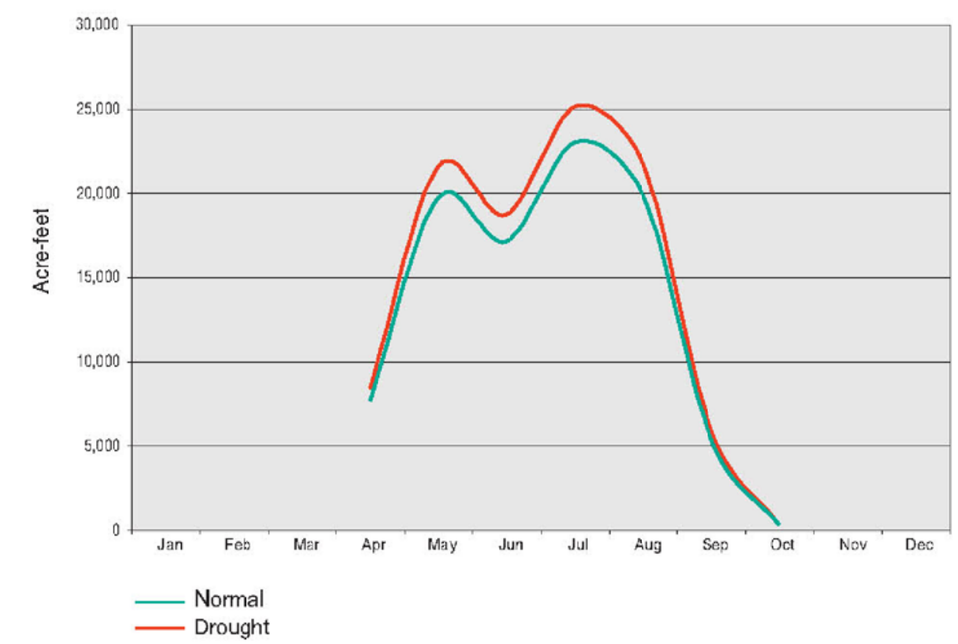


FIGURE 2-33
RECLAMATION DISTRICT NO. 1004
IRRIGATED ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_22 (8/17/05)

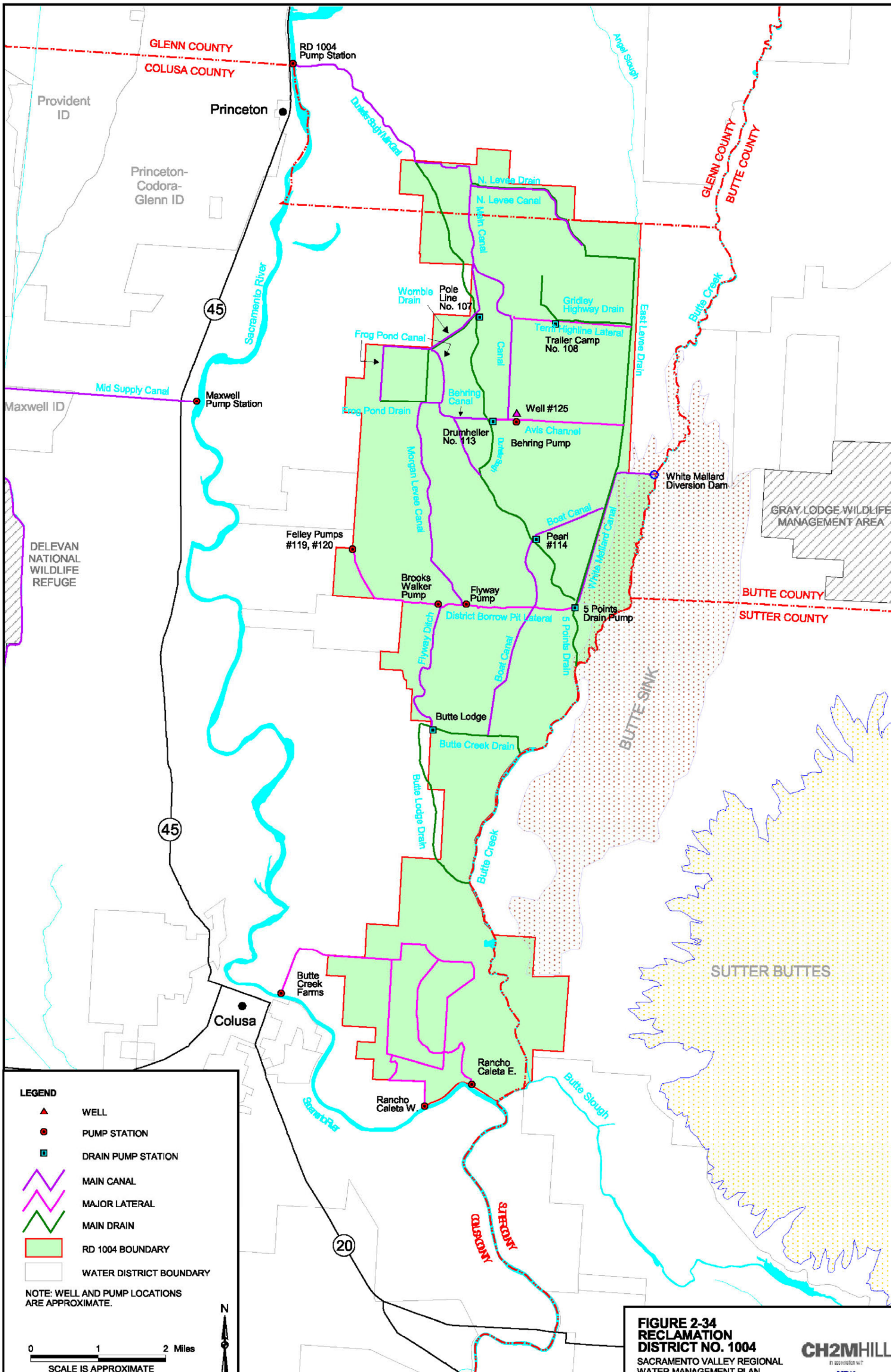


FIGURE 2-34
RECLAMATION DISTRICT NO. 1004
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
MBK

Sutter Sub-basin

2.4 Sutter Sub-basin

The Sutter Sub-basin, shown on Figure 2-35, is south of Butte Sub-basin (described above) and is located on the east side of the Sacramento Valley floor. This sub-basin is bounded on the west and south by the Sacramento River, on the north and northeast by Butte Creek and Butte Slough, and on the east by the Sutter Bypass west levee. The participating SRSCs within this sub-basin include the following:

- MFWC
- SMWC
- PMWC

In addition to the participating SRSCs, there are numerous short-form SRSCs, riparian diverters, groundwater users, and other irrigation companies with water rights on Butte Creek and Butte Slough. There are no SWP contractors in the sub-basin (BWMP TM 3; see Appendix D). Inflows to the sub-basin include diversions from the east bank of the Sacramento River, Butte Slough, and Sutter Bypass West Borrow Channel. Outflows occur through the RD 1500 pumping plant and other pumping plants operated by RD 70 and RD 1660. Surplus water from precipitation and return flows from irrigation are rediverted in portions of the sub-basin for further irrigation of crop lands. In particular, drain flows from “rim landers” (landowners along the Sacramento River not within SMWC’s and PMWC’s boundaries) located along the west edge of the southern portion of the sub-basin are reused by adjacent companies before being pumped out of the sub-basin.

2.4.1 Water Supply within the Sutter Sub-basin

2.4.1.1 Surface Water

Surface water is the primary source for water purveyors in the Sutter Sub-basin. Agricultural needs account for approximately 99 percent of the demand in the sub-basin (over 350 taf/yr, depending on hydrologic and other factors). Surface water is diverted from the following sources: East bank of the Sacramento River, Butte Slough, Butte Creek and Sutter Bypass West Borrow Channel. Use is an important water supply component to the sub-basin. Use is highly variable and not measured regionally; however, estimates suggest that approximately 65 to 75 taf/yr is reused. This accounts for approximately 15 to 20 percent of the total supply (BWMP TM 6; see Appendix D).

2.4.1.2 Water Shortage Allocation Policies

Water availability during critical or shortage years varies by contract type and water right. As dictated by the CVP Settlement contracts, surface water allocations can be reduced up to twenty-five percent of contract total in years determined to be “critical” by Reclamation per the Shasta Index criteria referred to in the contracts. While SRSCs represent 90 percent of the total water supplied to the Sutter Sub-basin, other users such as those with riparian rights and groundwater users are not subject to contract-related reductions. Additional information related to water shortage allocation policies is provided in Section 1, Regional Description (BWMP TM 6; see Appendix D).

2.4.1.3 Groundwater

Although the majority of water supply within the Sutter Sub-basin is from surface water, there is some limited private landowner use of groundwater especially along the west side of the basin near the Sacramento River. The Sutter Sub-basin covers about 170 square miles in the south central portion of the Sacramento Valley and over lies the Sacramento Valley Groundwater Basin. The Sacramento Valley Groundwater Basin is divided into sub-basins of which the Sutter Sub-basin (groundwater basin number 5-21.62) is relevant to this section. This groundwater sub-basin is defined and described in more detail in the Department's Groundwater Bulletin 118 individual basin description. The basin description includes details regarding local hydrogeology, groundwater level trends, and groundwater quality.

Geologically, the Sutter Groundwater Sub-basin is fairly complex. Geologic units in the sub-basin include continental and clastic volcanic deposits of Tertiary to Quaternary age. Quaternary age deposits include alluvial, stream channel and floodplain deposits of Pleistocene to Recent age. The Tertiary deposits include the Tehama, Laguna, Sutter, and Mehrten formations.

The Tehama Formation consists of alluvial material derived from the Coast Ranges. The Mehrten Formation is a sequence of late Miocene to middle Pliocene age reworked volcanic rocks consisting of "black sands," stream gravel, and silt and clay deposits interbedded with intervals of dense tuff breccia. The Pliocene age Laguna Formation generally overlies the Mehrten Formation and consists of interbedded alluvial gravel, sand, and silt.

Alluvium of the Sutter Buttes is exposed in the vicinity of where it has been uplifted by tectonic activity associated with the formation of the buttes, and consists of thin-bedded volcanic sediments transported by rivers from the Sierra Nevada. Floodplain deposits occur between the Sutter Bypass and the Sacramento River, and consist primarily of low permeability silts and clays. Finally, stream channel deposits consist primarily of unconsolidated silt, fine to medium sand, and gravel.

In the southeastern portion of the Sutter Sub-basin, the northwest-southeast trending Sutter Basin Fault exhibits a south side up displacement of about 550 feet (Curtin, 1971). The Sutter Basin Fault extends across SMWC and continues through the Sutter Bypass to its terminus north of Nicolaus. The fault is believed to act as a conduit for the upward movement of connate water from deeper marine sediments. It has been reported that saline intrusion has displaced as much as 2,000 feet of fresh water in the continental deposits, forming a mound of saline water in the east-central portion of the sub-basin. The Upper Cretaceous age marine deposits are the primary source of the rising connate water. The fault cuts the Upper Cretaceous marine sands and allows saline water to rise along the fault into the post-Eocene alluvium. Throughout the Sutter Basin, the base of fresh water is at a depth of less than 500 feet and rises to the surface in the southern part of the basin (Curtin, 1971). There is speculation that there is fresh water at depths nearing 1,000 feet, which is why SMWC is pursuing the installation of a monitoring at this depth.

The Department Bulletin 118 indicates that the majority of groundwater recharge is associated with percolation from streams, rainfall, and irrigation. Groundwater levels seem to remain relatively constant and the water table is relatively shallow at about 10 feet bgs. Information is limited as far as the estimated available groundwater storage within the sub-basin. Sutter County in cooperation with local water purveyors is developing a plan to better account for the local groundwater resource.

Although, groundwater use within the sub-basin is cautioned to be of limited use, it is believed by local and state agencies that there could be potential for cultivating the resource if carefully managed in conjunction with surface water supplies. It is generally believed that the use of the groundwater resource may be more limited in the southern portion of the basin due to areas of Connate water than in the northern portion where such issues are not as prevalent. Water purveyors and Sutter County are working together to investigate the potential and limitations of conjunctive water management and are working with the Department to install the infrastructure necessary to monitor the local groundwater.

2.4.1.4 Reuse and Other Water Supplies

Reuse accounts for a substantial amount of the total water supply used in the Sutter Sub-basin (approximately 70,000 ac-ft/yr). Based on the current high level of reuse, existing informal efforts at regional management practices, and the extensive reuse infrastructure in place, the sub-basin may have potential for effective regional management. Because the Tisdale Bypass splits the surface hydrology of the sub-basin into north and south portions, it is more practical to consider each portion of the sub-basin separately in terms of regional management.

Major entities that use or are involved in its management within the sub-basin include MFWC, Butte Slough Irrigation Company, TIDC, SMWC, and PMWC. Reclamation districts in the area include RD 70, RD 1660, and RD 1500.

Given the geographic extent of RD 1500 and SMWC over the southern portion of the sub-basin, and just three irrigation districts in the northern portion, the institutional challenges of regional management in the Sutter Sub-basin may be less complicated compared to sub-basins with a larger number of local parties (BWMP TM 6; see Appendix D).

No other significant sources of supply are used in the sub-basin.

2.4.2 Water Use within the Sutter Sub-basin

Within the Sutter Sub-basin agricultural needs account for approximately 99 percent of the demand in the sub-basin, over 350 taf/yr, depending on hydrologic and other factors). Managed environmental water supply requirements (i.e., wildlife refuge demands) are not a significant demand on the sub-basin, and M&I demands are relatively insignificant at less than 1 percent (BWMP TM 6; see Appendix D).

2.4.2.1 Agricultural

Agricultural land use within Sutter Sub-basin is primarily rice, tomatoes, and grain. These three crops compose 70 percent of the total crop mix served by the sub-basin (BWMP TM 2; see Appendix D). Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and diversions have therefore been more a function of water-year type and climate than changes in cropping. Table 2-48 presents participating SRSCs irrigated acreage by crop within the Sutter Sub-basin.

TABLE 2-48
Sutter Sub-basin: Irrigated Acreage[a]
Sacramento Valley Regional Water Management Plan

	Irrigated Acres			
Crop Type	**SMWC**	**PMWC**	**MFWC**	**TIDC**
Grain	8,100	100	1,000	500
Rice	17,400	600	3,500	600
Sugar beets	300	-	-	-
Corn	300	700	-	-
Dry Beans	5,500	300	500	300
Safflower	2,200	400	2,400	-
Other Field	1,100	-	100	-
Alfalfa	100	-	-	-
Tomatoes	12,200	600	1,300	200
Cucurbits	4,800	200	200	-
Other Deciduous	200	-	600	200

[a]Source –Acreages from 1995 crop reports.

Future irrigated acreage is expected to remain relatively constant. Crop type may vary with market conditions and corresponding water use will vary with crop type. An example of this has occurred within SMWC which has experienced a general increase in rice acreage with a corresponding reduction in tomato acreage. In 2004, there were more than 29,000 acres of rice and less than 5,000 acres of tomatoes.

2.4.2.2 Urban

M&I requirements within the Sutter Sub-basin account for less than 1 percent of current use. M&I water requirements are currently met by groundwater supply. M&I water use is anticipated to increase only slightly by 2020 (BWMP TM 2; see Appendix D).

2.4.2.3 Environmental

SMWC has worked with the National Marine Fisheries Service, USFWS, Reclamation, and various state agencies to finalize the design and corresponding environmental documentation for the installation of a positive barrier fish screen at its largest Sacramento River diversion, the Tisdale Pumping Plant. Construction is expected to be completed in 2006 or 2007. PMWC was one of the first districts to install an improved screen under the CVPIA Anadromous Fisheries Restoration Program, and completed an operations-related retro-fit. In addition, PMWC continues to maintain an agreement with USFWS to provide winter water for waterfowl. MFWC is currently in the early screen design process.

A number of projects have been completed and continue to be proposed along the Sutter Bypass. The Lower Butte Creek Project included a number of weir enhancements to promote fish passage and exclude salmon from agricultural conveyance facilities through use of barriers. Other related fish passage improvement facilities are also being investigated in the area. Most of these projects are located within the Sutter Bypass adjacent to and east of SMWC.

As in other sub-basins, rice lands also provide habitat for waterfowl during the year, and the conveyance of water supports habitat for a variety terrestrial and water fowl species (BWMP TM 6; see Appendix D).

2.4.2.4 Transfers and Exchanges

Water users in the sub-basin have completed successful transfers and are expected to continue to use transfers as conditions dictate in the future. SRSCs within the sub-basin participate in the Sacramento River Water Contractors Association Project Supply Pool, SMWC has been one of the most active in the past. Among the others participating in the BWMP located within the Sutter Sub-basin, MFWC and PMWC have also contributed water in the past.

The SMWC has historically had some water available for transfer in non-critical months during normal years, a trend that is not likely to continue when the contract are renewed due to a reduction in SMWC's contract quantity. In 2004, SMWC completed a water transfer of 28,000 ac-ft to members of TCCA under the old contract.

Even though transfers occur, in dry years, the sub-basin should be viewed overall as one that would likely be seeking to transfer water within the sub-basin rather than having supplies available for transfer out of the basin, due to current limitations on groundwater use and the reliance of some districts on imported.

2.4.2.5 Other Uses

Beyond M&I and agricultural use, there are no other significant water uses within the Sutter Sub-basin.

2.4.2.6 Sub-basin Water Budget

The Sutter Sub-basin boundary is shown on Figure 2-35. This combined area encompasses four SRSCs participating in the BWMP. These four SRSCs represent approximately 15 percent of the total SRSC entitlements valleywide. In addition to the participating SRSCs, numerous short-term SRSCs and riparian diverters are located in the Sutter sub-basin. No SWP contractors are in the sub-basin, and groundwater pumping is typically very minor, largely only used by private landowners outside of water purveyor boundaries (the "rim landers" along the Sacramento River on the west side of the sub-basin).

A water balance for the Sutter Sub-basin for 2020 average-year conditions is presented on Figure 2-36. Under 2020 average conditions for this sub-basin, the following projections are made:

- The SRSC Base and Project Supplies will make up approximately 90 percent of the total supplies to this region.
- For the negotiated agreement's average diversion of 284 taf/yr, 211 taf/yr (or 75 percent of this total diversion) is Base Supply, and 73 taf/yr (or 25 percent of the total diversion) is Project Supply. The Project Supply diversions occur during the critical months of July, August, and September.

- The SRSC diversions could range from 240 taf/yr to 360 taf/yr, depending on hydrologic conditions and other outstanding issues (the lower bound representing a combination of 75 percent Base Supply deliveries and approximately 45 percent of Project Supply deliveries, computed from average Project Supply deliveries during critically dry years 1977, 1991, 1992, and 1994; the upper bound represents maximum diversion of current Base and Project Supply entitlements).
- Given the limited use of groundwater in the sub-basin, dry-year reductions in diversion are likely made up by increased reuse within the sub-basin, increased reliance on agricultural drainage inflows originating from outside the sub-basin, purchase of water from sources outside the sub-basin, and changes in crop types and acreages.

Figure 2-37 presents a water use balance for Sutter Sub-basin under 2020 critical-year conditions.

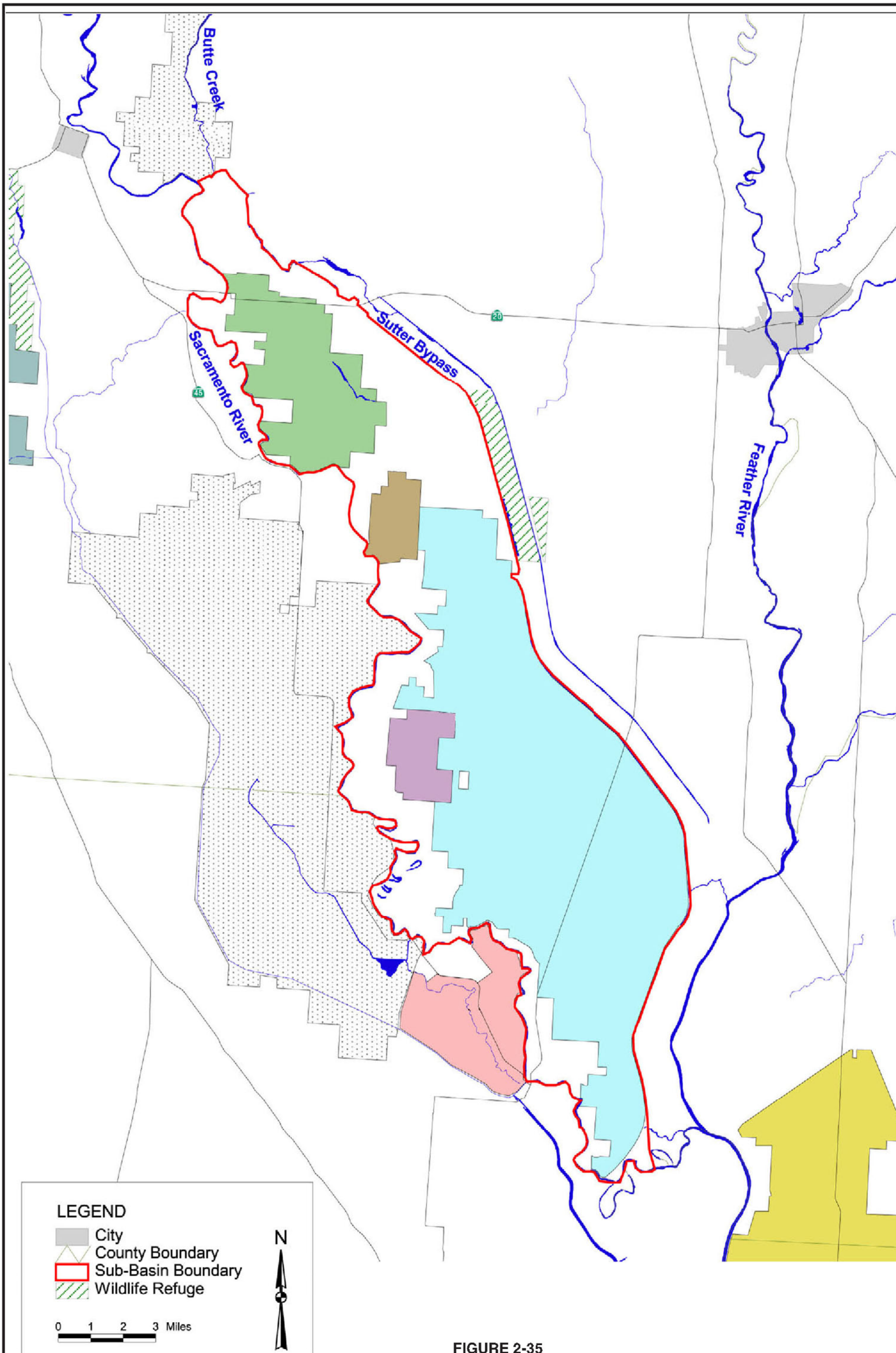
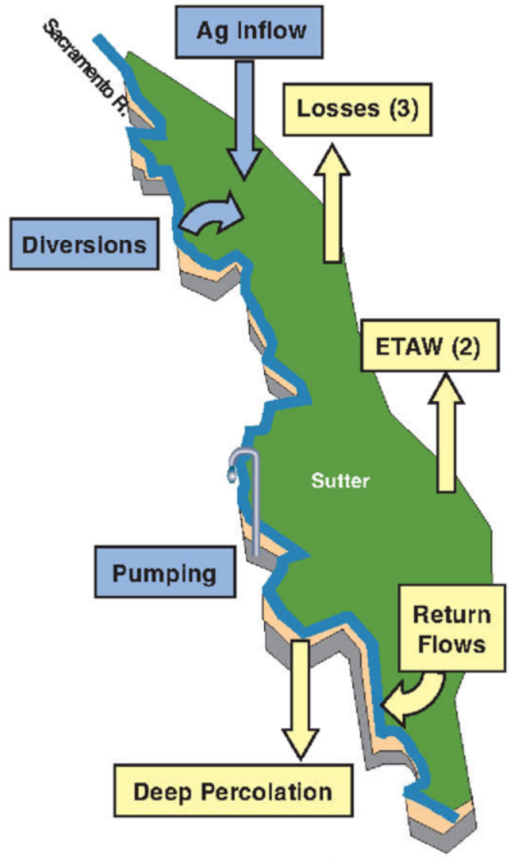


FIGURE 2-35
SUTTER SUB-BASIN
AND PARTICIPATING SACRAMENTO
RIVER SETTLEMENT CONTRACTORS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W032005010RDD_56 (8/17/05)



WATER USE (1)

ETAW (2):	Agricultural	=	180
	M&I	=	5
Fall Flooding		=	12
Wildlife Refuges		=	1
SUBTOTAL		=	198
Other:	Losses (3)	=	16
	Deep Perc	=	31
	Return Flows	=	69
TOTAL		=	314

WATER SUPPLY

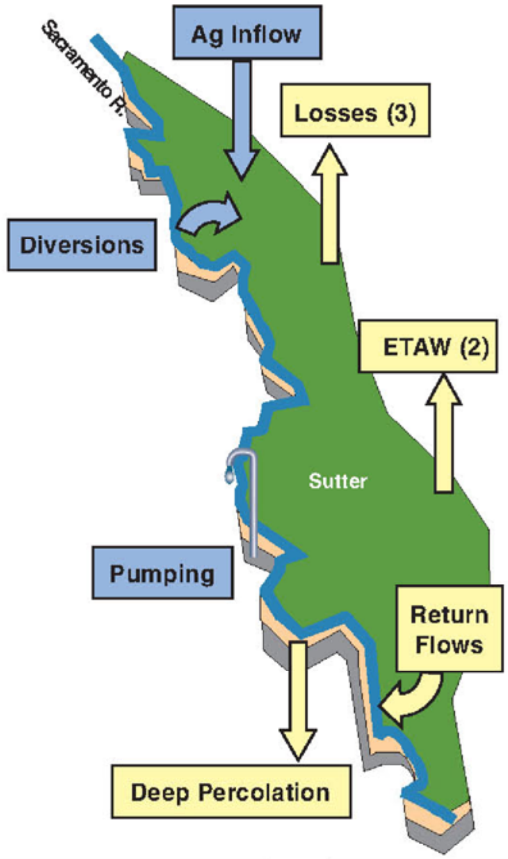
Surface Water Diversions:			
	Riparian	=	9
Settlement Contracts:			
	Base Supply	=	211
	Project Supply	=	73
CVP Water Service Contracts		=	0
Local Surface Water		=	1
SUBTOTAL		=	294
Agricultural Drainage Inflow		=	21
Groundwater Pumping		=	3
TOTAL		=	318

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.

FIGURE 2-36
SUTTER SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

W032005010RDD_118 (8/17/05)



WATER USE (1)			
ETAW (2):	Agricultural	=	205
	M&I	=	7
Fall Flooding		=	12
Wildlife Refuges		=	1
SUBTOTAL		=	225
Other:	Losses (3)	=	11
	Deep Perc	=	22
	Return Flows	=	27
TOTAL		=	285

WATER SUPPLY		
Surface Water Diversions:		
Riparian	=	9
Settlement Contracts:		
Base Supply	=	175
Project Supply	=	66
CVP Water Service Contracts	=	0
Local Surface Water	=	1
SUBTOTAL	=	251
Agricultural Drainage Inflow	=	21
Groundwater Pumping	=	5
TOTAL	=	277

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.

FIGURE 2-37
SUTTER SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_117 (8/17/05)

Meridian Farms Water Company

2.4.3 Meridian Farms Water Company

2.4.3.1 History

MFWC (or the Company) was formed in 1926, under the state corporation laws and codes. The Company entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water MFWC could divert from the Sacramento River. The resulting negotiated agreement recognized MFWC's annual entitlement of a Base supply of 23,000 ac-ft/yr of flows from the Sacramento River and also provided for a 12,000 ac-ft allocation of Project Supply, resulting in a contract entitlement of 35,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Exhibit A to the Settlement Contract for MFWC, and is shown in Table 2-49. The Settlement Contract negotiated in 1964 remains in effect until March 2006. MFWC is working with Reclamation and counsel to finalize environmental documentation for contract renewal.

TABLE 2-49
Schedule of Monthly Water Diversions – MFWC
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	4,400	0	4,400
May	6,200	0	6,200
June	5,900	0	5,900
July	2,000	5,000	7,000
August	1,100	5,000	6,100
September	3,400	2,000	5,400
October	0	0	0
Total	**23,000**	**12,000**	**35,000**

Notes:
Contract No. 14-06-200-838A-R-1
Points of Diversion: 71.L, 74.8L, 80.0L

In addition to the contract water, MFWC has entitlements to pump water from drains within the service boundary for water recycling. The Company operates five wells to supplement surface water supplies. These wells are used in conjunction with the river pumps and recycling pump to meet irrigation needs.

2.4.3.2 Service Area and Distribution System

MFWC is located on the east side of the Sacramento River east of the community of Meridian and directly southwest of the Sutter Buttes. The Company encompasses approximately 9,900 acres and serves 73 landowners. The main pumping facility is located at River Mile 134 on the Sacramento River.

MFWC uses an arranged schedule to deliver irrigation water to Company customers. MFWC also pumps water from the Sacramento River using two other pump stations. The Company's distribution and conveyance system includes approximately 16 miles of main canals and 19 miles of major laterals. Seepage from the canals and laterals is approximately 15 percent. MFWC coordinates drain operations with RD 70, and has no specific agreements in place to handle floodwaters. MFWC has usable groundwater resources within its boundaries and uses groundwater as a normal part of its resource mix, although some nearby wells have low-quality groundwater as a result of connate water upwelling. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These landowners, called "rimlanders," are not within Company boundaries, but contribute runoff that may be reused by Company farmers. Past efforts to coordinate operations with these landowners have failed.

The Company relies heavily on runoff to supplement their own water sources. The Company is able to reuse a large portion of its due to the flat physiography of the area and the use of Long Lake and several pumps that can "step" water to the upper reaches of the Company. MFWC currently uses an average of 15,000 ac-ft/yr of runoff, equivalent to approximately 60 percent of the Company's average Sacramento River diversion.

2.4.3.3 Water Supply

MFWC holds water rights to divert water from the Sacramento River as well as the RD 70 Main Drain, Lateral Drain No. 4, and Long Lake. These diversions differ in the quantity and timing in which they can be used as indicated in Table 2-50.

Surface Water. The MFWC surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0838A (Contract No. 0838A). This contract provides for an agreement between MFWC and the United States on MFWC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract was set to expire March 31, 2004. However, Congress granted a 2-year extension and, therefore, the contract will remain in effect until March 31, 2006. MFWC is working with Reclamation and counsel to finalize environmental documentation for the proposed contract renewal, expected to take effect for another 40 years at the end of the 2-year extension.

TABLE 2-50
MFWC: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A001074B (9/10/18)	000591 (6/10/19)	004676B (8/6/57)	Mar 1 to Nov 1	138
RD 70 Main Drain, Long Lake, and Lateral Drain No. 4	A009737	005935 (3/12/42)	007160 (3/10/65)	Apr 1 to Oct 1	100

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
- A – Appropriative right W
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Contract No. 0838A provides for a maximum total of 35,000 ac-ft/yr, of which 23,000 ac-ft is considered to be Base Supply and 12,000 ac-ft is CVP water (Project Supply), as shown in Table 2-51. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-51
MFWC: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	6,500	12,000
Non-critical Months	16,500	0
Total Annual	**23,000**	**12,000**

The contract specifies the total quantity of water that may be diverted by MFWC each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-38. The monthly Base Supply ranges from a minimum of 1,100 ac-ft in August to a maximum of 6,200 ac-ft in May. Although the contract period is April through October, no Base or Project Supply is allocated for the month of October. However, Base and Project Supply, can be shifted between non-critical months. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 5,000, 5,000, and 2,000 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 6,500 ac-ft, and the total Project Supply is 12,000 ac-ft, as shown in Table 2-51.

Settlement Contract Historical Diversions. MFWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 2-39. During drought conditions in the late 1980s and early 1990s, annual diversions declined. From 1987 to 1997, annual diversions declined every year in comparison with the previous year except for in 1994 (critically dry year) and 1997. The reduction in diversions during this period is primarily related to changes in cropping patterns and irrigated acreage.

Figure 2-38 shows the historical monthly average diversions for the following three periods:

- 1965 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- From 1965 to 1991, MFWC diverted over 80 percent of their contract amounts from May to August.
- From 1965 to 1997, MFWC has diverted its Base Supply and approximately 69 percent of its Project Supply entitlement during critical months (also see Figure 2-39).

- During the critically dry years, MFWC has used nearly all of its entitlement water (Base and Project Supply) during the critical months (also see Figure 2-39). Critical-month water use and annual diversions have remained constant whether the allocation was 100 percent or reduced to 75 percent.
- The distribution of the monthly average diversion for the three periods is similar for most months.

Non-contract Period (November – March). Contract No. 0838A does not limit MFWC from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. MFWC has historically irrigated in months prior to April (pre-irrigation), especially for grain crops, tomatoes, and orchards. Additional water is also diverted from the Sacramento River prior to April 1 to prime the Company's conveyance and distribution facilities, including Long Lake. MFWC does not divert water for rice decomposition because of limited pump capacity to pump back into the Sacramento River at the southern end of the Company.

Other Surface Water Sources. The Sacramento River is the only existing surface water sources for MFWC. No additional surface water sources are available to MFWC.

Groundwater. The MFWC service area overlies the Sutter Sub-basin (Department groundwater basin number 5-21.62) of the Sacramento Valley Groundwater Basin. MFWC lies within the northwestern corner of the Sutter Sub-basin. The area is located on recent alluvial sediments including channel, floodplain, basin, and alluvial fan deposits. Flood-basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities.

Alluvial fan and stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeabilities. These recent sediments are underlain by older deposits of the Laguna, Mehrten, and Tehama Formations (Department, 2003c).

The Laguna Formation is predominantly composed of silt, clay, and sand with local sand and gravel lenses (Page, 1980). The unit is highly variable, ranging from predominantly silt with sandy lenses to sand with clay and silt lenses (Department, 1978). The Laguna Formation was deposited as a westward thickening "wedge" on low-sloping alluvial fans by streams draining the Sierra Nevadas.

The Mehrten Formation includes both hard-gray tuff breccias derived from eruptions in the Sierra Nevadas and fluvatile volcanic silts, sands, and gravels (Department, 1978; Page, 1980). These deposits dip southwestward and range in thickness from 0 to 325 feet. Although tuff breccias and clays yield little water, the volcanic sands of the Mehrten Formation can yield large quantities.

The Tehama Formation dips eastward from the western margin of the sub-basin (near the Sacramento River), forming the base of the continental deposits. In the Sutter Sub-basin, the Tehama Formation consists of alluvial sediments (predominantly sand, silt, and clay) deposited by streams draining the Coast Ranges (Department, 1978).

Groundwater quality in the Sacramento Groundwater Basin is generally good and is sufficient for agricultural, domestic, and M&I uses. The northwest trending Sutter Basin

Fault creates water quality problems within the Sutter Sub-basin (Department, 2003a). The fault acts as a conduit for the upward movement of connate water from deeper marine sediments. It has been reported that saline intrusion has displaced as much as 2,000 feet of fresh water in the continental deposits, forming a mound of saline water in the east-central portion of the sub-basin. The total depth of fresh water aquifer in the MFWC area is approximately 1,400 to 1,600 feet bgs (Berkstresser, 1973). The freshwater is underlain by saline water in older marine units.

Groundwater in the vicinity of MFWC generally flows to the southwest, toward the Sacramento River, at a gradient of approximately 1.5 feet per mile (Department, 2003a). Seasonal fluctuations in groundwater levels are generally less than 10 feet, but can be as much as 35 feet in drought years (Department, 2003b).

In the northern portion of MFWC, groundwater movement is generally to the southeast, toward the Sacramento River, at a gradient of 4.8 feet per mile. In the southern portion of MFWC, the flow changes to a more southerly direction with a gradient of approximately 2.5 feet per mile (Department, 2003a). Limited groundwater data are available for the MFWC area, because the Department monitors only one well in the area. During years of normal precipitation, groundwater levels have been shown to fluctuate from 2 to 4 feet seasonally; during drought years, groundwater levels have been shown to fluctuate as much as 6 feet (Department, 2003b).

Historically, past pumping and drought conditions have not negatively affected the overall long-term groundwater-level trends in the MFWC service area. Groundwater-level data since 1980 from more than 2,300 wells in the Sacramento Valley were reviewed and the historical trends show that groundwater levels in the MFWC area are generally stable over the long term, although short-term fluctuations are observed that correlate to precipitation trends.

One privately owned well and three Company-owned wells are located within the MFWC's boundaries. MFWC operates and maintains the privately owned well, which has a capacity of approximately 9 cfs. The three Company-owned wells have a combined capacity of approximately 16 cfs. Groundwater is used to supplement surface water supplies during peak demand and drought periods (Department, 1978).

Other Water Supplies. MFWC has relied heavily upon recirculation/recycling to supplement its Sacramento River entitlement. In the past, MFWC pursued an aggressive recapture program. Approximately 40 percent of the acreage within the Company is irrigated with recirculated water. MFWC has permits to pump 100 cfs from its own main drain.

MFWC uses eight relift pumps throughout the system in order to efficiently reuse. MFWC has the capability of pumping water from the bottom of the service area back up to the upper portion of Long Lake for reuse. Long Lake is within MFWC's boundaries and functions as a regulatory reservoir; Long Lake is an integral part of the tailwater recovery system. The capacity of Long Lake is not significant from a water supply standpoint but is essential from a regulatory and tailwater reuse standpoint.

MFWC does not actively pump tailwater from sources outside of its boundaries. MFWC receives minor quantities of tailwater, approximately 15,000 ac-ft, from the lands that lie north of it along the Sacramento River.

2.4.3.4 Water Use

District Water Requirements. MFWC operates similarly to larger districts in terms of cropping patterns and cultural practices. In the recent past, rice has typically accounted for less than half of the Company's irrigated acreage on an annual basis; other key crops include tomatoes, safflower, alfalfa, and walnuts (Department, Central District). As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of the crops grown and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. Local rice production is assisted by using recycled and storing water in canals and Long Lake. Recycling and brief storage allow for warming of the water, which benefits rice production. Also, several fields have recently been certified as organic rice farms. Organically grown rice is a higher-value crop that requires additional water to offset herbicides commonly used for weed control. Irrigation water requirements are met through the contract surface water supplies, recycling, and groundwater.

As noted above, the Company has been experiencing an increase in rice production in the service area, and a reduction in tomato production due to changing market conditions. This increase in rice production has placed additional demands on the water service system, which has limited capacity in the middle of the Company due to a relatively flat slope and the need to maintain full canals to recirculate. Currently, tomato crops are trending toward the use of greenhouse-grown seedlings. Use of seedlings allows for farmers to plant as soon as weather forecasts are favorable, which may be as early as March, earlier than typical start dates for seed-grown tomatoes. Seedlings use less water because the soil does not need to be kept as moist as typically required for seed emergence.

Table 2-52 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 2-52
MFWC Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995	2020
Rice	3,500 (± 44%)	3,500 (± 44%)
Safflower	2,400 (± 11%)	2,400 (± 11%)
Tomatoes	1,300 (±32%)	1,300 (± 32%)
Grain	1,000 (± 13%)	1,000 (± 13%)
Other Deciduous	600 (± 8%)	600 (± 8%)
Other Crops	900 (± 5%)	900 (± 5%)
Total Irrigated Acreage	**9,700 (± 5%)**	**9,700 (± 5%)**

Figure 2-40 summarizes irrigated acreage by crop, on-field water requirements, and total Company requirements.

The Company's Board of Directors issued a policy directive against the use of winter water for rice straw decomposition. The policy directive was issued in response to concerns regarding flood pumping capacity – if a flood were to occur during decomposition, existing drain pumps would not be able to remove floodwater and decomposition water. Removal of rice straw has not been a large issue in the service area because of the regular practice of crop rotation. Rice straw is usually disked under after the growing season, before the field is planted with a different crop the following year.

Future irrigation season cropping patterns and associated water requirements are anticipated to continue the current trend toward increased rice production and a reduction in tomato production, with rotations of beans, wheat, and safflower.

Urban. MFWC is near the agricultural and residential Town of Meridian, but does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to be negligible to 1995 estimated levels (Department, Central District). Future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the Company does not preclude the possibility of serving such requirements in the future.

Environmental. Long Lake is a substantial, privately owned environmental resource within the Company boundary, supporting migratory waterfowl, including pelicans. Additionally, the lake has catfish, crappie, bass, frogs, and crawdads, supporting a modest local sport fishery. The flooding of rice fields in the spring and summer provides wetlands, habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. The Company does not serve any private duck clubs, nor are there any formally designated wetlands habitat areas.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the District. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter County.

Soil profile characteristics in the Sutter County area of MFWC are as follows (Appendix C):

- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.
- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.

Transfers and Exchanges. MFWC is one of 34 SRSCs that currently participate in the Pool program. Since 1974 the Pool has been the forum to move available Project Supply supplies within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool rather than for diversion.

Other Uses. No other significant water uses other than those discussed above occur within MFWC.

2.4.3.5 District Facilities

Diversion Facilities. MFWC's main supply facility is River Pump No. 1 located at River Mile 134 on the Sacramento River. MFWC also pumps water from the Sacramento River using River Pump No. 3 at River Mile 128.6 and River Pump No. 4 at River Mile 126. Table 2-53 summarizes MFWC's surface water supply facilities. See Figure 2-41 for a map of MFWC's major conveyance facilities. MFWC currently operates four groundwater wells, shown on Figure 2-41, with a combined capacity of 25 cfs.

TABLE 2-53
MFWC Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
River Pump No. 1	Sacramento River	Pump	100-125	17,000
River Pump No. 3	Sacramento River	Pump	40	3,500
River Pump No. 4	Sacramento River	Pump	30-35	5,500

Conveyance System. MFWC has approximately 16 miles of main canal and 19 miles of major laterals. The main canals are the primary conveyance facilities for the Company. Table 2-54 summarizes MFWC's main canal and irrigation lateral features. MFWC has four relift pumps that are used to convey water from canals with lower elevations to canals with higher elevations.

TABLE 2-54
MFWC Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Railroad Main Lateral	River Pump No. 1	40	Partial (2.5 miles)	Eastern District Boundary, 1/4 mile South of Highway 20	15
No. 1 Main Lateral	River Pump No. 1	100	Yes	Drain Pump No. 9	15
No. 3 Main Lateral	River Pump No. 3	30	Partial (0.5 mile)	Hageman Road Drain	15
No. 4 Main Lateral	River Pump No. 4	50	Partial (0.25 mile)	Mills Road Drain	15
No. 5 Main Lateral	Drain Pump No. 5	50	No	Wood Road Southern Drain	15
No. 7 Main Lateral	Drain Pump No. 7	50	No	Wood Road Southern Drain	15

Storage Facilities. MFWC currently has no storage facilities.

Spill Recovery. MFWC has a network of drainage lines for conveying irrigation return flows and regional surface runoff. The flows are generally from north to south within the Company. Drainage water is pumped via several relift pumps back into supply laterals. Forty percent of the water users within the Company are supplied with water from the drains. For MFWC, the drains act as a key part of their distribution facilities. MFWC pumps approximately 15,000 ac-ft of water from the drains annually. The RD 70 Drain Pump Station shown on Figure 2-41 is not used for irrigation. This pump discharges regional drainage into the Sacramento River when a gravity discharge is prevented by a high river stage. Tables 2-55 and 2-56 summarize the MFWC drainage facilities.

TABLE 2-55
MFWC Drain Pump Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping (ac-ft/yr)
Drain Pump No. 5	Wood Road-Southern Drain	No. 5 Main Lateral	23	2,700
Drain Pump No. 7	Mills Road Drain	No. 7 Main Lateral	34	3,900
Drain Pump No. 9	Wood Road-Northern Drain	Long Lake Lateral	23	2,700
Drain Pump No. 10	Summy Road Drain	No. 1 Main Lateral	27	3,000
Drexler Drain Pump No. 11	Wood Road-Northern Drain	Drexler Road Lateral	23	2,700

TABLE 2-56
MFWC Drainage Laterals
Sacramento Valley Regional Water Management Plan

Name	End Spill	Downstream Diverters/Recapture[a]
Wood Road-Northern Drain	Long Lake	No
Summy Road Drain	Hageman Road Drain	No
Hageman Road Drain	Mills Road Drain	No
Mills Road Drain	Wood Road-Southern Drain	No
Wood Road-Southern Drain	Sacramento River	No
Girdner Road Drain	Wood Road-Southern Drain	No
Gormire Road Drain	Girdner Road Drain	No

[a]Drainage that leaves the Company is discharged to Sacramento River via the RD 70 Pump Station.

2.4.3.6 District Operating Rules and Regulations

Delivery of water must be ordered 48 hours in advance of need. Wasteful practices are not allowed and no water is delivered until all financial obligations are met. MFWC is a mutual water company and governed by a board of directors consisting of seven members. The O&M of the canals, laterals, and irrigation works of the Company are under the exclusive management and control of the manager which works at the pleasure of the board of directors as set forth in the Company's rules and regulations.

Water rotation, apportionment, and shortage allocation:

> Rule 4 of MFWC rules and regulations: *All demands for water must be made in writing on blanks furnished by the Company, and must be delivered to the ditchtender or Manager at least 48 hours before water is needed.*

> Rule 10 of MFWC rules and regulations: *When, for any reason, the full supply of water required cannot be delivered to the users or stockholders, such supply as can be delivered shall be prorated until such time as delivery of full supply can be resumed.*

Use of drainage water:

> Rule 13 of MFWC rules and regulations: *Before water will be turned from the canals or laterals of the Company for service to consumers or stockholders, seep ditches and farm service ditches must be constructed along the toe of slopes of main service laterals of the Company and across and along the boundaries of the fields of the water users to be irrigated in such way and manner as will control the water upon the lands of the user and provide an outlet to the District drainage canals provided for that purpose.*

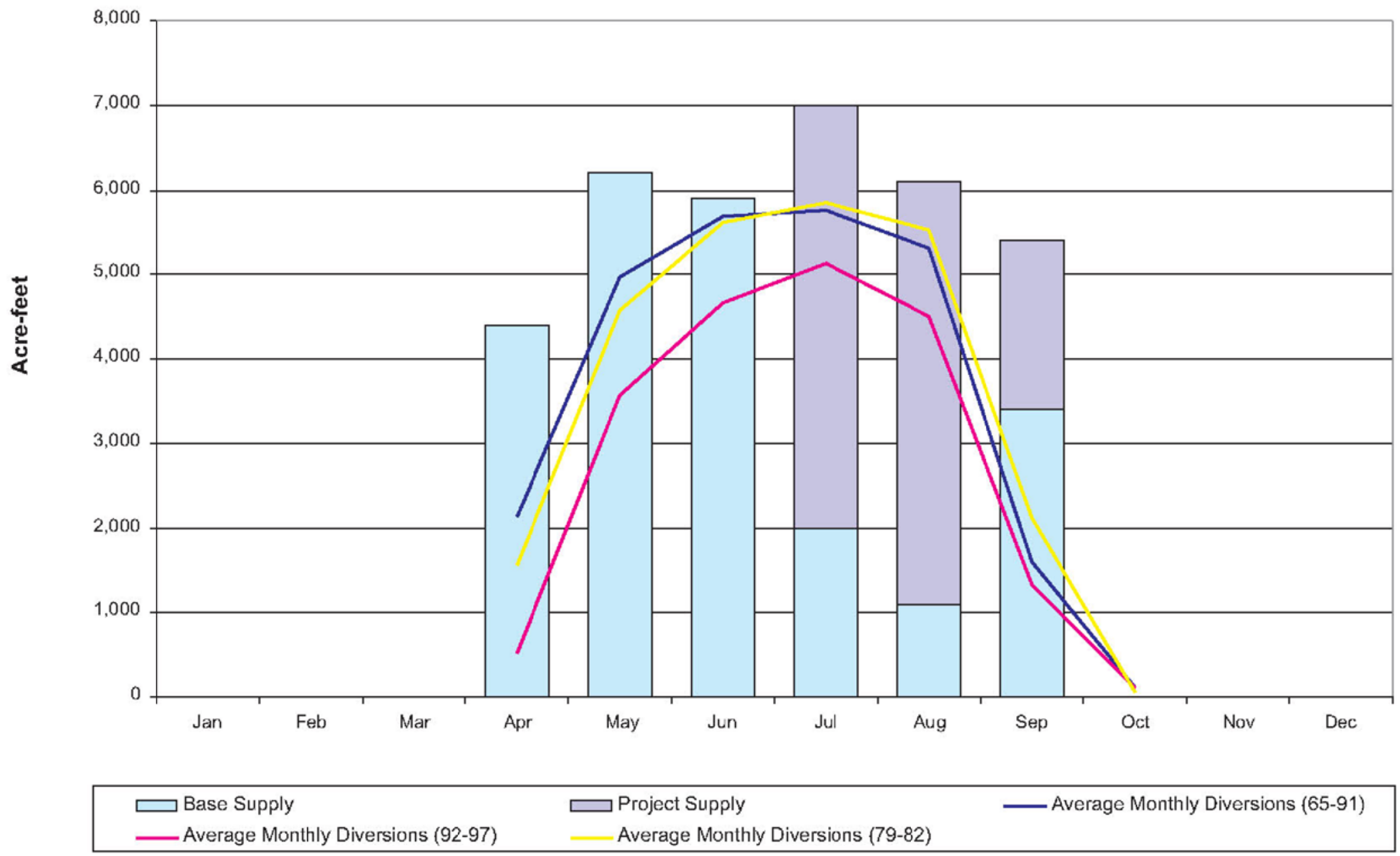
Policies for wasteful use of water:

> Rule 9 of MFWC rules and regulations: *Any user of water, consumer or stockholder wasting water on roads or vacant land or land previously irrigated, either willfully, carelessly, or on account of defective farm service ditches, or who shall flood certain portions of the land to an unreasonable depth or amount in order to irrigate other portions, or whose land has been improperly checked, furrowed or leveled for the economical use of water, or who is causing damage to adjoining lands, through lack of farm service, drains or drainage ditches, will be refused the use of water until such conditions are remedied. The Company reserves the right to refuse delivery of water to any lands when it appears that its proposed use, or method of use will require such excessive quantities of water, and will cause such damage to adjoining or other lands of the stockholders as will constitute waste. All lands to be flood irrigated shall first be prepared for use of water by the construction of levees or borders following the natural contours of the ground, checks to be spaced at intervals not to exceed three tenth of one foot between borders or levees. Borders and levees shall be of sufficient height and width so as to prevent water from wasting outside of the boundaries of the field to be irrigated.*

2.4.3.7 Water Measurement, Pricing, and Billing

MFWC measures water at its three river diversion pump stations using flowmeters. Canal and lateral flow rates are measured using weir or gate head/flow curves. Wells are metered. Drain pump flows are estimated based on power consumption and pump efficiency data. Minor increases in water savings are possible through a program of improved water measurement that includes installation of intermediate measurement points along the main canals, improved lateral headgate measurement, and drain pump metering. These new measurement facilitates would be integrated with the operations automation program described above to increase overall distribution system efficiency.

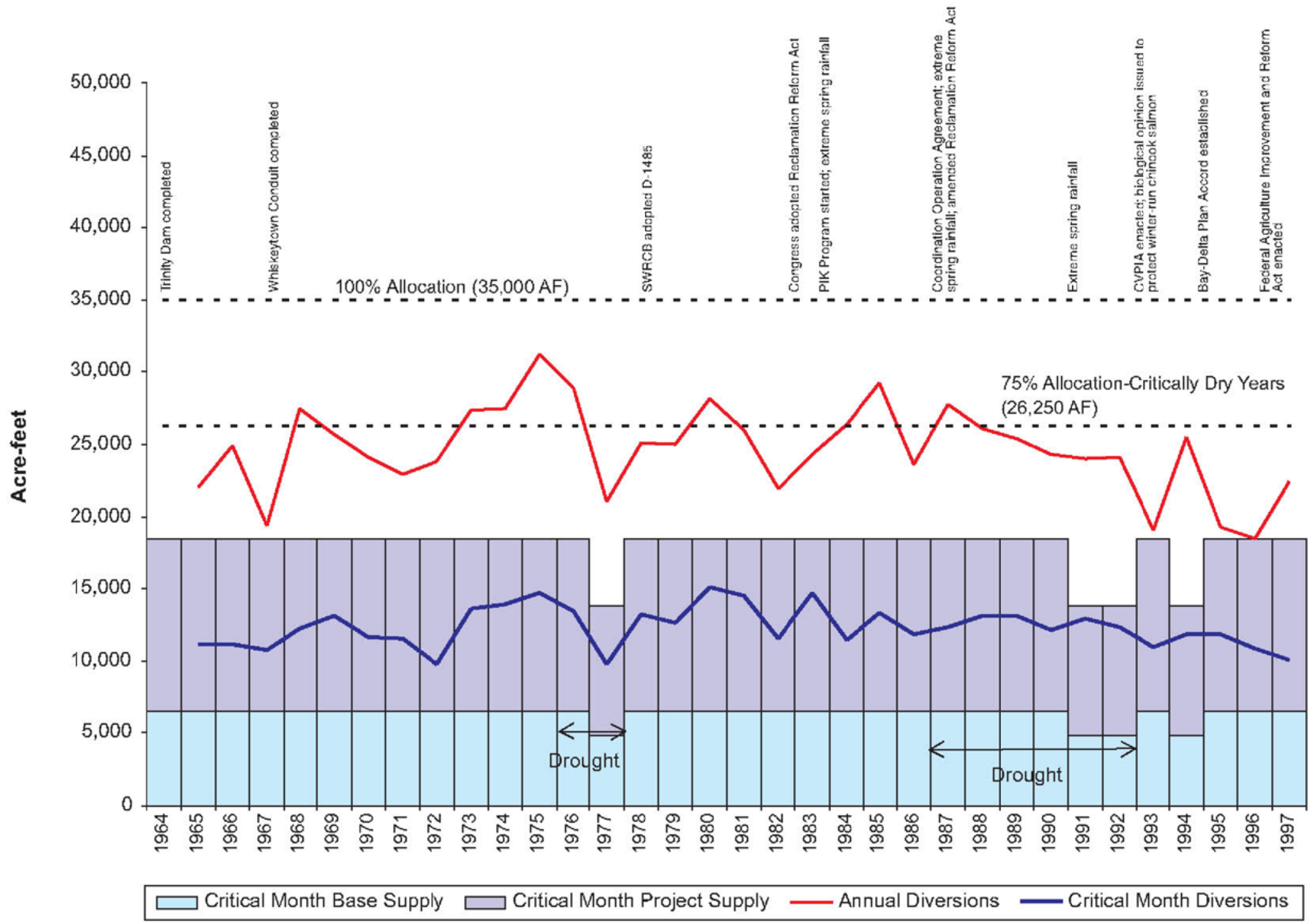
MFWC does not meter individual customer turnouts. Flow rates at field turnouts are measured using head/orifice relationships. MFWC does not measure and record the total quantity of water delivered to each turnout. MFWC's on-farm efficiency is approximately 65 percent. Field metering, in combination with a modified delivery arrangement, an appropriate incentive pricing structure, and on-field improvements such as land leveling may increase the average on-farm efficiency, with minor savings in water use. The effective implementation of such a program would depend on optimal combination of the above components, in addition to basic economic considerations such as the return on investment to the Company and landowner. The installation, maintenance, and reading of the 150 meters would represent a major upfront capital cost to the Company as well as an ongoing labor and capital expense.



Notes:
1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (65-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-38
MERIDIAN FARMS WATER COMPANY MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-39
MERIDIAN FARMS WATER COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

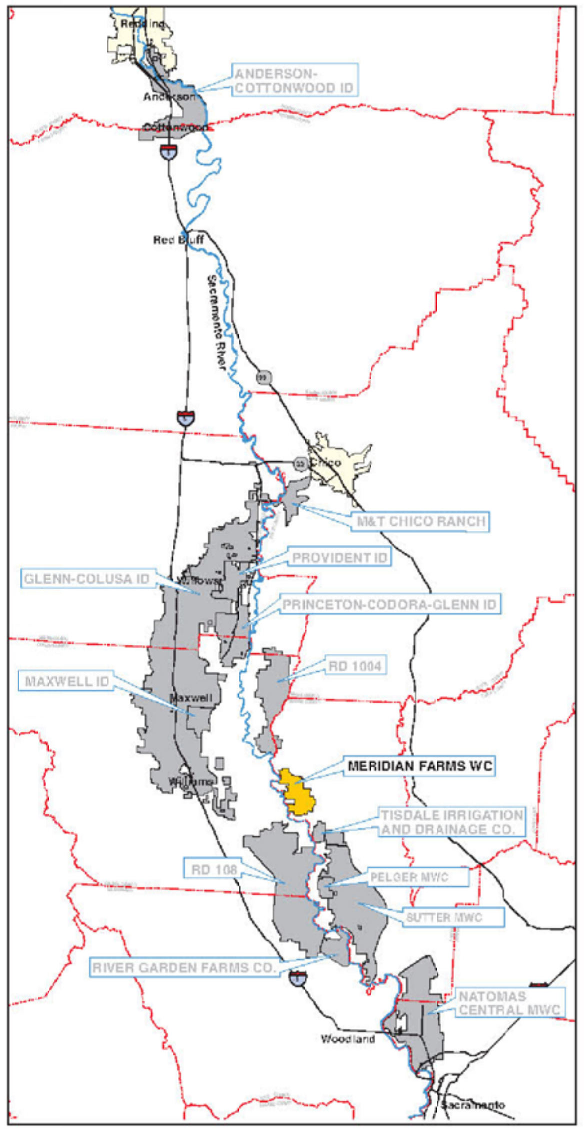
W032005010RDD_121 (8/17/05)

Meridian Farms Water Company

Manager: Harold Webster • P.O. Box 308 • 1138 4th Street • Meridian, CA 95957 • (530) 696-2456

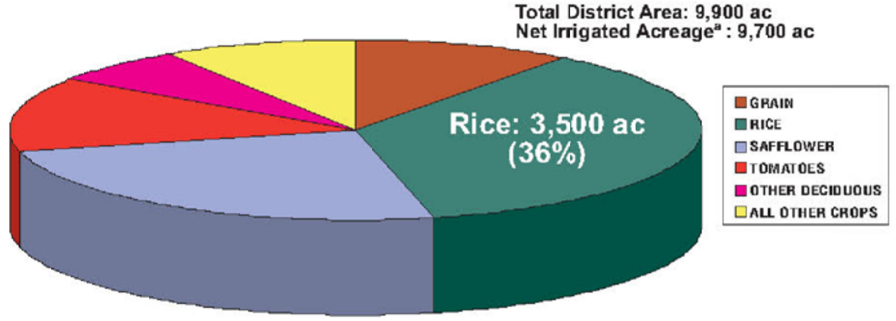
Settlement Contract:	35,000 af
Base Supply:	23,000 af
Project Supply:	12,000 af

Location Map



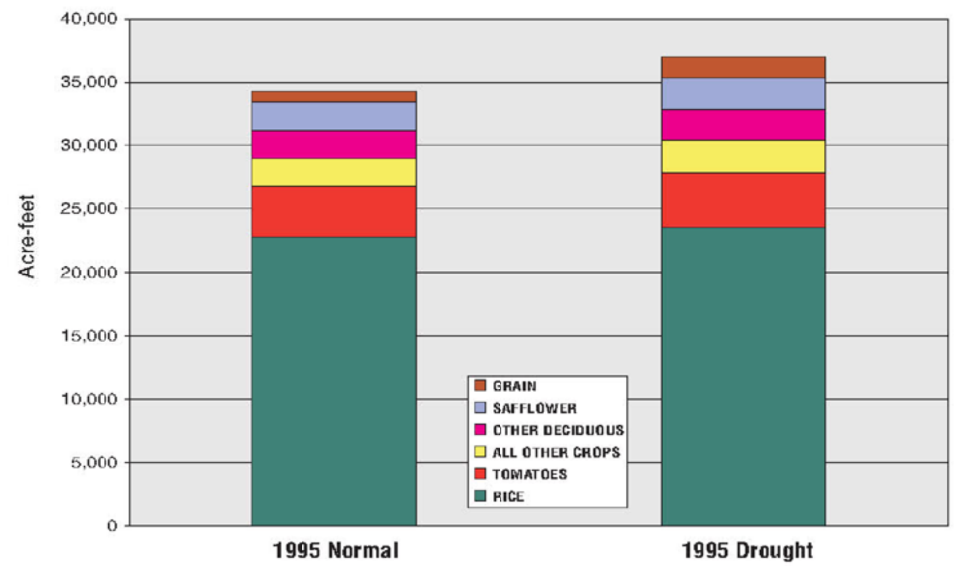
Irrigated Acreage by Crop

Total District Area: 9,900 ac
Net Irrigated Acreage[a] : 9,700 ac

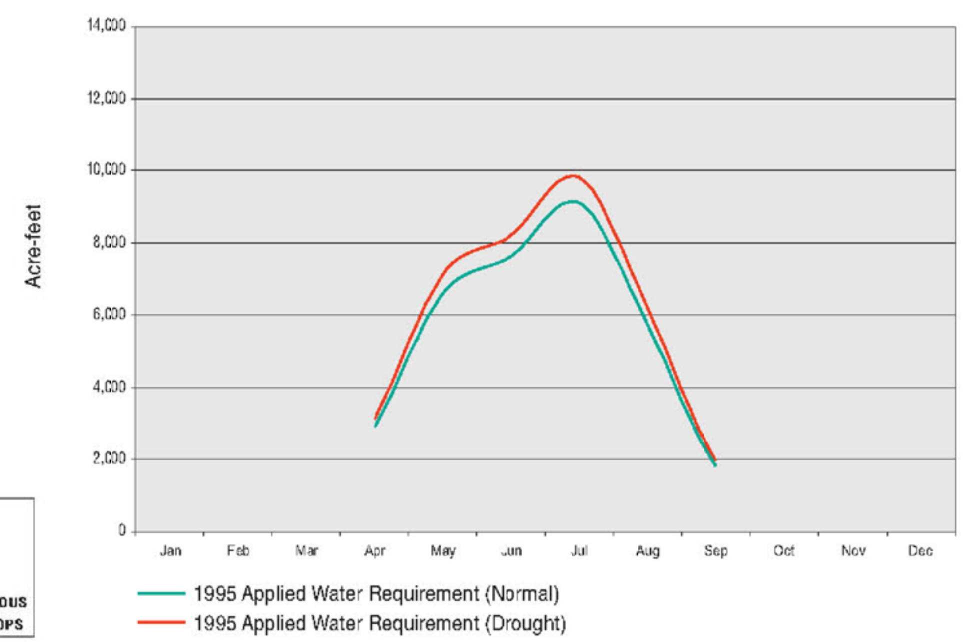


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



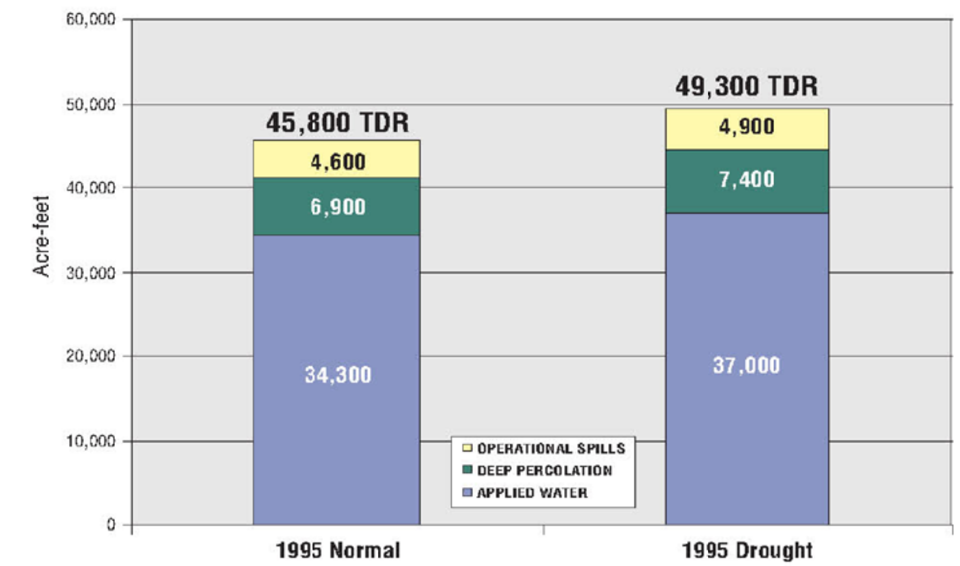
Monthly Applied On-field Water Requirement[b]
(Normal and Drought)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 10% Operational Spills and 15% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 15% Deep Percolation Estimates)

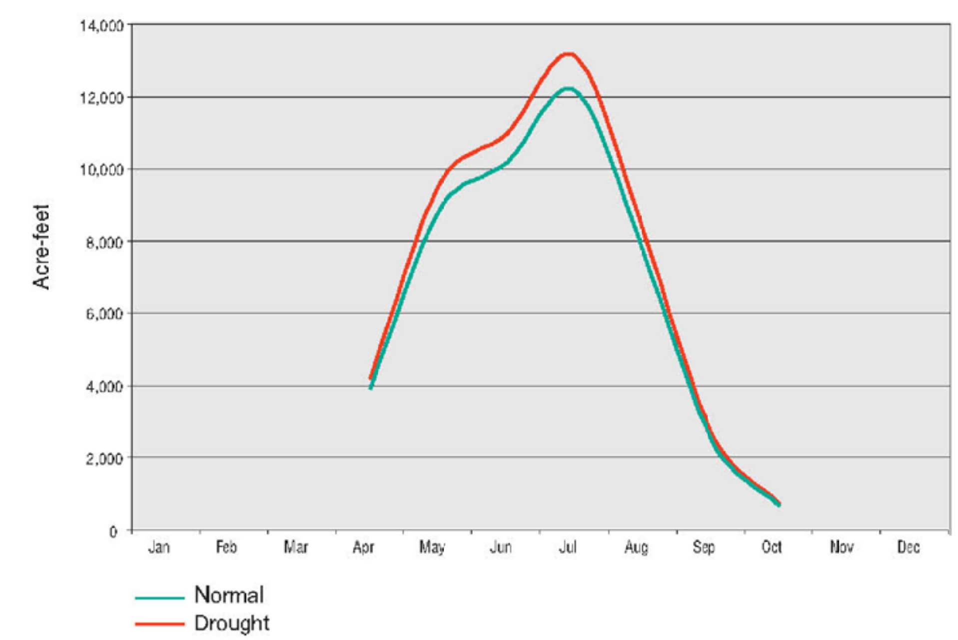


FIGURE 2-40
MERIDIAN FARMS
WATER COMPANY IRRIGATED ACREAGE
SACRAMENTO VALLEY REGION WATER MANAGEMENT PLAN

CH2MHILL
MBK

W032005010RDD_122 (8/17/05)

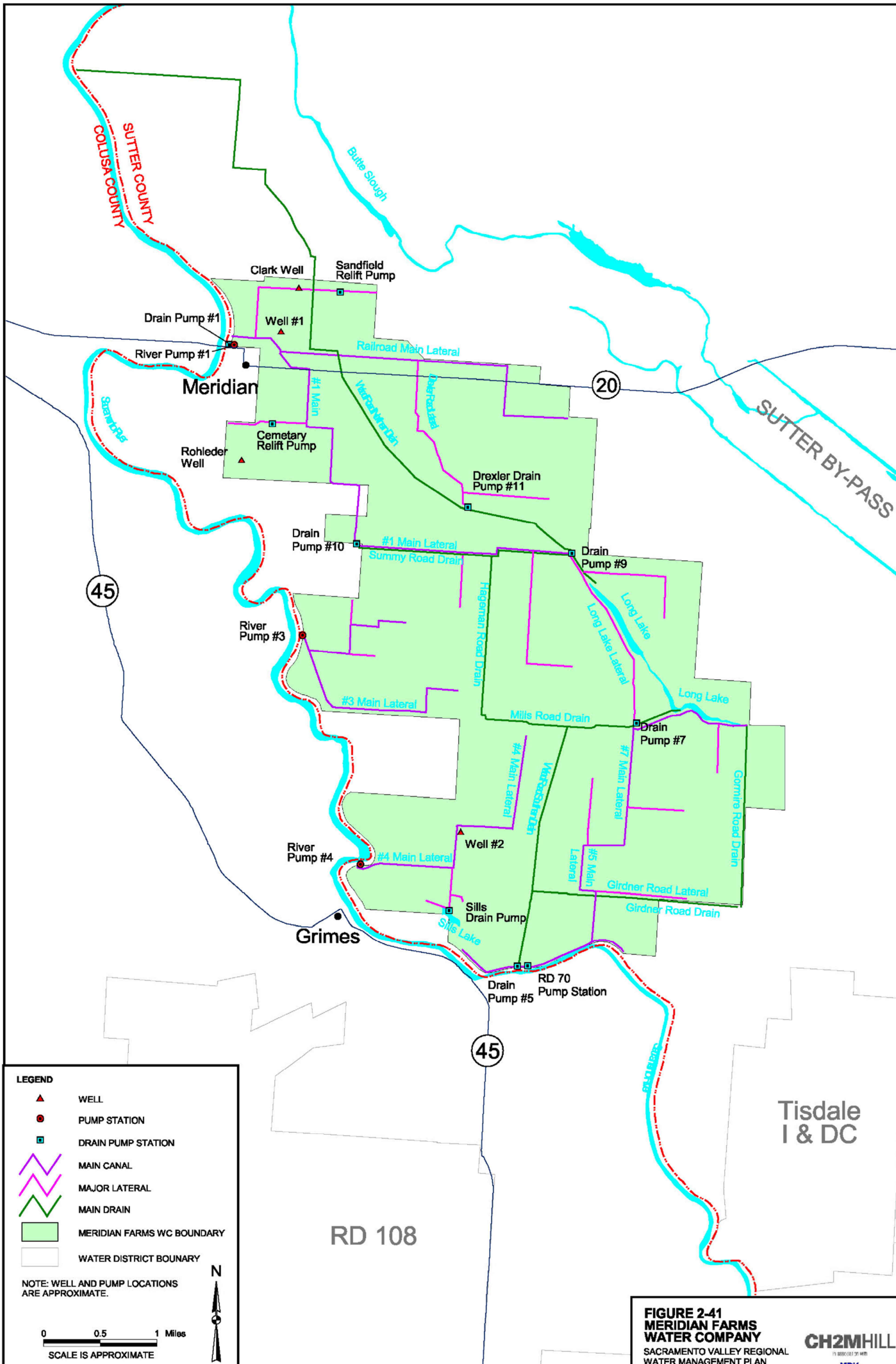


FIGURE 2-41
MERIDIAN FARMS
WATER COMPANY
SACRAMENTO VALLEY REGIONAL
WATER MANAGEMENT PLAN

CH2M HILL RDD \\LOKI\projects\rddgis\SacBWMP\gisdata\newhydro3_0605.apr meridian.pdf 08/18/2005

Sutter Mutual Water Company

2.4.4 Sutter Mutual Water Company

2.4.4.1 History

SMWC (or the Company) was formed February 5, 1919, under the state corporation laws and codes. The Company entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water SMWC could divert from the Sacramento River. The resulting negotiated agreement recognized SMWC's annual entitlement of a Base Supply of 169,500 ac-ft/yr of flows from the Sacramento River and also provided for a 56,500 ac-ft allocation of Project Supply, resulting in a total contract entitlement of 226,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Exhibit A to the Settlement Contract for SMWC is included in Table 2-57. The Settlement Contract negotiated in 1964 remains in effect until March 2006. SMWC has completed negotiations with Reclamation for a contract renewal and expects to execute that contract in 2005. In addition to the contract water, SMWC has entitlements to pump water during the non-irrigation season for wetlands and rice straw decomposition given appropriative rights during the winter months of approximately 250 cfs.

TABLE 2-57
Schedule of Monthly Water Diversions – SMWC
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	20,000	0	20,000
May	42,500	0	42,500
June	48,000	0	42,500
July	28,500	25,000	53,500
August	20,000	24,000	44,000
September	5,000	7,500	12,500
October	5,500	0	5,500
Total	**169,500**	**56,500**	**226,000**

Notes:

Contract No. 14-06-200-856A-R-1

Points of Diversion: 32.4L, 40.6L, 63.75L

2.4.4.2 Service Area and Distribution System

SMWC is located approximately 45 miles northwest of Sacramento and is bordered by three levee systems. The Company encompasses approximately 50,000 acres and serves 150 landowners. Company boundaries encompass the Town of Robbins. The Company operates three pumping plants: Tisdale Pumping Plant (960-cfs capacity), State Ranch Bend Pumping Plant (125-cfs), and Portuguese Bend Pumping Plant (100-cfs). SMWC also has eight booster pump sites (they typically operate four to five in any given year) and one internal recirculation system with a total combined capacity of 290 cfs per day. These facilities are used for reuse and are located in the central and northeast portions of the Company.

SMWC is interlaced with drainage ditches (which are operated and maintained by RD 1500) that carry water toward the Main Drain and eventually out of the service area at the southern end of the Company at the Karenak Pump Station. Drainage ditches in the eastern portion of the Company intercept naturally occurring saline groundwater, called “connate water.” This saline groundwater tends to be most prevalent toward the eastern portion of the Company associated with artesian pressure through the Sutter Basin Fault. Salinity concentrations tend to increase with depth (NRCS, 1996). Irrigation practices using Sacramento River water and drainage systems have allowed the Company and other districts/landowners to maintain suitable crop yields and keep the connate water below the crop root zones.

The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These landowners, called “rimlanders,” are not within Company boundaries, but contribute that may be reused by Company farmers. Company operations are coordinated with RD 1500 and PMWC. RD 1500 manages drainage in the service area, and SMWC delivers water to the majority of water users in the area.

SMWC uses an arranged schedule to deliver irrigation water to Company customers. The Company’s distribution and conveyance system includes approximately 56 miles of irrigation water delivery canals and 144 miles of laterals. Delivery system leakage associated with the operation of the Company is approximately 15 percent of the diversion during the spring, summer, and early fall irrigation season. Approximately 38 wells have been drilled within the Company boundaries, but most have been abandoned due to high salinity levels and lack of sustained yield as discussed above. Reuse of water is driven in part by year type; however, the high water table and its saline nature limit the amount of water that can be successfully reused without impacting crop yields and salt accumulation in the soil profile. Winter operations call for most drains to be opened around Labor Day of each year to allow for the dewatering of the basin in preparation for the passage of winter flows.

2.4.4.3 Water Supply

SMWC is located approximately 45 miles northwest of Sacramento and is bordered by three levee systems totaling 55 miles. Sutter Bypass is located along the eastern and southern edges of the Company, and the Sacramento River is located to the west of the Company. SMWC encompasses approximately 50,000 acres and serves 150 landowners. The Sacramento River serves as the principal water source for the Company. The Company has water rights to the Sacramento River as shown in Table 2-58. The following discussion describes this source and its historical use.

Surface Water. SMWC, formed in 1919, holds a water right to divert water from the natural flow of the Sacramento River. The SMWC surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0815A (Contract No. 0815A). This contract provides for an agreement between SMWC and the United States on SMWC’s diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract was set to expire March 31, 2004. However, Congress granted a 2-year extension and therefore the contract will remain in effect until March 31, 2006. SMWC is working with Reclamation and counsel to finalize environmental documentation for the proposed contract renewal, expected to take effect for another 40 years at the end of the 2-year extension.

TABLE 2-58
SMWC: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A000581 (2/1/17)	000287 (5/8/17)	002817 (3/6/46)	Mar 1 to Oct 31	45
Sacramento River	A000878 (1/3/18)	000419 (4/4/18)	002818 (3/6/46)	Mar 1 Oct 31	116.72
Sacramento River	A000879 (1/3/18)	000420 (4/4/18)	002819 (3/6/46)	Mar 1 to Oct 31	25.25
Sacramento River	A000880A (1/3/18)	000421 (4/4/18)	002820A (3/6/46)	Mar 1 to Oct 31	404.82
Sacramento River	A001160 (1/24/19)	000569 (5/9/19)	002822 (3/6/46)	Mar 1 to Oct 31	40.5
Sacramento River	A001758 (4/9/20)	001103 (7/26/22)	000552 (11/5/26)	Apr 1 to Oct 31	1.5
Sacramento River	A001763 (4/9/20)	001108 (7/31/22)	001110 (9/15/31)	Apr 15 to Sep 15	3
Sacramento River	A001769 (4/9/20)	001117 (8/9/22)	000547 (6/22/26)	Apr 1 to Oct 31	7.67
Sacramento River	A001772 (4/9/20)	001120 (8/10/22)	000657 (1/31/28)	May 1 to Oct 1	0.31
Sacramento River	A003195 (12/27/22)	002169 (7/25/25)	000882 (11/30/29)	Apr 1 to Oct 31	1.38
Sacramento River	A007886 (3/29/34)	004354 (7/3/34)	002240 (6/19/41)	Mar 1 to Oct 1	7.32
Sacramento River	A009760 (11/3/39)	005510 (4/1/40)	002821 (3/6/46)	Jan 1 to Dec 31	250
Sacramento River	A010658 (6/16/43)	006189 (10/14/43)	002823 (3/6/46)	Mar 1 to Oct 31	7.52
Sacramento River, West Borrow Pit Sutter Bypass	A011953 (6/23/47)	007194 (10/25/48)	004562 (2/25/57)	Apr 1 to Oct 1	7.5
Sacramento River	A012470A (4/13/48)	0072687A (12/17/49)	008547A (8/16/95)	Apr 1 to Nov 1	35.9
Sacramento River	A016677 (10/20/55)	013867 (2/15/63)	008220 (9/7/67)	Primary: Apr 1 to Jun 15 Secondary: Sep 1 to Oct 31	7.5

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
- A – Appropriative right
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

The renewed Contract No. 0815A provides for a maximum total of 226,000 ac-ft/yr, of which 169,500 ac-ft is considered to be Base Supply and 56,500 ac-ft is CVP water (Project

Supply), as shown in Table 2-59. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-59
SMWC: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	53,500	56,500
Non-critical Months	116,000	0
Total Annual	**169,500**	**56,500**

The renewed contract specifies the total quantity of water that may be diverted by SMWC each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-42. The monthly Base Supply ranges from a minimum of 5,000 ac-ft in September to a maximum of 48,000 ac-ft in May. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 25,000, 24,000, and 7,500 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 53,500 ac-ft, and the total Project Supply is 56,500 ac-ft, as shown in Table 2-59.

Settlement Contract Historical Diversions. SMWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract. The Company's total annual diversions from the Sacramento River can be characterized into two time periods, 1964 to 1982 and 1983 to 2004 (shown on Figure 2-43). From 1964 to 1982, annual diversions fluctuated between a minimum of 189,000 ac-ft in 1977 (critically dry year) to a maximum of 258,700 ac-ft in 1975. From 1983 to 2004, there has been a gradual reduction in annual diversions. During this period, annual diversions fluctuated between a minimum of 150,300 ac-ft in 1983 to a maximum of 226,000 ac-ft in 2004. Several factors contributed to the change in diversions between these two periods, including changes in cropping patterns, rice varieties, cultural practices, and farm machinery technology. Cropping patterns within SMWC, specifically a reduction in rice acreage due to government programs, occurred between these periods. From 1964 to 1982, an average of 20,900 acres of rice was irrigated in comparison to 16,200 acres between 1983 to 1997. The variety of rice planted during these periods also changed from a taller stalked, slow maturing variety to a short stalked, fast maturing variety. In addition, improvement in farm machinery technology and the development of the laser land leveler allowed for greater precision in leveling rice fields. The development of this technology reduced the quantity of water required to obtain uniform minimum water depths on the rice fields.

Figure 2-42 shows the historical monthly average diversions for the following three periods:

- 1964 to 1982: Long-term period of record from beginning of recording period to changes in crop pattern, rice varieties, cultural practices, and farm machinery technology.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1983 to 2004: The period following the changes in crop pattern, rice varieties, cultural practices, and farm machinery technology.

The following observations are noted:

- A reduction in diversions during all months was observed during the recent period (1984 to 2004) in comparison to the previous period (1964 to 1982). The reduction in diversions is attributed to changes in crop pattern, rice varieties, cultural practices, and farm machinery technology.
- From 1964 to 1982, SMWC diverted over 90 percent of their contract amounts from May through August.
- Every year during critical months, from 1964 to 2004, SMWC has diverted its Base Supply and a majority of its Project Supply.

The distribution of the monthly average diversions for the three periods is similar for most months. However, during the recent period (1983 to 2004), diversions were reduced relative to the other periods during the months of April, May, and June.

- On average, monthly diversions by SMWC from 1964 to 1982 peaked during June. During the recent period (1983 to 2004), monthly diversions peak in July.

Non-contract Period (November – March). In addition to the contract water, SMWC has entitlements to pump water during the non-contract period for other uses including rice straw decomposition given appropriative rights during the non-contract months. These entitlements allow for a maximum diversion of 250 cfs. Approximately 4,000 to 8,000 acres have been flooded in the past for rice straw decomposition. Due to flood control and drainage concerns, the maximum acreage that may be flooded is considered and managed by acreage limitations adopted by the Company each year.

Other Surface Water Sources. Excluding Sacramento River water rights/contract entitlements, SMWC does not hold water rights to any other surface water sources.

Groundwater. The SMWC boundary overlies the Sutter Sub-basin (Department groundwater basin number 5-21.62) of the Sacramento Valley Groundwater Basin. SMWC lies within the southwestern portion of the Sutter Groundwater Sub-basin. The area is located on recent alluvial sediments including: channel, floodplain, basin, and alluvial deposits. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities. Stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeabilities. Underlying these recent fluvial deposits are the Tehama, Mehrten, and Laguna Formations (Department 1978; Department, 2003c).

In the Sub-basin, the Tehama Formation interfingers with the Laguna and Mehrten Formations, forming the base of the continental deposits in this area. Although the Tehama Formation is mostly fine-grained, it contains sufficient sand and gravel zones in many areas to provide large quantities of groundwater. From its source area in the Coast Ranges, the Tehama Formation dips eastward beneath the valley floor (Department, 1978).

The Laguna Formation overlies the Mehrten Formation and is composed predominantly of fine-grained poorly sorted reddish to yellowish brown silt, clay, and sandy with local sand and gravel lenses (Page, 1980). The unit is highly variable ranging from predominantly silt with sandy lenses to sand with clay and silt lenses (Department, 1978). The Laguna formation was deposited as a westward thickening "wedge" on low-sloping alluvial fans by streams draining the Sierra Nevadas. Thickness ranges from 300 feet along the Sierra Nevada foothills to as much as 1,000 feet near the Sacramento River (Department, 1978). Deposits of the Laguna Formation exhibit low to moderate permeability.

The Mehrten Formation includes both hard-gray tuff breccias derived from eruptions in the Sierra Nevadas and interbedded fluvatile volcanic silts, sands, and gravels (Department, 1978; Page, 1980). These deposits dip southwestward and range in thickness from 0 to 325 feet. While tuff breccias and clays yield little water and function as confining layers, the volcanic sands of the Mehrten Formation can yield large quantities to agricultural wells (Department, 2003c).

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for agricultural, domestic, and M&I uses. In general, natural groundwater quality is influenced by streamflow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range. The northwest-trending Sutter Basin Fault creates water quality issues within the Sutter Sub-basin (Department, 2003c). The fault may act as a conduit for the upward movement of connate water from deeper marine sediments. It has been reported that saline intrusion has displaced up to 2,000 feet of fresh water in the continental deposits, forming a mound of saline water in the east-central portion of the sub-basin. The total depth of fresh water in SMWC is approximately 400 feet bgs (Berkstresser, 1973). The fresh water is underlain by saline water.

In the northern portion of SMWC, groundwater generally flows from the northeast and northwest at a gradient of approximately 2.3 feet per mile. Flow converges in the central portion of the Company. In the southern portion of SMWC the horizontal gradient becomes very flat and groundwater flow directions vary. Limited recent groundwater data is available for the SMWC area, as the Department monitors only one well within the Company. Three other wells have been monitored in the past; however data collection was discontinued between 1964 and 1980. The closest monitoring wells are located within 2 miles of the Company boundary (Department, 2003b). Examination of available data indicates that during years of normal precipitation, groundwater levels in the unconfined portion of the aquifer fluctuate between 2 and 6 feet seasonally; while during drought years, groundwater levels have been shown to fluctuate up to 8 feet (Department, 2003c). In the confined portion of the aquifer system, groundwater levels have been shown to fluctuate between 4 and 6 feet during years of normal precipitation and up to 26 feet during drought conditions.

Past pumping and drought conditions have not historically negatively affected the overall long-term groundwater level trends in SMWC. Groundwater level data since 1980 from over 2,300 wells in the Sacramento Valley were reviewed and the historical trends show that groundwater levels in the SMWC area are generally stable over the long term, although short-term fluctuations in groundwater levels are observed that can be correlated with precipitation trends.

Although, groundwater use within the sub-basin is cautioned to be of limited use, it is believed by local and state agencies that there could be potential for cultivating the resource if carefully managed in conjunction with surface water supplies. It is generally believed that the use of the groundwater resource may be more limited in the southern portion of the basin due to areas of Connate water than in the northern portion where such issues are not as prevalent. SMWC is working with Sutter County, RD 1500, and PMWC to better define the local groundwater resource and is working with these entities to explore potential conjunctive management and groundwater monitoring opportunities.

Other Water Supplies. SMWC presently uses approximately 10,000 to 15,000 ac-ft/yr of drainage water from sources both inside and outside of the Company. Private landowners pump an additional 5,000 to 15,000 ac-ft from these sources. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These rimlanders are not within Company boundaries, but contribute that may be reused by Company farmers. SMWC uses a portion of the rimlanders' tailwater that they may not otherwise use within their systems. Company operations are coordinated with RD 1500 and PMWC. RD 1500 manages drainage in the service area, while SMWC delivers water to the majority of water users in the basin area.

SMWC currently operates five booster pumps and has dismantled one internal recirculation system (ML 10, which has three booster pump locations but is now inoperative) with a total combined capacity of 190 cfs. These facilities are used for reuse and are located in the central and northeast portions of the Company. SMWC is interlaced with drainage ditches that carry water towards the main drain and eventually out of the service area at the southern end of the Company. Drainage ditches in the eastern portion of the Company intercept naturally occurring saline groundwater, called "connate water." This salt-laden groundwater seeps into the drain ditches and causes an increase in salinity in the drains. Irrigation practices using Sacramento River water and drainage systems have allowed the Company and other districts/landowners to maintain suitable crop yields and keep the connate water below the crop root zones. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability.

2.4.4.4 Water Use

Company Water Requirements. The two major crops grown within the Company's service area are tomatoes (grown in rotation with wheat, safflower, and beans) and rice (sometimes grown in rotation with wheat, safflower, beans, and melons, or grown 7 or 8 years consecutively without rotation).

Rice is the predominant crop grown within SMWC's service area, accounting for in recent years approximately 40 to 60 percent of the Company's irrigated acreage on an annual basis. As is the case with most of the other districts, water requirements are typically highest during the summer months (June, July, and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice and other crops are greatest early in the growing season during dry years associated with irrigating previously dry fields. The vast majority of irrigation water requirements are met through the contract surface water supply, although is used depending on availability and quality.

Annual cropping patterns have changed a great deal over the last few decades, as rice acreage had declined substantially but in recent years rice acreage has increased noticeably with other crops leaving the area or becoming unprofitable. The prevalence of relatively rich, well-drained soils allows for a diversity of crops within the Company boundary. Tomato acreage has declined in recent years due to processors (canneries) leaving the area resulting in more acres of rice and substitute crops. Therefore, associated water requirement needs and associated diversions are driven by changes in cropping patterns, as well as water-year type.

Table 2-60 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 2-60
SMWC Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Rice	17,400 (± 10%)[c]	23,000 (± 25%)[c]
Tomatoes	12,200 (± 10%)[c]	6,000 (± 20%)[c]
Grain	8,100 (± 15%)[c]	8,000 (± 15%)[c]
Dry Beans	5,500 (± 15%)[c]	4,900 (± 15%)[c]
Other Crops	8,900 (± 15%)[c]	9,100 (± 25%)[c]
Total Irrigated Acreage	**52,100 (± 5%)[c,d]**	**51,000 (± 5%)[c,d]**

[a]Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Central District.

[b]Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Central District.

[c]Percentages obtained from SMWC.

[d]Includes 5,500 double-cropped acres for 1995, and 4,900 double-cropped acres for 2020.

Figure 2-44 summarizes irrigated acreage by crop, on-field requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the Company's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 4,000 to 8,000 acres have been flooded recently, a trend that may continue or increase assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. Flood-related concerns currently considered by the Company may limit the total acreage potentially available for rice decomposition. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to change, but the total water requirements for the Company remain relatively the same as current conditions.

Urban. SMWC overlies the agricultural and residential Town of Robbins, but does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the Company service area is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by approximately 1,900 ac-ft compared to 1995 estimated levels (Department, Central District). Future M&I requirements are assumed to be met by groundwater supplies. In the future, SMWC may provide M&I water to meet growing future M&I requirements.

Environmental. In 1990, approximately 250 acres of riparian vegetation were estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. Other endangered species that occur within the service area include the western yellow-billed cuckoo, Swainson's hawk, bank swallow, wood duck, western pond turtle, California tiger salamander, California red-legged frog, valley elderberry longhorn beetle, and the California hibiscus. Agricultural development has favored other species, notably waterfowl and ring-necked pheasants. Drainage ditches support blue and channel catfish, carp, crayfish, and bullfrogs.

Up to 8,000 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. As previously described, the Company has considered limitations on total flooded acres due to winter flooding and drainage risks and concerns. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. No formally managed designated environmental or wetlands areas are within the Company.

Groundwater Recharge. Groundwater recharge in the Company is obsolete because minimal amounts of water are extracted from groundwater sources. Although no direct groundwater recharge plan is practiced, the basin is routinely recharged by groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter County.

Soil profile characteristics in the Sutter County area of SMWC are as follows (Appendix C):

- San Joaquin-Cometa: Moderately deep and very deep, level to nearly level, well-drained sandy loam and loam on terraces.
- Oswald-Gridley-Subaco: Moderately deep, level to nearly level, poorly drained and moderately well-drained clay and clay loam in basins and on basin rims.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.

- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.

Transfers and Exchanges. SMWC is one of 34 SRSCs that has participated in the Pool program. Since 1974 the Pool has been the forum to move available Project Supply supplies within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool rather than for diversion. Within the Sutter Sub-basin SMWC has been the most active participator in the Pool.

Other Uses. No other significant water uses other then those discussed above occur within MFWC.

2.4.4.5 District Facilities

Diversion Facilities. SMWC operates three pumping plants located on the Sacramento River: Tisdale Pumping Station, State Ranch Bend Pumping Plant, and Portuguese Bend Pumping Plant. Company operations are coordinated with RD 1500 and PMWC to manage the supply and conveyance of. RD 1500 manages drainage within the SMWC service area. SMWC also supplies water to users in the RD 1660 area north of the Tisdale Bypass. Table 2-61 summarizes the primary SMWC surface water supply facilities. The Company does not own or operate any groundwater wells. Approximately 38 groundwater wells have been drilled within the Company boundaries, but most have been abandoned because of high salinity levels, lack of sustained yield, and readily available surface water supplies. See Figure 2-45 for a map of SMWC's major conveyance facilities.

TABLE 2-61
SMWC Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Tisdale Pumping Plant	Sacramento River	Pump	960	170,500
State Ranch Bend Pumping Plant	Sacramento River	Pump	128	23,000
Portuguese Bend Pumping Plant	Sacramento River	Pump	106	11,800

Conveyance System. SMWC's distribution and conveyance system includes approximately 56 miles of irrigation water delivery canals and 144 miles of laterals. The Company service area's main distribution facilities include seven canals, listed in Table 2-62. The Main Canal supplies water from the Tisdale Pumping Plant to the West Canal, RD 1660 Main Canal, the Central Canal, and the East Canal. The State Ranch Bend Main Canal supplies water from the State Ranch Bend Pumping Plant to Lateral S and the West Side Canal. The Portuguese Bend Main Canal supplies water from the Portuguese Bend Pumping Plant to the southern end of the Company service area.

TABLE 2-62
SMWC Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Main Canal	Tisdale Pumping Plant	960	No	Reclamation Drain	15
East Canal	Main Canal	300	No	Reclamation Drain	15
Central Canal	East Canal	300	No	Reclamation Drain	15
West Canal	Main Canal	300	No	Reclamation Drain	15
Portuguese Bend Main Canal	Portuguese Bend Pumping Plant	106	portion	Reclamation Drain	15
State Ranch Bend	State Ranch Bend Pump Plant	128	No	Risers into drains along canals	15
1660 Main Canal	Main Canal	45	No	Risers into drains along canals	15

Storage Facilities. SMWC currently has no storage facilities.

Spill Recovery. Drainage for SMWC is handled by RD 1500. The area is interlaced with drainage ditches that carry water towards the Reclamation Main Drain and eventually out of the service area at the southern end of the Company via the RD 1500 Karnak Pumping Plant. The Company currently operates six active drain recapture pumps, ranging in size from 12 to 70 cfs. The Company reuses between 7,000 and 15,000 ac-ft/yr of with these pumps.

The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These landowners contribute that may be used by Company farmers. However, the high water table and its saline nature limit the amount of water that can be reused without impacting crop yields. In addition to the Company recapture system, individual farmers reuse with their own pumps.

2.4.4.6 District Operating Rules and Regulations

SMWC is a private mutual water Company formed under California corporate laws and operates as a non-profit entity. The Company functions by its approved articles of incorporation and adopted bylaws. The Company is governed by a Board of Directors made up of seven elected shareholders (landowners) or appointed representatives. Elections are held each year in April. An annual budget is developed and approved each year so that the Company can perform on a cost of doing business basis. Cash reserves are kept at a minimum and held essentially only to meet working capital and emergency capital needs.

Water rotation, apportionment, and shortage allocation:

> Requests for water delivery and shutoff can be given to the canal operator by 9 a.m. the day water is needed.
>
> According to Rule 5 of SMWC Rules and Regulations: *Whenever a general shortage of water appears imminent, the Board of Directors shall so find by resolution duly passed and recorded in its minutes. The resolution shall incorporate special rules and regulations to*

cover the distribution of the available water supply during the period of the shortage. In the event of temporary, local or similar shortages, the Manager is authorized to place in effect such variations in service as in his judgment the occasion requires.

Use of drainage waters:

According to Rule 18 of SMWC Rules and Regulations: *The Company has an agreement with Reclamation District No. 1500 which allows the Company shareholders to make use of water from the District drains for irrigation purposes. Pursuant to this agreement, a user (shareholder/landowner) may pump drain water without further permission from either the District or Company by pumping directly from a drain situated in the Company service area boundaries for use on lands within the Company.*

Policies for wasteful use of water: According to Rule 6 of SMWC Rules and Regulations: *Any water user who deliberately, carelessly or otherwise wastes water on roads, vacant land or land previously irrigated or who floods certain portions of the land to an unreasonable depth or who uses and unreasonable amount of water in order to irrigate other portions or who irrigates land which has been improperly checked for the economical use of water will be refused the use of water until such conditions are remedied or will have his use curtailed by the amount of waste, as the Manager may determine.*

The Company reserves the right to refuse delivery of water to any lands when it appears to the satisfaction of the Manager that its proposed use or method of use would require such excessive quantities of water as would constitute waste or unreasonable use.

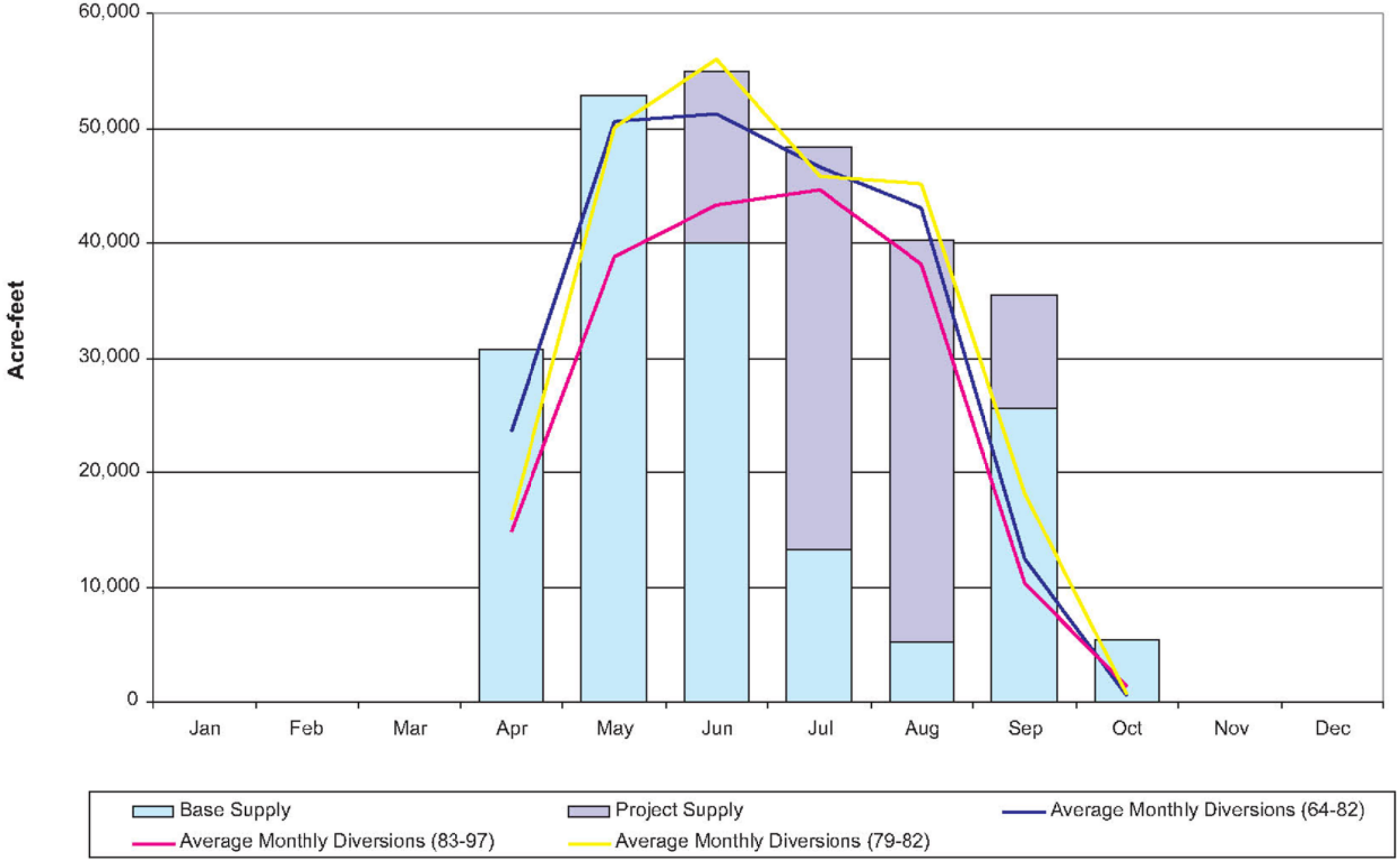
Management shall be authorized to shut off water or reduce the flow when the ditchtender sees that the irrigation is finished, or water is being wasted, after first attempting to advise the person by telephone designated in the water order to be advised.

2.4.4.7 Water Measurement, Pricing, and Billing

SMWC currently measures flows at the main pump stations using flowmeters and pump flowcharts. Flows at lateral headgates are measured using headgate position. Drain lift pump flows are measured using power consumption records and capacity information. Drainage leaving the Company is measured using a Department formula for the main drainage discharge pump station. Minor increases in conveyance efficiency could be achieved by increased operations measurement, with installation of measuring facilities along the main canal and at the heads of laterals. Any new operations measurement program should be integrated with the long-term operations automation program described above.

SMWC has in the past measured both the flow rate and the total quantity of water delivered at each turnout. Flow rates were measured using canal stage and turnout gate position. The volume of delivery was measured based on the flow rate and time of delivery (typically 24 hours). In recent years, the Company has provide water to its users on a per-acre basis. SMWC’s average on-farm efficiency of approximately 63 percent could potentially be increased through a combination of incentive pricing and on-farm improvements, providing some conservation savings. SMWC is participating in a water measurement study with other SRSCs to compare sub-basin and lateral level measurement to on-farm measurement.

The intent is to demonstrate whether water purveyors need to measure water conveyance down to the on-farm level to accurately measure Company flows and deliveries. Preliminary indications are that sub-basin and lateral measurement is adequate for Company measurement and monitoring.



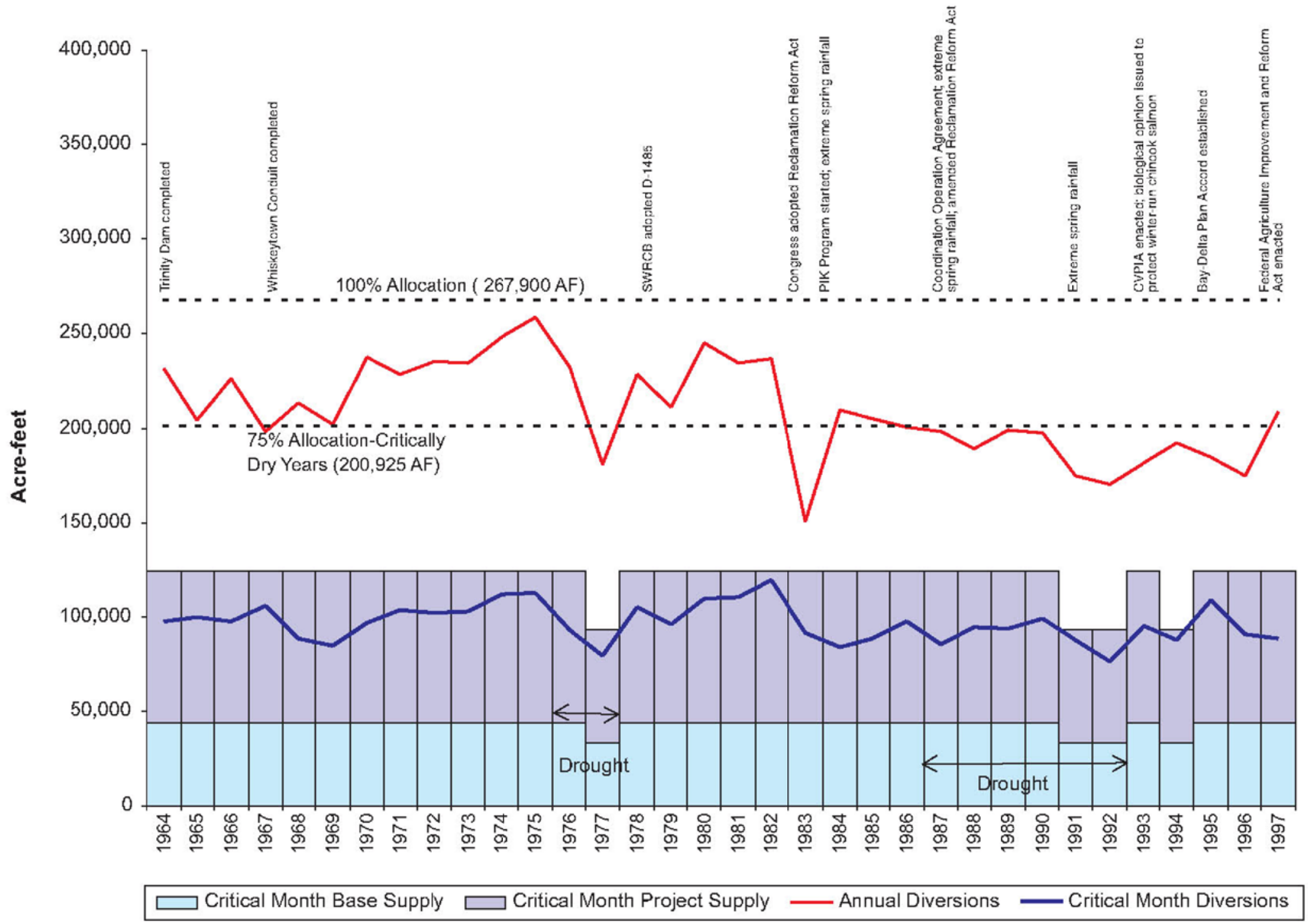
Notes:

1. Critically dry year 1977 is omitted from Average Monthly Diversions (64-82).
2. Critically dry years 1991, 1992 and 1994 are omitted from Average Monthly Diversions (83-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-42
SUTTER MUTUAL WATER COMPANY MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_862 (8/17/05)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-43
SUTTER MUTUAL WATER COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

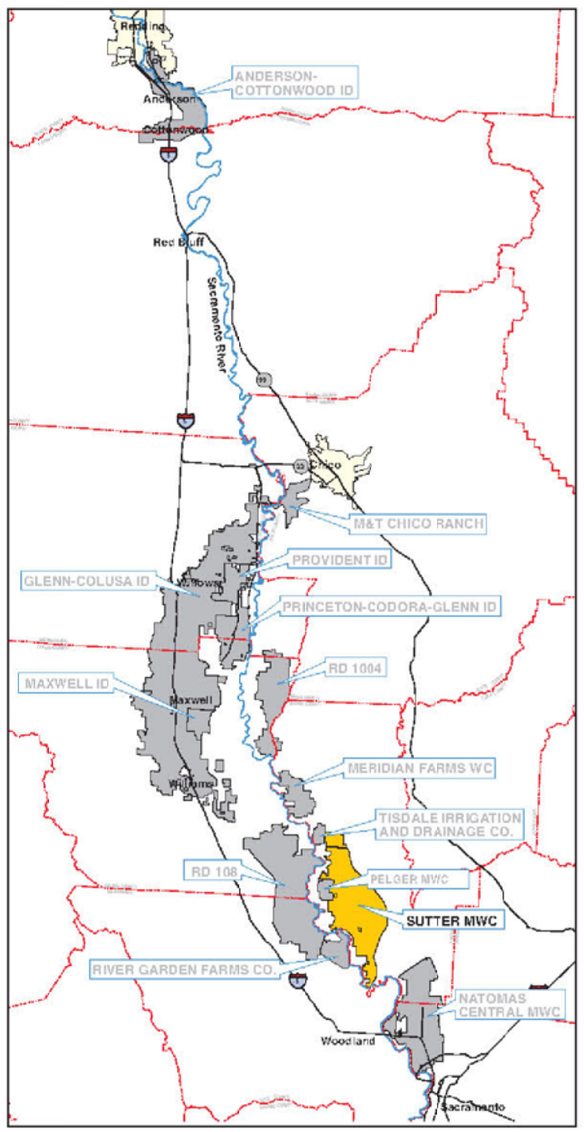
CH2MHILL
in association with
MBK

Sutter Mutual Water Company

Manager: Max S. Sakato • P.O. Box 128 • Robbins, CA 95676 • (530) 738-4423

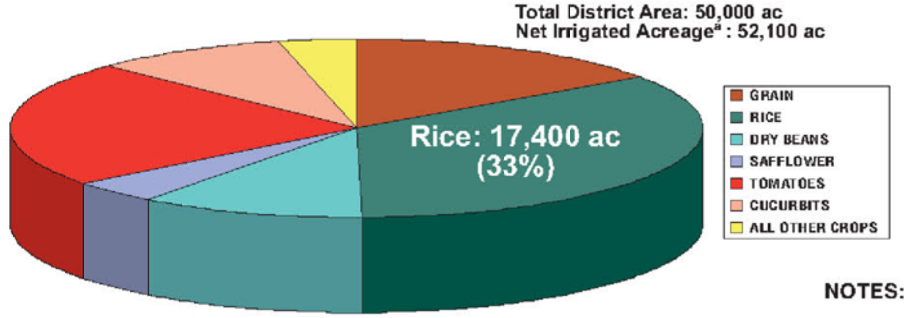
Settlement Contract:	226,000 af
Base Supply:	169,500 af
Project Supply:	56,500 af

Location Map



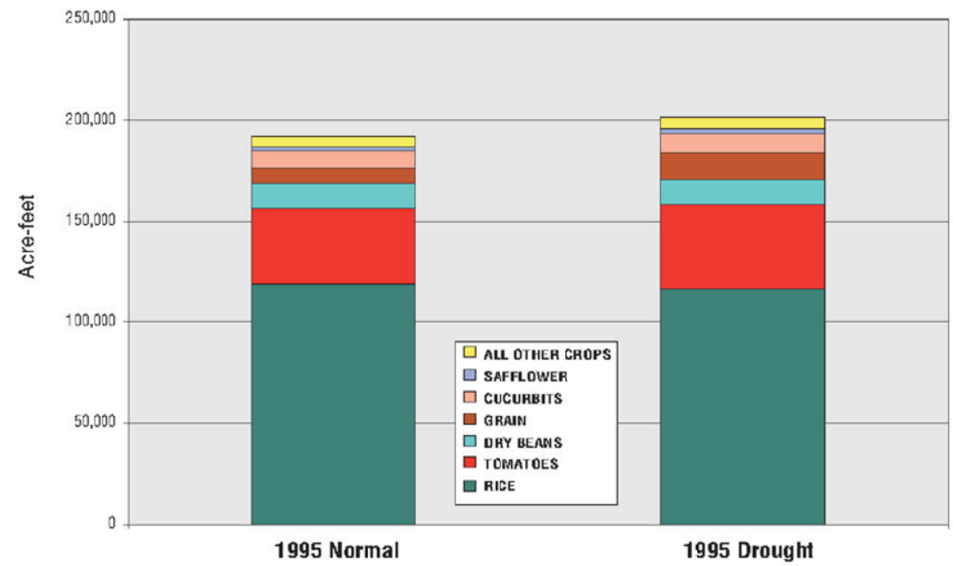
Irrigated Acreage by Crop

Total District Area: 50,000 ac
Net Irrigated Acreage[a] : 52,100 ac

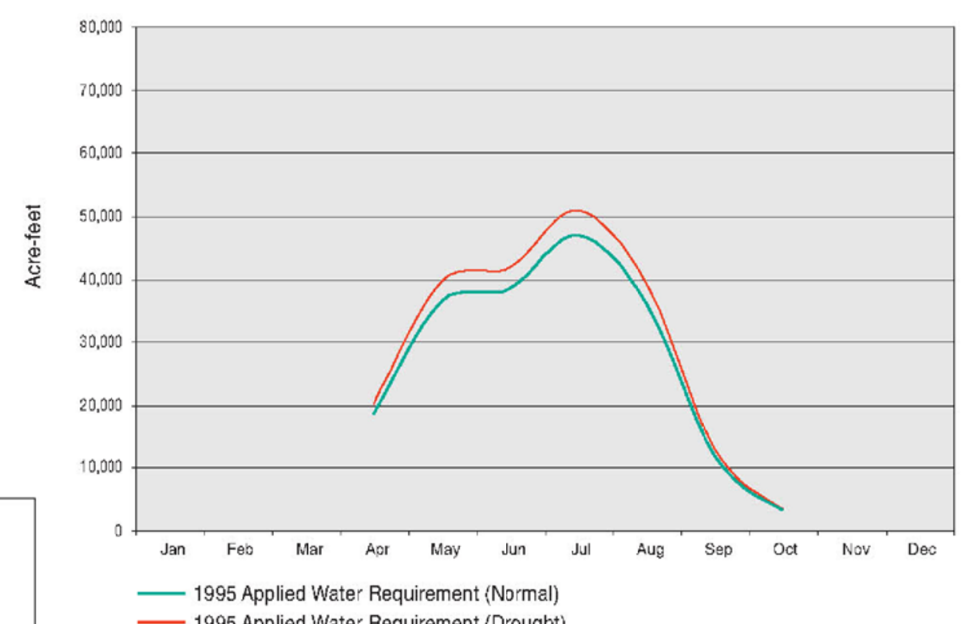


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

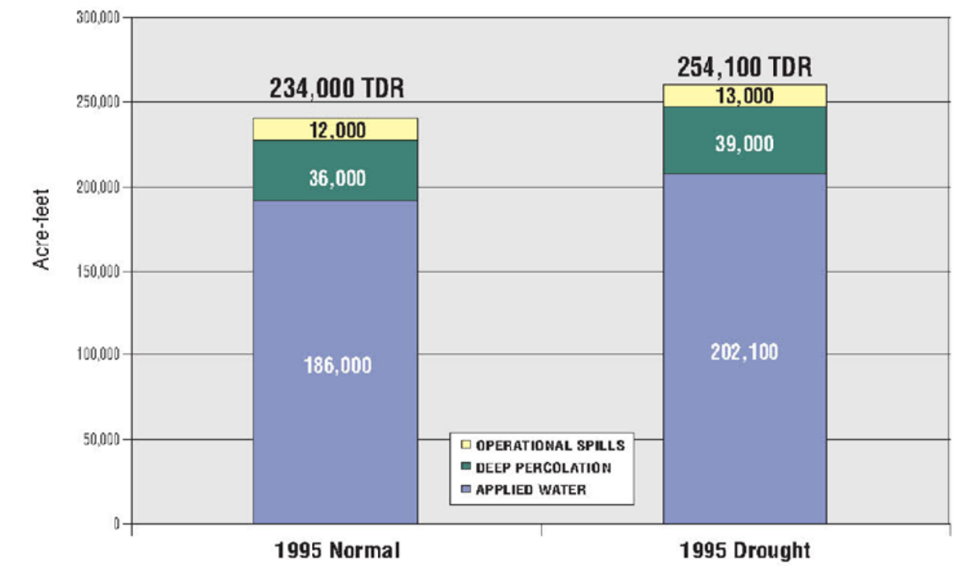


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

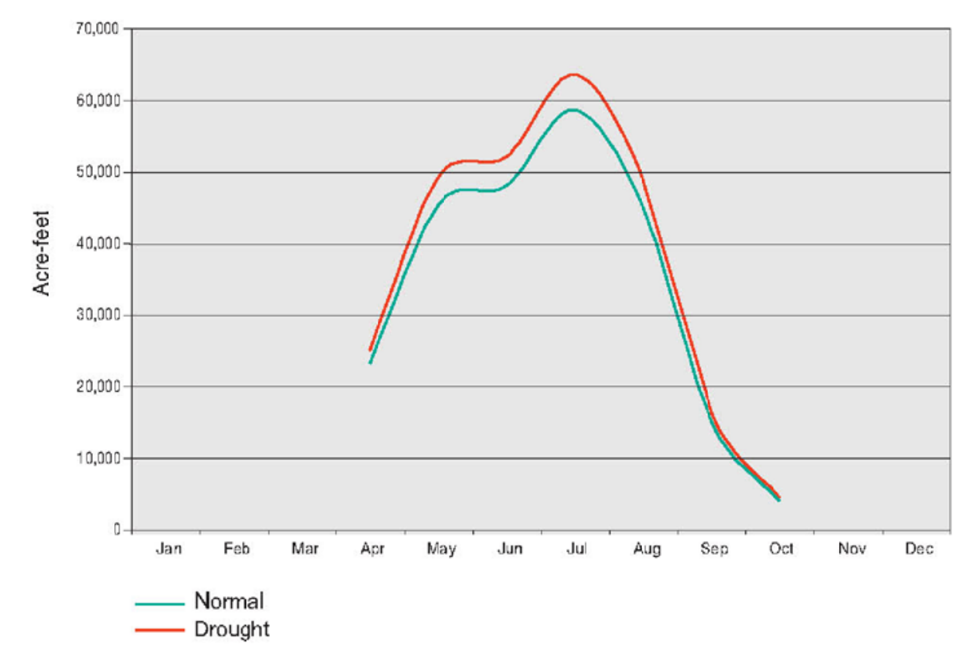


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates. Includes 5,500 double-cropped acres for 1995.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 2-44
SUTTER MUTUAL WATER COMPANY IRRIGATED ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_20 (8/17/05)

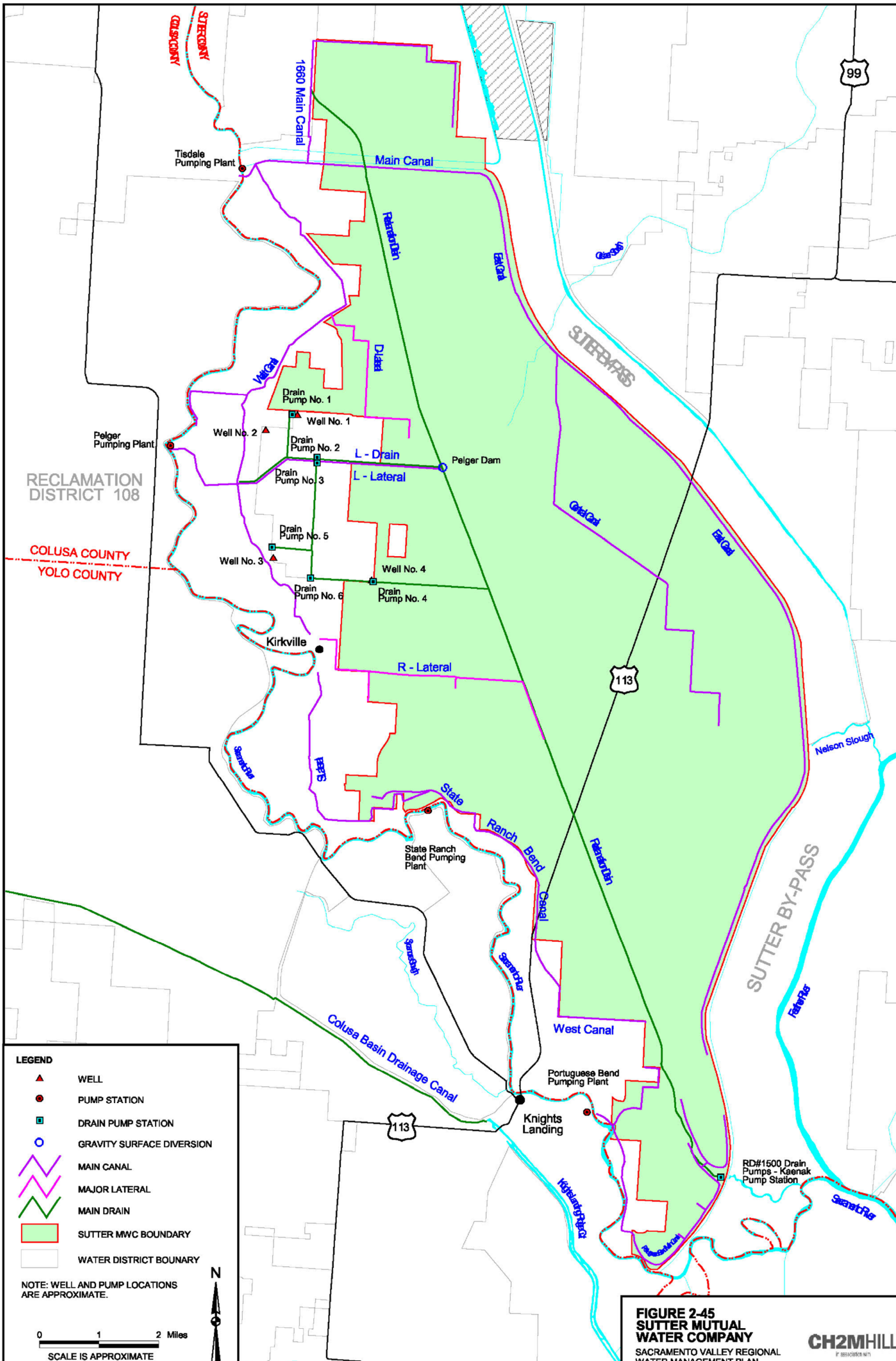


FIGURE 2-45
SUTTER MUTUAL WATER COMPANY
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
MBK

Pelger Mutual Water Company

2.4.5 Pelger Mutual Water Company

2.4.5.1 History

PMWC (or the Company) was formed on March 11, 1965, under the state corporate laws and codes. The Company entered into a negotiated agreement with Reclamation in 1965, quantifying the amount of water PMWC could divert from the Sacramento River. The resulting negotiated agreement recognized PMWC's annual entitlement of a Base Supply of 7,110 ac-ft/yr of flows from the Sacramento River and also provided for a 1,750 ac-ft allocation of Project Supply resulting, in a total contract entitlement of 8,860 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Exhibit A to the Settlement Contract for PMWC, and is included in Table 2-63. The Settlement Contract negotiated in 1964 remains in effect until March 2006. PMWC is working with Reclamation and counsel to finalize environmental documentation for contract renewal.

TABLE 2-63
Schedule of Monthly Water Diversions – PMWC
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	1,210	0	1,210
May	3,250	0	3,250
June	1,670	0	1,670
July	310	700	1,010
August	40	950	990
September	570	100	670
October	60	0	60
Total	**7,110**	**1,750**	**8,860**

Notes:
Contract No. 14-06-200-2073A-R-1
Points of Diversion: 56.96L

In addition to the contract water, PMWC has entitlements to pump water during the nonirrigation season for wetlands, rice straw decomposition and other irrigation demands. There are three privately owned wells and no Company-owned wells within PMWC's boundaries. These wells are used in conjunction with the river pumps and six -recycling pumps to meet irrigation needs. Rice, tomatoes, and corn are the predominant crops grown within the Company, in addition to rotation crops such as wheat and safflower that are rotated on rice and tomato fields. Rotation crops are not typically irrigated. PMWC's primary water supply facility is the Pelger Pump Station located on the Sacramento River. The Company also relies heavily on for a secondary supply, with diversions from the RD 1500 Main Drain just east of the Company service area.

2.4.5.2 Service Area and Distribution System

PMWC is located approximately 45 miles northwest of Sacramento and is bordered by SMWC to the north, east, and south, and by private landowners with RD 1500 to the west (known as "rimlanders"). The Company encompasses approximately 2,900 acres and serves 10 landowners. Water deliveries are coordinated with SMWC and drain usage with RD 1500. RD 1500 has sole authority and control of flood control matters. While portions of neighboring SMWC have low-quality groundwater as a result of connate water upwelling, PMWC has usable groundwater resources within its boundaries and uses groundwater as a normal part of its resource mix. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These landowners, called "rimlanders," are not within Company boundaries, but contribute that may be reused by Company farmers.

PMWC uses an arranged schedule to deliver irrigation water to Company customers. The Company's distribution and conveyance system includes approximately 10 miles of canals and laterals. Seepage from the canals and laterals is approximately 10 percent. PMWC has a network of unlined drainage ditches and drain pump stations for conveying irrigation return flows. The drains and pumps are also an integral part of the water supply and distribution system for capturing and reusing. Area drains generally empty into the RD 1500 Main Drain to the east.

The Company actively manages three main water sources to meet its needs: river diversions drain recycling, and groundwater pumping. The flexibility to supply water from these various sources is a function of the infrastructure in the Company and the relatively small acreage served. The reliance on is very important but the Sacramento River is the primary source of supply and always relied on first and foremost. In 2004, PMWC used 100 percent of the Project Supply water from the Reclamation contract and 95.5 percent of the Base Supply. River contract allocations were 96 percent used. Out of 8,860 ac-ft contract totals PMWC used 8,535 ac-ft in 2004. The drains are very important to PMWC, but a supplemental supply to the river. Groundwater has been used in the case of forbearance programs and/or water transfers. Groundwater is in reserve for use in times of water shortages and transfers (or forbearance), but because of quality issues (total dissolved solids) is mixed with river and drain supplies.

2.4.5.3 Water Supply

The Company has water rights to the Sacramento River as shown in Table 2-64. The following discussion describes this sources and its historical use.

Surface Water. PMWC holds water rights to divert water from the natural flow of the Sacramento River. The PMWC surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-2073A (Contract No. 2073A). This contract provides for an agreement between PMWC and the United States on PMWC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract was set to expire March 31, 2004. PMWC signed their new contract with Reclamation on February 28, 2005. This contract will remain in effect until 2045.

TABLE 2-64
PMWC: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A001765A (4/9/20)	001111 (8/2/22)	000613A (3/13/72)	Apr 1 to Oct 31	4
Sacramento River	A012470B (4/13/48)	007268B (2/17/49)	008547B (8/16/95)	Apr 1 to Nov 1	53.5
Sacramento River	A030410 (11/2/94)	020933 (9/16/97)	Pending	Sep 15 to Mar 31	60

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).
[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.
[c]The type of water right is indicated by the first letter in the Application reference, as follows:
- A – Appropriative right
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.
[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Contract No. 2073A provides for a maximum total of 8,860 ac-ft/yr, of which 7,110 ac-ft is considered to be Base Supply and 1,750 ac-ft is CVP water (Project Supply), as shown in Table 2-65. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-65
PMWC: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Months	920	1,750
Non-critical Months	6,190	0
Total Annual	**7,110**	**1,750**

The contract specifies the total quantity of water that may be diverted by PMWC each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-46. The monthly Base Supply ranges from a minimum of 40 ac-ft in August to a maximum of 3,250 ac-ft in May. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 700, 950, and 100 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 920 ac-ft, and the total Project Supply is 1,750 ac-ft, as shown in Table 2-64.

Settlement Contract Historical Diversions. PMWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 2-47. From 1964 to 1970, diversions decreased from one year to the next. Total annual diversions in 1964 were 9,200 ac-ft in comparison to approximately 1,200 ac-ft in both 1969 and 1970. Between 1970 and 1983, the diversions went through two cycles where diversions generally increased for several years, then decreased for several years. Since 1983, diversions have continued to fluctuate; however, the overall trend has been an increase in annual diversions.

The fluctuations in Sacramento River diversions are attributed to several factors, including changes in cropping patterns, acreage farmed, and increased usage of alternative water sources (groundwater and) during drought years. The cropping pattern within PMWC is diverse, and typically the acreage of a specific crop varies from year to year. For example, a maximum of 1,565 acres of rice was planted in 1980 in comparison to zero acres in 1977[1]. Such variations in cropping patterns correspond to fluctuations in the total water requirements for the Company and resulting Sacramento River diversions. The total irrigated acreage has also fluctuated during the period of 1977 to 1997 from a minimum of 2,675 acres in 1995 to maximum of 3,985 in 1981.

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

Figure 2-46 shows the historical monthly average diversions for the following three periods:

The following observations are noted:

- Although the annual diversions varied greatly from 1964 to 1997, the monthly distributions for different time periods were relatively similar.
- Every year since 1991, PMWC has diverted some portion of their contract entitlement during critical months.
- For all three periods, the maximum diversions occurred during the month of May.

Non-contract Period (November – March). In addition to the contract water, PMWC has entitlements to pump water during the non-irrigation season for wetlands, rice straw decomposition and other irrigation demands. In response to increasingly stringent limitations on burning, some of the Company's rice growing landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 1,200 acres have been flooded in the past, a trend that is expected to continue or increase in the future. PMWC also has an agreement with USFWS to provide winter water for waterfowl.

Other Surface Water Sources. Excluding Sacramento River water rights/contract entitlements, PMWC does not hold water rights to any other surface water sources.

[1] Surface water diversions form PMWC were zero in 1977, a critically dry year with drought conditions throughout California.

Groundwater. The PMWC boundary overlies the Sutter Sub-basin (Department groundwater basin number 5-21.62) of the Sacramento Valley Groundwater Basin, and therefore within PMWC, occurs in a broad alluvial basin and is therefore not confined to any well-defined subsurface stream channels.

PMWC lies within the west-southern portion of the Sutter Sub-basin. The area is located on recent alluvial sediments including: channel, floodplain, basin, and alluvial deposits. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities. Stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeabilities. Underlying these recent fluvial deposits are the Tehama, Mehrten, and Laguna Formations (Department 1978; Department, 2003c).

In the Sutter Groundwater Sub-basin, the Tehama Formation interfingers with the Laguna and Mehrten Formations, forming the base of the continental deposits in this area. Although the Tehama Formation is mostly fine-grained, it contains sufficient sand and gravel zones in many areas to provide large quantities of groundwater. From its source area in the Coast Ranges, the Tehama Formation dips eastward beneath the valley floor (Department, 1978).

The Laguna Formation overlies the Mehrten Formation and is composed predominantly of fine-grained poorly sorted reddish to yellowish brown silt, clay, and sandy with local sand and gravel lenses (Page, 1980). The unit is highly variable ranging from predominantly silt with sandy lenses to sand with clay and silt lenses (Department, 1978). The Laguna formation was deposited as a westward thickening "wedge" on low-sloping alluvial fans by streams draining the Sierra Nevadas. Thickness ranges from 300 feet along the Sierra Nevada foothills to as much as 1,000 feet near the Sacramento River (Department, 1978). Deposits of the Laguna Formation exhibit low to moderate permeability.

The Mehrten Formation includes both hard-gray tuff breccias derived from eruptions in the Sierra Nevadas and interbedded fluvatile volcanic silts, sands, and gravels (Department, 1978; Page, 1980). These deposits dip southwestward and range in thickness from 0 to 325 feet. While tuff breccias and clays yield little water and function as confining layers, the volcanic sands of the Mehrten Formation can yield large quantities to agricultural wells (Department, 2003c).

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for agricultural, domestic, and M&I uses. In general, natural groundwater quality is influenced by streamflow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range. The northwest-trending Sutter Basin Fault creates water quality issues within the Sutter Sub-basin (Department, 2003c). The fault may act as a conduit for the upward movement of connate water from deeper marine sediments. It has been reported that saline intrusion has displaced up to 2,000 feet of fresh water in the continental deposits, forming a mound of saline water in the east-central portion of the sub-basin. The total depth of fresh water in PMWC is approximately 1,200 feet bgs (Berkstresser, 1973). The fresh water is underlain by saline water.

Throughout PMWC groundwater movement is generally to the southeast, toward SMWC. The gradient is about 2 feet per mile. Limited recent groundwater data is available for the PMWC area, as the Department does not monitor wells within the Company. The closest monitoring wells are located within 2 miles of the Company boundary; however, data has been collected discontinuously from these points from 1958 to 1980 (Department, 2003b). Examination of available data indicates that during years of normal precipitation, groundwater levels in the unconfined portion of the aquifer fluctuate between 4 and 6 feet seasonally; while during drought years, groundwater levels have been shown to fluctuate up to 8 feet (Department, 2003b). Wells located near recharge sources typically show less of an annual change in groundwater levels.

Past pumping and drought conditions have not historically negatively affected the overall long-term groundwater level trends in PMWC. Groundwater level data since 1980 from over 2,300 wells in the Sacramento Valley were reviewed and the historical trends show that groundwater levels in the PMWC area are generally stable over the long term, although short-term fluctuations in groundwater levels are observed that can be correlated with precipitation trends.

Since 1990, approximately 0 to 28 percent of the annual water requirements for the Company have been met by groundwater sources. Three privately owned wells are located within the Company's boundaries. These wells are used in conjunction with the river pumps and recycling pump to meet irrigation needs during drought periods. The total capacity of the three privately owned wells is approximately 26 cfs. PMWC does not own/operate any wells. PMWC is working with Sutter County, RD 1500, and SMWC to better define the local groundwater resource and is working with these entities to explore potential conjunctive management and groundwater monitoring opportunities.

Other Water Supplies. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These rimlanders are not within PMWC boundaries, but contribute that may be reused by Company farmers. In recent years, PMWC has relied heavily upon tailwater from both inside and outside of the Company to supplement its Sacramento River entitlement. Since the mid-1970s, the majority of irrigation water requirements have been meet by use (approximately 29 to 78 percent, depending on year). On average, use accounted for 55 percent of the irrigation water requirements from 1977 to 1997. In comparison, diversions from the Sacramento River accounted for 42 percent of the irrigation requirements during this period.

2.4.5.4 Water Use

District Water Requirements. As noted above, PMWC is a relatively small Company serving just 10 landowners. However, due to climate and soils, the Company operates similarly to larger districts in terms of cropping patterns and cultural practices. Rice typically accounts for less than half of the Company's irrigated acreage on an annual basis; other key crops include tomatoes and corn (Department, Northern District). As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of the crops grown within the PMWC boundary and the area's hot, dry climate.

Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. Irrigation water requirements are met through the contract surface water supplies, drain recycling, and groundwater. There is high variability in crop mix from year to year. Associated water requirement needs and associated diversions have therefore been a function of water-year type, climate, and changes in crop mix.

Table 2-66 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 2-66
PMWC Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a]	2020[b]
Corn	700 (± 10-25%)[c]	700(± 10-25%)[c]
Rice	600 (± 10-25%)[c]	600 (± 10-25%)[bc]
Tomatoes	600 (± 10-25%)[c]	600 (± 10-25%)[c]
Other Crops	1,000(± 10-25%)[c]	1,000 (± 10-25%)[c]
Total Irrigated Acreage	**2,900 (± 10%)[c,d]**	**2,900 (± 10%)[c,d]**

[a]Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Northern District.

[b]Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Northern District.

[c]Percentages obtained from PMWC.

[d]Includes 100 double-cropped acres for 2020.

Figure 2-48 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, some of the Company's rice-growing landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 1,200 acres have been flooded in the past, a trend that is expected to continue and increase assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. The Company currently has a verbal agreement with USFWS, which encourages winter straw decomposition flooding practices. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to vary widely, as shown by the historical data.

Urban. PMWC is near the agricultural and residential Town of Robbins, but does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the Company is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by approximately 1,900 ac-ft compared to 1995 estimated levels (Department, Central District). This water (in addition to current demands) is assumed to be groundwater. Although M&I requirements are not currently being served, the Company does not preclude the possibility of serving such needs in the future. In the future, PMWC may provide M&I water, but current estimates of future M&I requirements are minimal.

Environmental. Approximately 60 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. Other endangered species that occur within the service area include the western yellow-billed cuckoo, Swainson's hawk, bank swallow, wood duck, western pond turtle, California tiger salamander, California red-legged frog, valley elderberry longhorn beetle, and the California hibiscus. Agricultural development has favored other species, notably waterfowl and ring-necked pheasants. Ditches support blue and channel catfish, carp, crayfish, and bullfrogs; and the ditches are easily accessible to the public for fishing.

Up to 1,200 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. Additionally, the Company serves approximately 1,000 acres of privately owned duck clubs; however, no other formally managed environmental or wetlands areas are within the Company.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the Company. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter County.

Soil profile characteristics in the Sutter County area of PMWC are as follows (Appendix C):

- Oswald-Gridley-Subaco: Moderately deep, level to nearly level, poorly drained and moderately well-drained clay and clay loam in basins and on basin rims.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.

Transfers and Exchanges. PMWC is one of 34 SRSCs that currently participate in the Pool program. Since 1974 the Pool has been the forum to move available Project Supply supplies within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool rather than for diversion.

Other Uses. No other significant uses other than those discussed above occur within PMWC.

2.4.5.5 District Facilities

Diversion Facilities. PMWC's primary water supply facility is the Pelger Pump Station (screened for fisheries) located on the Sacramento River. The Pelger Pump Station supplies the Company's main canal, which runs east from the Sacramento River to the western boundary of the Company service area. The Company also relies heavily on for a secondary supply, with diversions from the RD 1500 Drain just east of the Company service area. The Pelger Diversion Dam located on the RD 1500 Reclamation Drain is used to back up from regional sources into the PMWC's L-Lateral, for supply to service laterals. PMWC has usable groundwater resources within its service area. Groundwater is typically used only during drought conditions. Total current groundwater pumping capacity is 25 cfs from three private wells that are operated by the Company under cooperative agreements with the land owners.

The Company actively manages three main water sources to meet its needs: river diversions, drain recycling, and groundwater pumping. In 2004, PMWC used 100 percent of the Project Supply water from the Reclamation contract and 95.5 percent of the Base Supply. River contract allocations were 96 percent used. Out of 8,860 ac-ft contract totals, PMWC used 8,535 ac-ft in 2004. The drains are very important to PMWC but a supplemental supply to the river. Groundwater has been used in the case of forbearance programs and/or Water Transfers. Groundwater is in reserve for use in times of water shortages and transfers (or forbearance), but because of quality issues (total dissolved solids) is mixed with river and drain supplies to improve the quality. Tables 2-67 and 2-68 summarize the surface water supply facilities. See Figure 2-49 for a map of PMWC's major conveyance facilities.

TABLE 2-67
PMWC Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Pelger Pump Station	Sacramento River	Pump	55	4,600

TABLE 2-68
PMWC Groundwater Wells (Private)
Sacramento Valley Regional Water Management Plan

Map ID	Capacity (cfs)	Water Quality
Well No. 1	8	Good
Well No. 2	8	Good
Well No. 4	10	Good

Conveyance System. The Company's distribution and conveyance system includes approximately 10 miles of canals and laterals. The Pelger Main Canal serves laterals in the northern portion of the Company service area, and is supplied from the Pelger Pump Station. The first 1.5 miles of the Main Canal, starting at the Pelger Pumping Plant, are lined to minimize losses in areas of high permeability soils. The L-Lateral in the center portion of the Company service area is supplied by Reclamation ponded behind the Pelger Diversion Dam. Table 2-69 summarizes PMWC's primary distribution facilities.

TABLE 2-69
PMWC Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Main Canal	Pelger Pump Station	40	Yes (partial)	NA	15
L-Lateral	N/A	N/A	No	SMWC Reclamation Drain	15

Storage Facilities. PMWC currently has no storage facilities.

Spill Recovery. PMWC has a network of unlined drainage ditches and drain pump stations for conveying irrigation return flows. The drains and pumps are also an integral part of the water supply and distribution system for capturing and reusing. Area drains generally empty into the Reclamation Drain to the east. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These land-owners are not located within the Company service area, but do contribute that may be reused by Company farmers. Tables 2-70 and 2-71 summarize the main PMWC drainage facilities.

TABLE 2-70
PMWC Drain Pump Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Low Lift Drain Pump No. 1	Local drain	Supply ditch	20	1,800
Low Lift Drain Pump No. 2	Local drain	Supply ditch	17	1,000
Low Lift Drain Pump No. 3	Local drain	Supply ditch	9	500
Low Lift Drain Pump No. 4	Local drain	Supply ditch	16	2000
Low Lift Drain Pump No. 5	Local drain	Supply ditch	9	570
Low Lift Drain Pump No. 6	Local drain	Supply ditch	8	500

TABLE 2-71
PMWC Drainage Laterals
Sacramento Valley Regional Water Management Plan

Name	End Spill	Downstream Diverters/Recapture
L-Lateral Drain	Reclamation Drain	SMWC service area users
Multiple Unnamed Drains	Sacramento River and Reclamation Drain	Reclamation Drain diverters

2.4.5.6 District Operating Rules and Regulations

PMWC was organized as a nonprofit corporation principally to supply water for crop irrigation, to maintain ditches, and to repair pump equipment for the Company's stock-holders. The Board of Directors manages the affairs of the corporation. The officers exercise, conduct, and control the corporate powers, business, and property of the corporation and otherwise carry out those policies established by the Board of Directors.

Water rotation, apportionment, and shortage allocation:

> PMWC operates on a modified demand system for irrigation purposes. Orders for irrigation demands must be made in advance (24 hours). Shutoff orders also rely on advance notice (24 hour), and communication between the users and water master are generally through cell phone.
>
> During times of water shortage the Company will increase water recirculation and use of groundwater to supplement available surface water. Since the inception of PMWC, cropping restrictions have not occurred because of water shortage.

Use of drainage waters:

> Drainage reuse is maximized when herbicide policies allow.

Policies for wasteful use of water:

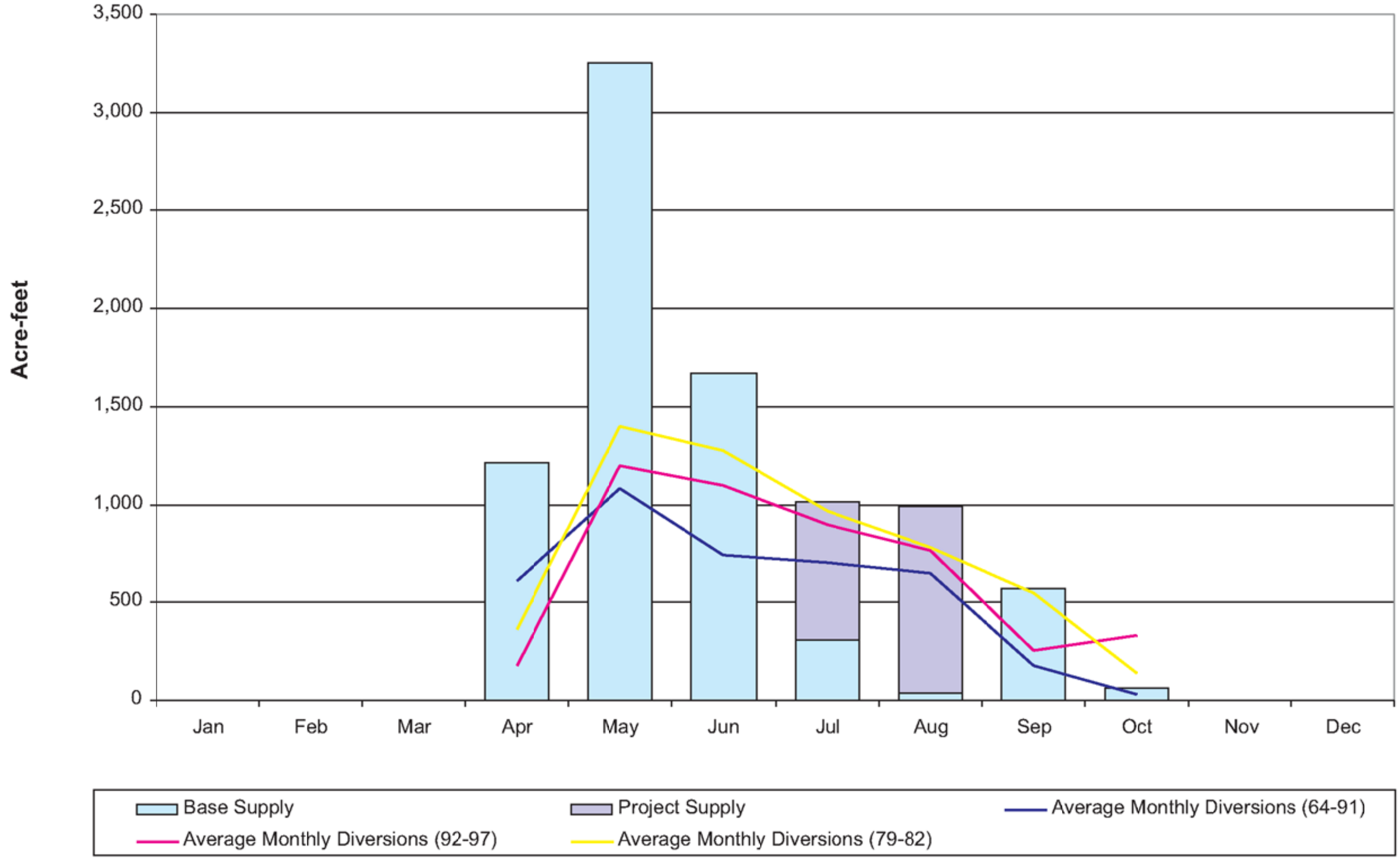
> Because of the small relative size of the Company, wasteful practices are closely monitored. Any problems are addressed prior to use of water in affected areas.

2.4.5.7 Water Measurement, Pricing, and Billing

PMWC currently measures flows at the main pump stations using flowmeters. Flows at lateral headgates are measured using headgate position. Drain pump flows are measured with meters. The three wells each have flowmeters installed. Review of the Company's records for the last ten seasons indicates that the existing water measurement program is very effective in matching supply and demand and accounting for the flow of water at key points in the system. The average deficit between supply into the distribution system and delivery to field turnouts is approximately 15 percent, which is largely accounted for by estimated leakage losses. No beneficial improvements are identified for the Company's water measurement program.

PMWC currently measures the flow rate and the total quantity of water delivered at each turnout. Flow rates are measured using canal stage and turnout gate position. The volume of delivery is measured based on the flow rate and time of delivery. The Company's average on-farm efficiency of approximately 70 percent, estimated using the Department crop consumptive use data and Company field delivery data, is near the upper practical limit for the crop types and irrigation methods in the service area. There is no significant potential for efficiency savings by use of flowmeters at turnouts.

Billing for water is made on a monthly basis in equal installments May-September. Rate costs are by crop per acre (example: rice=$75.00 per acre). Rates are established at PMWC annual meetings held in March of each year. The water master measures water at each turnout and totals water uses by month. A report of measured water pumped and delivered is made available to the shareholders each year after the irrigation season. In addition to water charges for irrigation there is established a Maintenance Assessment of $15.00 per acre.

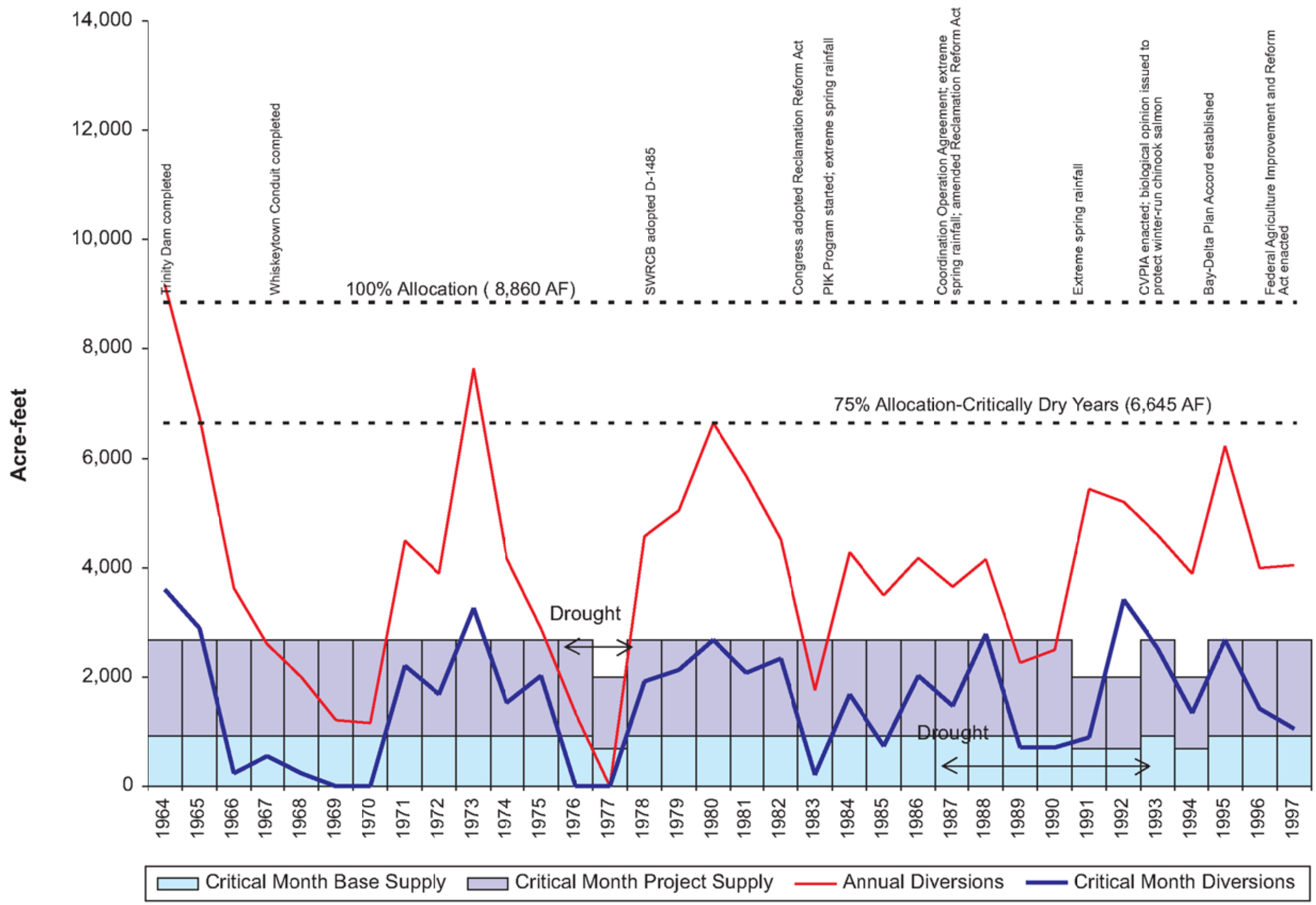


Notes:
1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 2-46
PELGER MUTUAL WATER COMPANY MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGMENT PLAN

CH2MHILL in association with MBK

WB062006010RDD_863 (10/19/06)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-47
PELGER MUTUAL WATER COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGMENT PLAN

CH2MHILL
in association with
MBK

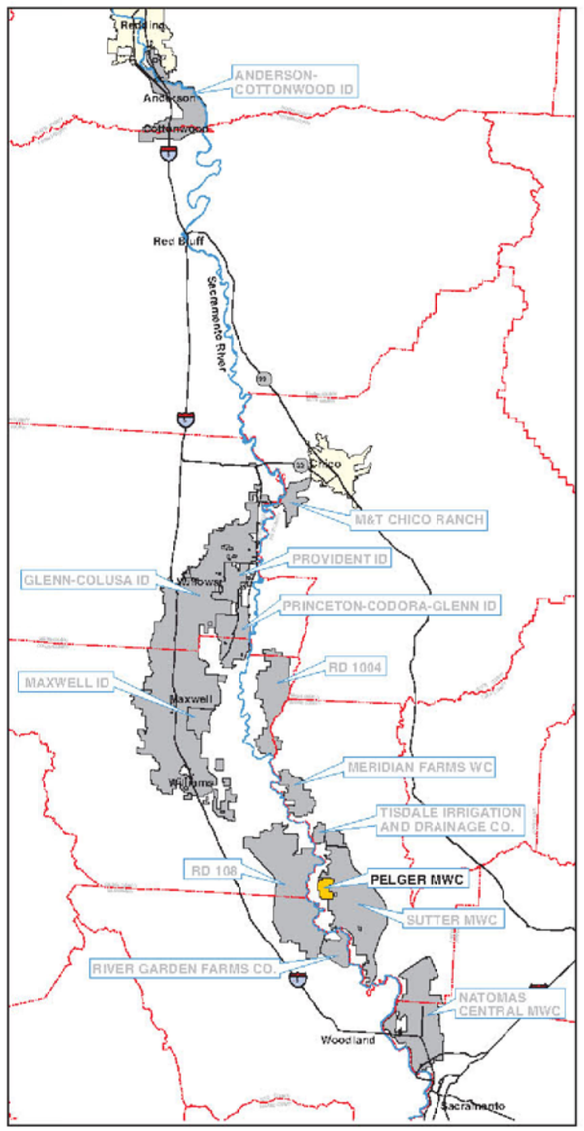
WB062006010RDD_72 (10/19/06)

Pelger Mutual Water Company

Manager: Scott C. Tucker • P.O. Box 488 • Knights Landing, CA 95645 • (530) 735-9455

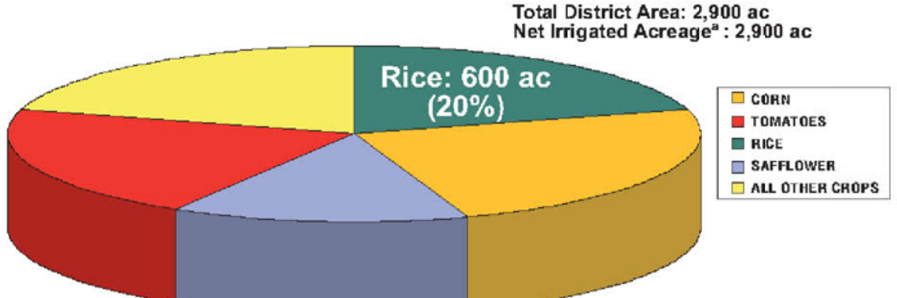
Settlement Contract:	**8,860 af**
Base Supply:	**7,110 af**
Project Supply:	**1,750 af**

Location Map



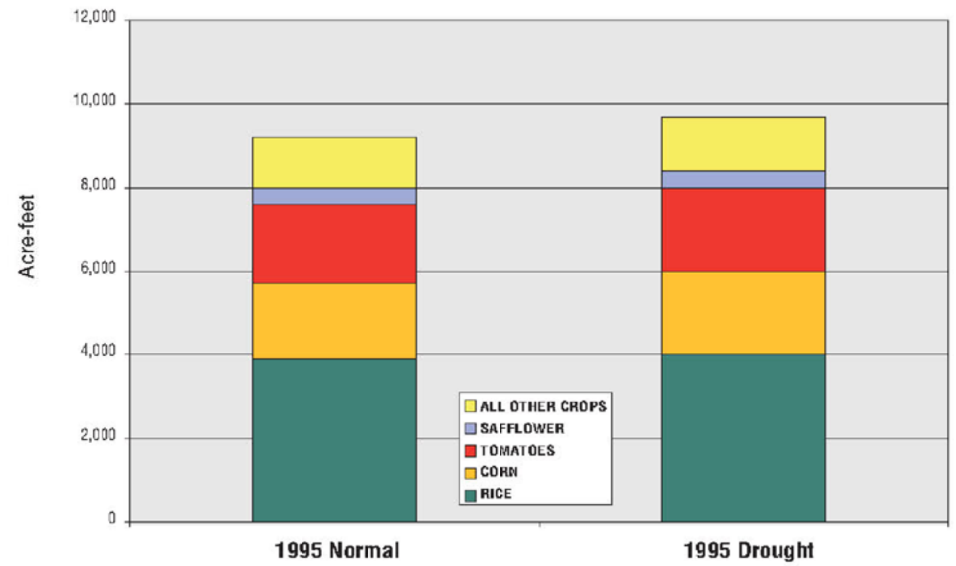
Irrigated Acreage by Crop

Total District Area: 2,900 ac
Net Irrigated Acreage[a] : 2,900 ac

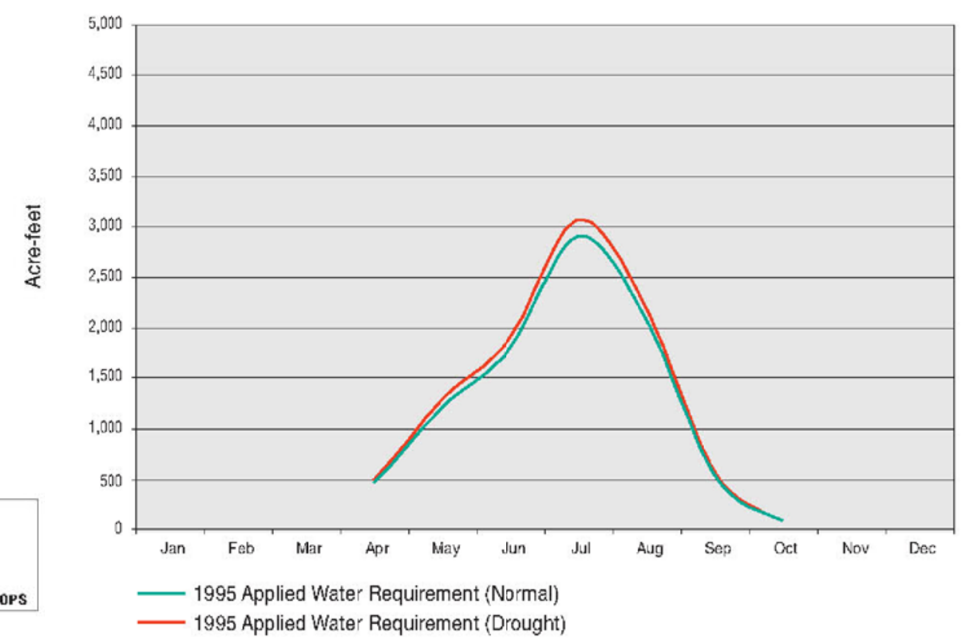


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

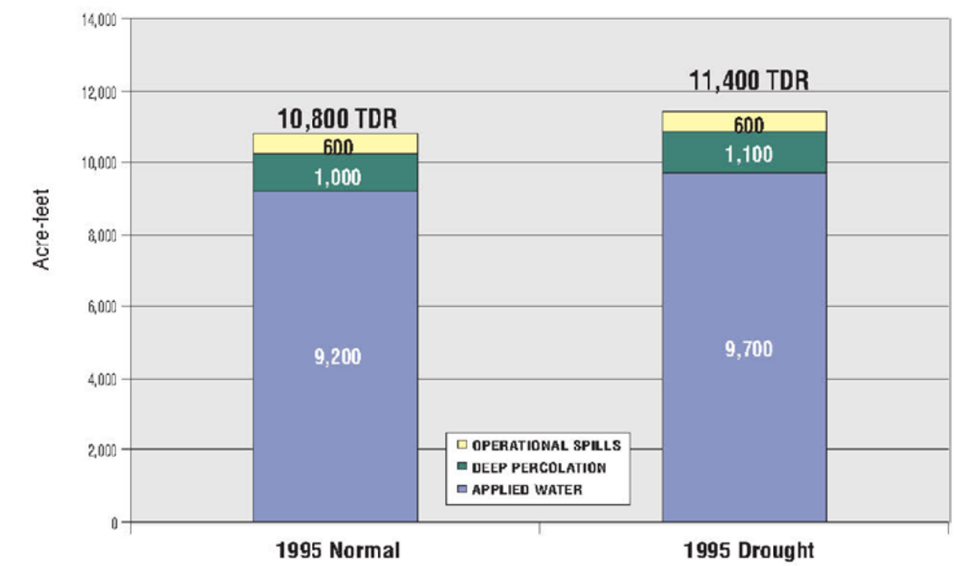


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

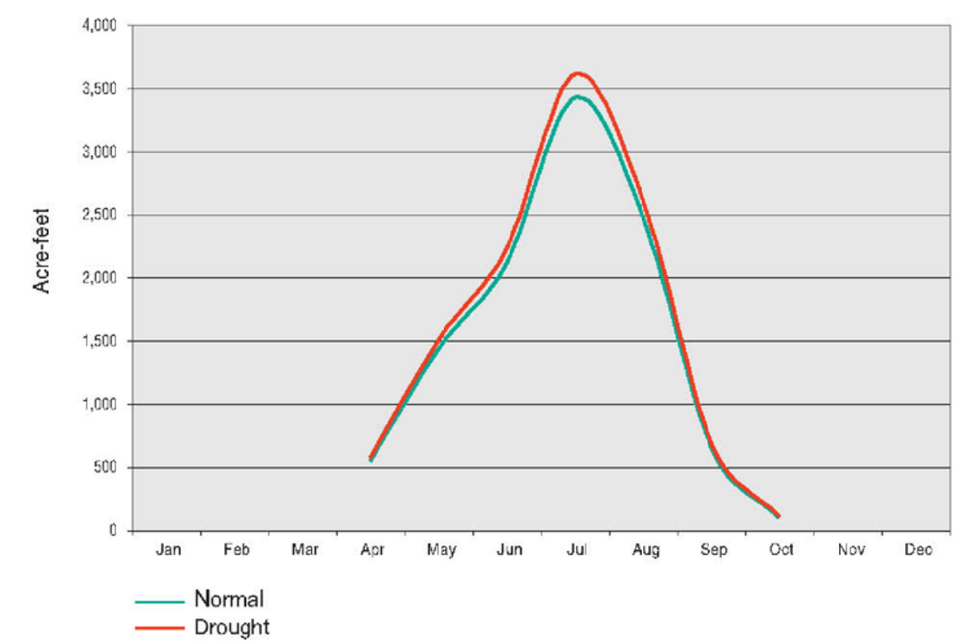


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 2-48
PELGER MUTUAL WATER COMPANY IRRIGATED ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

W032005010RDD_19 _TM 2 (3/25/05)

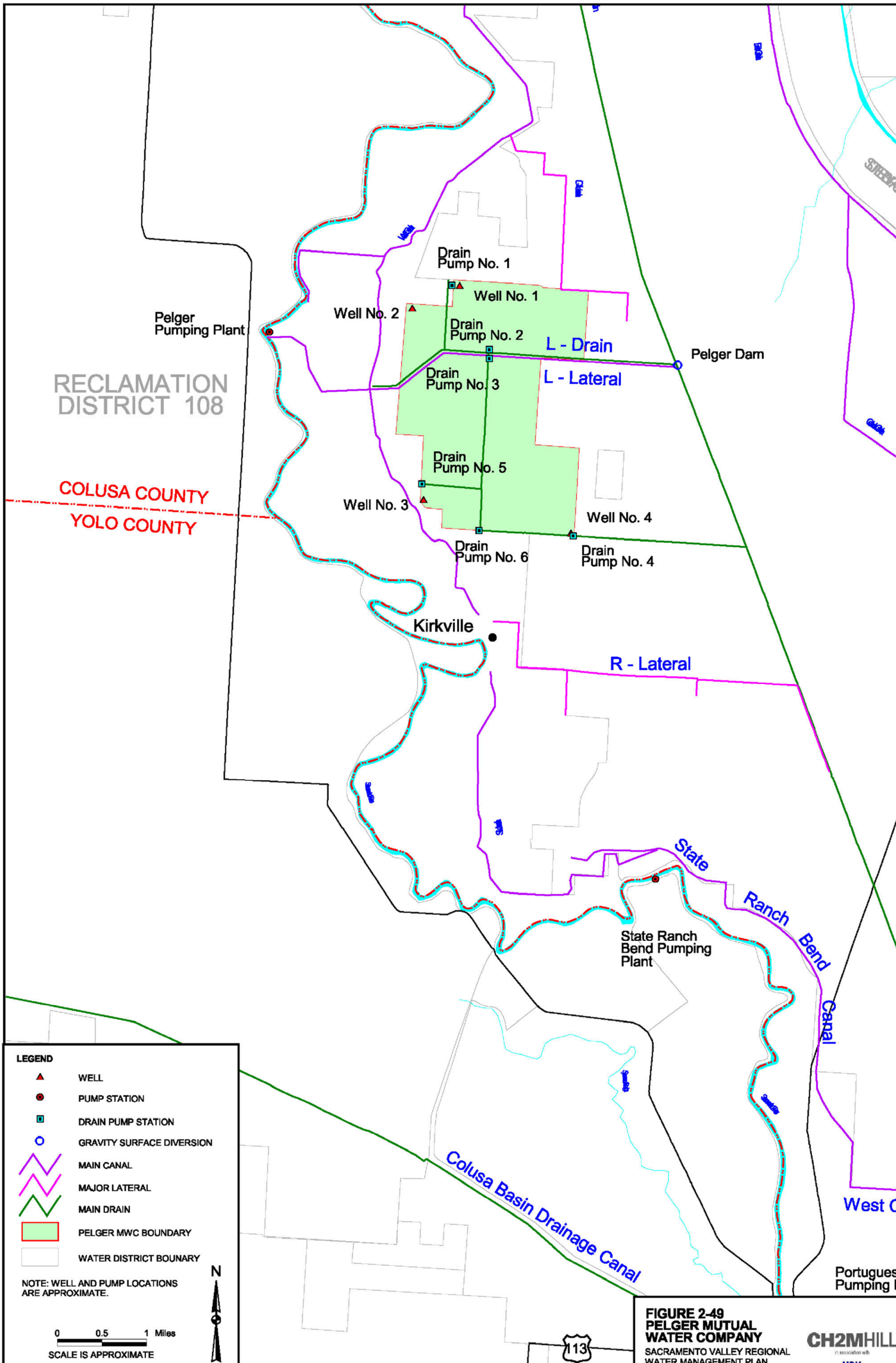


FIGURE 2-49
PELGER MUTUAL WATER COMPANY
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

American Sub-basin

2.5 American Sub-basin

The American Sub-basin, shown on Figure 2-50, is bounded on the west by the Sacramento and Feather Rivers, on the north by the Bear River, and on the south and southeast by the American River. The eastern boundary is defined as the edge of the Valley floor. Like the Redding Sub-basin, this sub-basin is unique in that a large proportion of municipal users are present throughout the area, including parts of the City and County of Sacramento and urban centers in Placer County, such as the City of Roseville. Most of the area is served with surface water or a combination of surface water and groundwater. NCMWC is the only participating SRSC within this sub-basin.

Other Sacramento River Settlement Contracts include Pleasant Grove-Verona Mutual Water Company and numerous short-form SRSCs. Other major water users in the sub-basin include various CVP contractors associated with the American River; South Sutter Water District; Nevada Irrigation District; riparian diverters associated with the Sacramento, American, Feather, and Bear Rivers; and groundwater users. There are no SWP contractors in the sub-basin.

Inflows to the sub-basin include diversions from the Sacramento, Feather, Bear, and American Rivers, and imported water from canals and tributaries originating in the foothills to the east. Outflows occur through the RD 1000 pumping plants (four) to the Sacramento River, and RD 1001 plant to Natomas Cross Canal. Surplus precipitation and return flows from irrigators is rediverted in portions of the sub-basin for further irrigation of crop lands (BWMP TM 3; see Appendix D).

2.5.1 Water Supply within the American Sub-basin

2.5.1.1 Surface Water

Most of the sub-basin is served with surface water or a combination of surface water and groundwater. On average, surface water makes up 60 percent of the American Sub-basin's total water supply (approximately 180 to 220 taf/yr) (BWMP TM 4; see Appendix D). The majority of the surface water diverted to various water users within the American Sub-basin comes from the Sacramento River. Other surface water sources are the Feather, Bear, and American Rivers.

Water availability during critical or shortage years varies by contract type and water right. As dictated by the CVP Settlement contracts, surface water allocations can be reduced up to twenty-five percent of contract total in years determined to be "critical" by Reclamation per the Shasta Index criteria referred to in the contracts. Cities such as Shasta Lake hold M&I Water Service contracts. These contracts include shortage provisions which allow for reductions of up to 25 percent of contract total in extreme conditions. While these two types of contractors represent the vast majority of water users within the American Sub-basin, other users such as those with riparian rights and groundwater users are not subject to contract-related reductions. Additional information related to water shortage allocation policies is provided in Section 1, Regional Description (BWMP TM 6; see Appendix D).

2.5.1.2 Groundwater

Groundwater is a significant source of supply in the American sub-basin and accounts for approximately 40 (approximately 300 to 350 taf/yr) percent of total supply. The American sub-basin overlies the Sacramento Valley Groundwater Basin The Sacramento Valley Groundwater Basin is divided into sub-basins of which the North American Sub-basin (groundwater basin number 5-21.64) is relevant to this section. This groundwater sub-basin is defined and described in more detail in the Department's Groundwater Bulletin 118 individual basin description. The basin description includes details regarding local hydrogeology, groundwater level trends, and groundwater quality. The Department has identified the North American Sub-basin as suitable for further developing conjunctive use management options. Some extraction and transmission, distribution, and monitoring facilities exist and will need to be expanded if a more substantial program is determined feasible.

Geology, Hydrogeology, and Hydrology. The North American Sub-basin covers about 550 square miles in the southeast corner of the Sacramento Valley. The North American Sub-basin is bounded by the American River to the south, the Feather and Sacramento Rivers to the west, the Bear River to the north, and metamorphic rock of the Sierra Nevada foothills to the east. Although these rivers provide substantial recharge to the sub-basin, extensive groundwater extraction in the north Sacramento area is contributing to perennial depressions of groundwater levels in the southern portion of the sub-basin.

The freshwater aquifer system in the North American Sub-basin is composed of Tertiary age volcanic rock and younger continentally-derived sediments. The oldest freshwater-bearing formation is the Mehrten Formation. The Mehrten Formation unconformably overlies marine and brackish-water sediments of Eocene age.

The Mehrten Formation can be divided into two units. The first consists of gray to black andesitic sands, and the second unit consists of dense hard gray tuff breccia. The sands are fluvial deposits derived from andesitic source rock in the Sierra Nevada and contain lenses of sand and gravel, in addition to cobble and boulder material. The second unit is composed of angular andesite blocks and fragments in a cemented matrix of andesitic devitrified lapilli and ash derived from volcanism within the Sierra Nevada. Where present, the tuff breccia yields little water to wells and acts as a confining layer in the subsurface.

Unconformably overlying the Mehrten Formation are the Laguna Formation and the Turlock Lake Formation. These units are exposed in the dissected uplands along the eastern margin of the basin and dip westward beneath the land surface toward the axis of the valley. The formations consist of a heterogeneous mixture of tan to brown interbedded silt, clay, and sand, with occasional gravel lenses. Gravel lenses are poorly sorted and have low permeability. Wells drawing from the Laguna Formation sands and gravels produce significant quantities of groundwater.

Overlying the Laguna and Turlock formations are terrace deposits of the Riverbank and Modesto formations. The maximum combined thickness of these units in this area of the Sacramento Valley is 50 to 75 feet. Overall permeability is moderate with occasional coarse-grained zones of high permeability.

Flood basin deposits and alluvium are the youngest geologic units in the study area.

Conjunctive Water Management and Groundwater Use. A feasibility study by the Department and cooperating districts (American Basin Conjunctive Use Project, June 1997) determined that groundwater recharge by direct methods is not generally suitable for much of the American Sub-basin, and that recharge is likely better accomplished by in-lieu means. However, several key technical issues could not be resolved due to data limitations.

To resolve some of the technical issues, the Sacramento Groundwater Authority (a joint powers authority charged with the protection and regulation of groundwater also known as SGA) is developing a groundwater monitoring network and data management system for the purposes of assessing groundwater resources in the sub-basin and for tracking the performance of future programs.

Attempts to develop a legal and institutional framework to manage groundwater in the American Sub-basin have evolved further than other sub-basins considered in the BWMP. The Sacramento Area Water Forum agreements, of which NCMWC is a signatory as well as the majority of the water users within the American Sub-basin, specifically encourage conjunctive use projects that are designed to meet the objectives described above. Conjunctive use projects of this type must also be consistent with the goals of SGA and a locally constituted AB 3030 Groundwater Management Plan. NCMWC and RD 1000 have developed their own AB 3030 groundwater management plan, and NCMWC is on the board of SGA (BWMP Plan Summary; see Appendix D).

Sacramento Area Water Forum. The Sacramento Area Water Forum was formed in 1993 to discuss ways to accommodate two coequal objectives, provide a reliable and safe water supply for the region's economic health and planned development to the year 2030; and Preserve the fishery, wildlife, recreational and aesthetic values of the lower American River. The Water Forum consists of a number of entities including, the Cities of Sacramento, Galt, and Folsom; County of Sacramento; more than twenty urban and agricultural water agencies; several environmental groups; and representatives from the business community and other community groups (Department Bulletin 160-98). There are seven major elements to the Water Forum Agreement, which must be implemented in combination through 2030 for the Agreement to be successful.

These elements are as follows:

1. Increased Surface Water Diversions
2. Actions to Meet Customers' Needs While Reducing Diversion Impacts in Drier Years
3. Improved Pattern of Fishery Flow Releases from the Folsom Reservoir
4. Lower American River Habitat Management Element
5. Water Conservation
6. Groundwater Management
7. Water Forum Successor Effort

An additional joint power authority within the region that supports and implements objectives of the Water Forum Agreement is the Regional Water Authority. The Regional Water Authority is a joint powers authority that serves and represents the interests of 21 water providers in the greater Sacramento, and Placer and El Dorado County region. Formed in 2001, the Regional Water Authority's primary mission is to help its members protect and enhance the reliability, availability, affordability and quality of water resources (The Water Forum, 2004).

Regional Water Authority programs include the following:

- Implementation of the American River Basin Regional Conjunctive Use Program
- Developing and implementing a regional water master plan, and
- A water efficiency program designed to help local purveyors implement best management practices on a regional basis.

2.5.1.3 Reuse and Other Water Supplies

Although reuse in the sub-basin plays less of a role in terms of overall supply than in relation to other sub-basins within the Sacramento Valley Basin, still accounts for approximately 60,000 ac-ft/yr of sub-basin supply, 35,000 ac-ft of which is in NCMWC. Although this accounts for less than 10 percent of the total supply for the sub-basin reuse allows for increased flexibility in regards to timing and amount of diversions.

Major entities that use or are involved in its management within the American Sub-basin include NCMWC, RD 1000, Pleasant Grove-Verona Mutual Water Company, and RD 1001. A drain management agreement between NCMWC and RD 1000 allows NCMWC to maintain water levels in the RD 1000 drainage canal system that are conducive to the operation of a recirculation system. NCMWC uses this agreement to operate a "closed" irrigation system within the RD 1000 boundaries. RD 1001 also operates a closed irrigation system in conjunction with Pleasant Grove-Verona Mutual Water Company. reuse plays a major role in the sub-basin, increasing the supply flexibility and reliability, as well as the overall water use efficiency of the sub-basin.

NCMWC operates a closed system for several reasons that include water conservation and benefits to the in-basin users, rice growers, and downstream users. The system that NCMWC implements has been recognized by the SWRCB to conserve over 18,000 ac-ft/yr. In-basin users see the benefit of this closed system through the incorporation of the RD 1000 service area runoff, including the non-NCMWC agricultural water users and the M&I water users within the City of Sacramento. This water reuse allows RD 1000 to reduce the use of its discharge facilities, thus reducing costs to its rate payers. The closed system allows rice growers to reduce holding periods for several herbicides. This has been shown to improve crop vitality and increase yields. Lastly, downstream users benefit from this system through prevention of further Sacramento River water quality degradation caused by agricultural runoff.

On the basis of the current high level of reuse, existing informal efforts at regional management practices and the extensive drain reuse infrastructure in place, the American Sub-basin may have potential for effective regional management. Potential management objectives and benefits would likely be similar to the objectives and benefits for other sub-basins (i.e., modification of Sacramento River diversion patterns in support of short-term in-stream flow targets; drought-year increase in reuse, and groundwater use)(BWMP Plan Summary; see Appendix D).

2.5.2 Water Use within the American Sub-basin

2.5.2.1 Agricultural

Agricultural land use accounts for 55 percent of the American Sub-basin's demand. Rice is overwhelmingly the predominant crop within the sub-basin. Other crops include dried plums, peaches, walnuts, and tomatoes, in addition to rotation crops such as wheat and safflower, which are rotated with rice and tomatoes. Within the sub-basin the main water users include NCMWC, South Sutter Water District, Nevada Irrigation District, Pleasant Grove-Verona Water Company, and Placer County Water Agency. Each of these users has different agricultural land uses. Rice is the overwhelmingly predominant crop grown within NCMWC's service area. Other crops include tomatoes and sugar beets, in addition to rotation crops such as wheat and safflower, which are rotated with rice and tomatoes. Rice typically accounts for approximately 70 percent of the Company's irrigated acreage on an annual basis. Agriculture in NCMWC is under increasing pressure to convert to urbanized, residential use in the face of growth in the greater Sacramento region. Additionally, some of the irrigated acreage for urban developments, such as the airport, use Company water for ornamental landscaping. The South Sutter Water District primarily supports field, fruit and nut, and vegetable crops with their agricultural water. The top five leading value crops in 2003 were rice, peaches, dried plums, walnuts, and tomatoes. Within the Nevada Irrigation District, irrigation water is used in gardens, nurseries, orchards and vineyards for both commercial and home production. Grapes, apples, peaches, nuts, berries, corn, rice, wheat, and oats are among the many crops grown with Nevada Irrigation District water. There are an estimated 97,000 irrigable acres in the Nevada Irrigation District, about a third of which are presently in irrigation. About 90 percent of this total is used for local agriculture. In recent years, Nevada Irrigation District has supplied an average 145,000 ac-ft/yr (www.nid.dst.ca.us/Ag_Water.htm; Retrieved 2/23/2005). The top five leading value crops for 2003 for Placer County Water Agency are rice, nursery products, cattle and calf operations, timber productions, and irrigate pastures. In the year 2030, Placer County Water Agency expects to have an agricultural water supply of 140,000 ac-ft, or 62 percent of the total water demand (Reclamation, 2003).

As is the case with most of the other water providers, water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. The vast majority of irrigation water requirements are met through the contract surface water supply, although groundwater is used in drought years on an individual grower basis. Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

In response to increasingly stringent limitations on burning, some of the rice-growing landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 5,780 acres were flooded in 1999 in comparison to 6,700 acres that were flooded in 2004 for NCMWC, a trend that is expected to continue or increase, assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture (BWMP TM 2; see Appendix D).

2.5.2.2 Urban

Compared to the other sub-basins within the Sacramento Valley, the American Sub-basin has the largest M&I water demand. The M&I water accounts for 45 percent of the total sub-basin water demand. The water users within the southern portion of the American Sub-basin, such as NCMWC and Placer County Water Agency have been experiencing increased growth pressure from the Sacramento area

The M&I water demand within the sub-basin is anticipated to increase substantially. For example, the NCMWC's annual water requirements in the year 2020 expected to increase by 80,000 ac-ft (an increase of approximately 40 percent) compared to 1995 estimated levels (Department, Central District). The majority of this water (in addition to current demands) is assumed to be groundwater. Although M&I demands are not currently being served, NCMWC does not preclude the possibility of serving such needs in the future (BWMP TM 2; see Appendix D). Placer County Water Agency expects to see an increase in their future as well. M&I water is expected to make up 38 percent (85,400 ac-ft) of Placer County Water Agency's yearly demand in the year 2030. Due to the regulatory framework created by the Placer County General Plan, which generally disfavors reliance on groundwater, the majority of this M&I water will be reclaimed water (Reclamation, 2003). In the future the M&I user demands can continue to be met by the existing supply mix only at the expense of groundwater supply overdraft (BWMP TM 6; see Appendix D).

2.5.2.3 Environmental

Several environmentally beneficial water management actions and programs have been completed or are underway in the sub-basin. A consolidated NCMWC fish screen improvement project is proposed that would potentially serve as a Sacramento River diversion point for NCMWC, the City of Sacramento, and Placer County. Placer County involvement in the project is dependent on being able to successfully transfer water rights and point of diversion from the American River to the Sacramento River. The City of Sacramento is also in the process of finalizing design on a separate intake structure and screen on the Sacramento River near Richards Avenue.

A habitat conservation plan for the Natomas Basin in Sacramento is currently being implemented. The habitat conservation plan (developed by several agencies including the City of Sacramento) includes 53,342 acres, 8,750 of which are proposed to be protected. The area provides habitat to a number of listed species including valley elderberry longhorn beetle, giant garter snake, various ferry shrimp associated with vernal pools, Aleutian Canada goose, Swainson's hawk, and a variety of non-listed species.

Current and future uses identified within the habitat conservation plan include agriculture, business/commercial construction, residential construction, and utility/infrastructure. The "city" habitat conservation plan was suspended in November 2000 by court order and is expected to resume in 2001. RD 1000 and NCMWC are not signatories to that habitat conservation plan, but are cooperating with the City of Sacramento in its implementation.

In addition, the sub-basin contains rice lands that provide seasonal habitat for waterfowl. As in other sub-basins, the conveyance of water also supports habitat for a variety of species (BWMP Plan Summary; see Appendix D).

2.5.2.4 Transfers and Exchanges

As with other sub-basins, a limited number of water transfers have occurred and will continue as water availability and regulations dictate. Given in-basin needs can be met, the potential for transfers with other Sacramento Valley water users downstream, as well as out-of-basin users, is also a possibility.

NCMWC has been active in the transfer arena, the partially approved/denied proposed short-term out-of-basin transfer in late 1999 of up to 14,000 ac-ft to the SMWD. NCMWC also completed a successful transfer to the Westlands Water District of 3,000 ac-ft in 1992 and conducted a pilot project transfer with the Mohave Water Agency in 1995 for 2,000 ac-ft. That transfer was used as a "test case" in proceeding on the recently partially denied transfer to SMWD.

NCMWC is currently in negotiations with Westlands Water District and the Department (who is representing a group of SWP contractors) to implement a groundwater exchange for approximately 10,000 to 15,000 ac-ft. Other transfers within the sub-basin have included Sacramento County, Placer County, SAFCA, and Sacramento North Area Groundwater Management Authority.

Although NCMWC will likely pursue additional transfers, the Company typically does not have large amounts of surplus water available for transfer given existing crop demands, particularly in dry years. However, the presence of several large municipal users (e.g., City and County of Sacramento, South Sutter Water District, Nevada Irrigation District, and Placer County) will likely encourage transfers that are mutually beneficial. Placer County is in the process of attempting to secure a transfer of water rights and point of diversion from the American River to the Sacramento River.

Water users in the American Sub-basin have engaged in water transfers in the past, and are expected to continue to use transfers to the extent possible. NCMWC is the only SRSC participating in the BWMP within the sub-basin. Although NCMWC is a member of the Pool, it has not contributed or purchased water through the program since 1993. NCMWC has been active in the transfer arena, most recently through the partially approved/denied proposed short-term out-of-basin transfer in late 1999 of up to 14,000 ac-ft to the SMWD via Western water discussed earlier. The Company completed a successful transfer to the Westlands Water District of 3,000 ac-ft in 1992. NCMWC conducted a pilot project transfer with the Mohave Water Agency in 1995 for 2,000 ac-ft. That transfer was used as a "test case" in proceeding on the recently partially denied transfer to SMWD. The Company is currently in negotiations with Westlands Water District and the Department (which is representing a group of SWP contractors) to implement a groundwater exchange for approximately 10,000 to 15,000 ac-ft.

Other transfers within the sub-basin include the following:

- Browns Valley (2,000 ac-ft) – Sacramento County to Leguna area
- Placer County to Sacramento Area Flood Control Agency (2,000 ac-ft)
- Conjunctive water management transfer involving SNAGMA and Sacramento Area Flood Control Agency

Although NCMWC will likely pursue potential water transfers in the future, the Company typically does not have large amounts of water available for transfer given existing crop demands, particularly in dry years. However, the presence of several large municipal users including the City and County of Sacramento and CVP contractors drawing from the American River such as South Sutter Water District, Nevada Irrigation District, and Placer County will likely encourage transfers that are determined to be mutually beneficial. Placer County is currently in the process of attempting to secure a transfer of water rights and point of diversion from the American River to the Sacramento River. In general, users attempting to serve continued urban growth in and around Sacramento can be expected to seek opportunities with NCMWC to secure additional short-term and long-term supplies using transfers as one potential vehicle.

Short-term or temporary transfers could be initiated during drought/critical years when some water purveyors have their surface water supplies reduced sharply, or long-term transfers could be made to permanently reallocate supplies in a beneficial manner. Given in-basin needs can be met, the potential for transfers with other Sacramento Valley water users downstream, as well as out-of-basin users, is also a possibility. Such transfers may also result in net increases in in-stream flows along the segment of the river between the Sacramento Sub-basin and the receiving entity's diversion.

2.5.2.5 Other Uses

Beyond M&I and agricultural use, there are no other significant water uses within the American Sub-basin.

2.5.2.6 Sub-basin Water Budget

The American Sub-basin, shown on Figure 2-50, is bounded on the west by the Sacramento and Feather Rivers, on the north by the Bear River, and on the south and southeast by the American River. The eastern boundary is defined as the edge of the Sacramento Valley floor. Like the Redding Sub-basin, this sub-basin is unique in that a large proportion of municipal users are present throughout the area, including parts of the City and County of Sacramento, and urban centers in Placer County, such as the City of Roseville. Most of the area is served with surface water or a combination of surface water and groundwater.

NCMWC is the only participating SRSC within this sub-basin. Other Sacramento River negotiated agreements include Pleasant Grove-Verona Mutual Water Company and numerous short-form SRSCs. Other major water users in the sub-basin include various CVP contractors associated with the American River, South Sutter Water District, Nevada Irrigation District; riparian diverters associated with the Sacramento, American, Feather, and Bear Rivers; and groundwater users. No SWP contractors are in the sub-basin. A water balance for the American Sub-basin for 2020 average-year conditions is presented on

Figure 2-51. Under 2020 average conditions for this sub-basin, the following projections are made:

- On average, surface water and groundwater pumping will be approximately 60 percent and 40 percent of the total water supply, respectively.
- The SRSC diversions make up approximately one-half of the surface water supply, the balance being associated with local supplies.

For the SRSCs' average 2020 diversions of 165 taf/yr, 145 taf/yr (or 70 percent of this total diversion) is Base Supply, and the remainder is Project Supply. These Project Supply diversions occur during the months of July, August, and September.

- The SRSC diversions could range from 210 taf/yr to 350 taf/yr, depending on hydrologic conditions and other outstanding issues.

Figure 2-52 presents a water use balance for American Sub-basin under 2020 critical-year conditions.

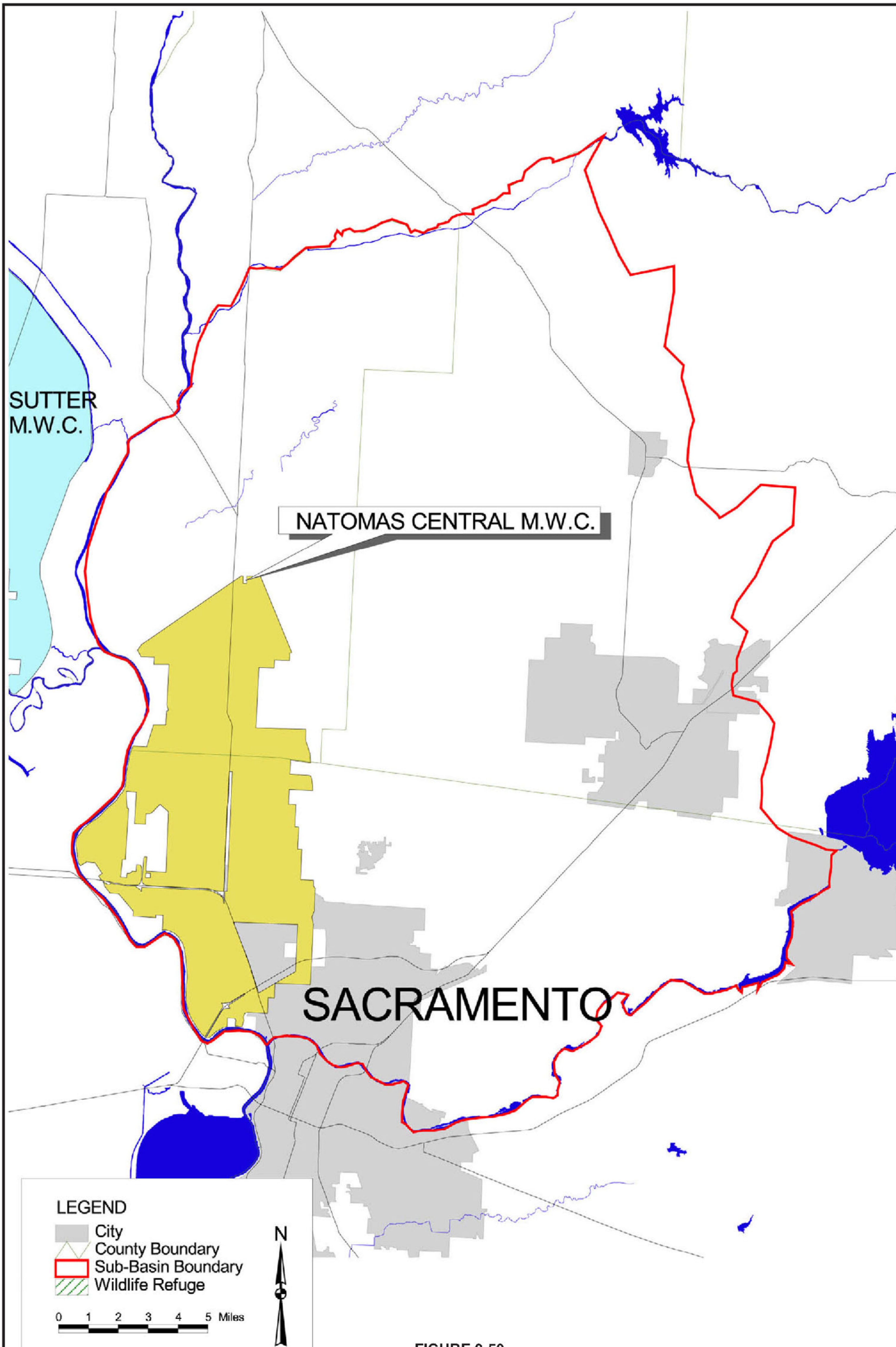
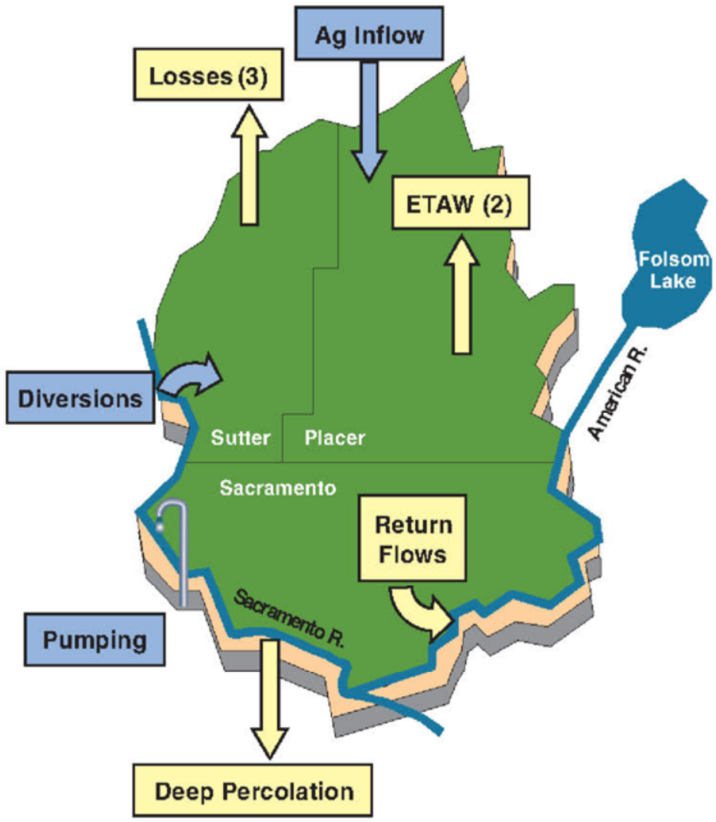


FIGURE 2-50
AMERICAN SUB-BASIN AND PARTICIPATING SACRAMENTO RIVER SETTLEMENT CONTRACTORS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL In association with MBK

W032005010RDD_52 (8/17/05)



WATER USE (1)

ETAW (2):	Agricultural	=	261
	M&I	=	175
Fall Flooding		=	9
Wildlife Refuges		=	45
SUBTOTAL		=	490
Other:	Losses (3)	=	40
	Deep Perc	=	118
	Return Flows	=	150
TOTAL		=	798

WATER SUPPLY

Surface Water Diversions:		
Riparian (4)	=	120
Settlement Contracts:		
Base Supply	=	145
Project Supply	=	20
CVP Water Service Contracts	=	56
Local Surface Water	=	142
SUBTOTAL	=	483
Agricultural Drainage Inflow	=	19
Groundwater Pumping	=	295
TOTAL	=	798

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) American River Water Rights diversions.

FIGURE 2-51
AMERICAN SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL In association with MBK

Natomas Central Mutual Water Company

2.5.3 Natomas Central Mutual Water Company

2.5.3.1 History

NCMWC (or the Company) was organized under the California Irrigation District Act of 1897. The Company entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water it would divert from the Sacramento River. The resulting negotiated agreement recognized NCMWC's annual entitlement to a Base Supply of 98,200 ac-ft/yr of flows from the Sacramento River and also provided for a 22,000 ac-ft allocation of Project Supply, resulting in a total contract entitlement of 120,200 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Supply are identified in Exhibit A to the Settlement Contract for NCMWC, and is included in Table 2-72. The Settlement Contract negotiated in 1964 remains in effect until March 2006. NCMWC is working with Reclamation and counsel to finalize environmental documentation for contract renewal.

TABLE 2-72
Schedule of Monthly Water Diversions – NCMWC
Sacramento Valley Regional Water Management Plan

Month	Base Supply (ac-ft)	Project Water (ac-ft)	Contract Total (ac-ft)
April	14,000	0	14,000
May	27,700	0	27,700
June	23,000	0	23,000
July	11,500	7,200	18,700
August	3,900	14,800	18,700
September	16,100	0	16,100
October	2,000	0	2,000
Total	**98,200**	**22,000**	**120,200**

Notes:

Contract No. 14-06-200-885A-R-1

Points of Diversion: 2.15L, 6.1L, 7.5L, 14.1L, 16.0L, 19.6L (Cross Canals 1.0sS and 2.0S)

In addition to the contract water, NCMWC has entitlements to divert Sacramento River water during the nonirrigation season for wetlands and rice straw decomposition. There are approximately 61 privately owned wells and two NCMWC-owned wells within its boundaries. These wells are used in conjunction with the river pumps and recycling pump to meet irrigation needs on an as-needed basis. Rice is the predominant crop grown within the Company boundaries, in addition to sugar beets and grain.

2.5.3.2 Service Area and Distribution System

NCMWC is located on the east side of the Sacramento River between the towns of Knights Landing and Sacramento in the Counties of Sutter and Sacramento within the southern portion of the American Basin. NCMWC's service area encompasses approximately

55,000 acres, which includes approximately 36,000 acres that are typically irrigated. The Company serves approximately 238 landowners. The Company's service area includes the Sacramento Municipal Airport and several residential developments, which are proposed in response to continued growth within and adjacent to the Sacramento area. NCMWC has three main pump stations located on the Sacramento River: Prichard Lake Pumping Plant, Riverside Pumping Plan, and Elkhorn Pumping Plant. The Company also diverts water from the Natomas Cross Channel, which is located along the northern boundary of the Company. Diversion waters from the Cross Channel subsequently flow from north to south, and water diverted from the Sacramento River flows generally flow from west to east or south.

2.5.3.3 Water Supply

NCMWC holds water rights to divert water from the natural flow of the Sacramento River, the Natomas Cross Canal, and various drains within the Company. These diversions differ in the quantity and timing in which they can be used as indicated in Table 2-73.

TABLE 2-73
NCMWC: Water Rights
Sacramento Valley Regional Water Management Plan

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River, Natomas Cross Canal	A000534 (12/13/16)	000247 (3/16/17)	001050 (5/28/31)	Apr 1 to Oct 1	42.18 cfs
Sacramento River, Natomas Cross Canal	A001056 (8/22/18)	000511 (11/27/18)	002814 (2/18/46)	Mar 15 to Oct 15	38 cfs
Sacramento River, Natomas Cross Canal	A001203 (3/5/19)	000580 (6/10/19)	003109 (9/28/50)	May 1 to Oct 31	160 cfs
Sacramento River, Natomas Cross Canal	A001413 (8/27/19)	001129 (8/16/22)	003110 (9/28/50)	May 1 to Oct 1	120 cfs
Sacramento River, Natomas Cross Canal	A015572 (10/8/53)	015015 (8/26/66)	009794 (5/26/71)	Apr 1 to Jun 30	131 cfs
RD 1000 East Drain, RD 1000 Main Drain, RD 1000 West Drain	A022309 (10/8/65)	015314 (2/21/67)	009989 (1/26/73)	Primary: Mar 1 to Jun 30 Secondary: Sep 1 to Oct 31	14 cfs
Sacramento River, Natomas Cross Canal, RD 1000 East Drain, RD 1000 Main Drain, RD 1000 West Drain	A025727 (5/1/78)	019400 (2/7/85)	Pending	Oct 1 to Apr 1	168 cfs 10,000 ac-ft/yr

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Surface Water. The NCMWC surface water supply entitlement is currently addressed in a contract with Reclamation entered into in 1964, Contract No. 14-16-200-0885A (Contract No. 0885A). This contract provides for an agreement between NCMWC and the United States on NCMWC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract was set to expire March 31, 2004. However, Congress granted a 2-year extension and therefore the contract will remain in effect until March 31, 2006. NCMWC is working with Reclamation and counsel to finalize environmental documentation for the proposed contract renewal, expected to take effect for another 40 years at the end of the 2-year extension.

Contract No. 0885A provides for a maximum total of 120,200 ac-ft/yr, of which 98,200 ac-ft is considered to be Base Supply and 22,000 ac-ft is CVP water (Project Supply), as shown in Table 2-74. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 2-74
NCMWC: Settlement Contract Supply
Sacramento Valley Regional Water Management Plan

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	31,500	22,000
Non-critical Months	66,700	0
Total Annual	**98,200**	**22,000**

The contract specifies the total quantity of water by NCMWC that may be diverted each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 2-53. The monthly Base Supply ranges from a minimum of 2,000 ac-ft in October to a maximum of 27,700 ac-ft in May. CVP water (Project Supply) is available during the months of July and August with entitlements of 7,200 and 14,800 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 31,500 ac-ft, and the total Project Supply is 22,000 ac-ft, as shown in Table 2-73.

Settlement Contract Historical Diversions. NCMWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 2-54. From 1964 to 1971, annual diversions were relatively constant (the exception being 1968). The average annual diversion during this period was approximately 75 percent of the total contract allocation. Between 1972 and 1984, annual diversions increased relative to the earlier time period. With the exception of 1983, annual diversions during this period were consistently above 85 percent of the total contract allocations. Furthermore, NCMWC purchased additional Project Supply above the 22,000 ac-ft in the years 1974 to 1976, 1979 to 1982, and 1984. Beginning in the mid-1980s, annual diversions dropped to below the 75 percent level and have remained at this level through 1997. In 1986, NCMWC implemented a water recycling program, thus reducing their diversions from the Sacramento River.

Referring again to Figure 2-53, average monthly diversions are depicted for the following three periods:

- 1975 to 1981: Period of full acreage farmed and prior to closed system operations.
- 1979 to 1982: Period of near normal hydrologic and water use conditions.
- 1986 to 1997: Period following the closed system operations.

The following observations are noted:

- During the recent period, diversions in April, May, and June show the greatest decline relative to the other two period averages. The primary two factors that contributed to these reductions are increased recirculation of and changes in cropping patterns. During the later time period (1986 to 1997), the crops shifted from wheat, barley, oats, and other "early" irrigated crops to sugar beets and other "late" irrigated crops.
- During all three periods, diversions were greatest during July; however, the largest contract allocation is in the month of May.
- Every year from 1964 to 1997 NCMWC has diverted some portion of their Project Supply during the critical months (also see Figure 2-54).
- During critically dry years, NCMWC has used over 95 percent of its entitlement water (Base and Project Supply) during the critical months (also see Figure 2-54).
- Between 1964 and 1997, NCMWC has purchased additional Project Supply in 9 of the 34 years (also see Figure 2-54).
- Average monthly diversions in October have increased under recent conditions in comparison to conditions prior to 1992. This is a result of flooding fields to decompose rice stubble.
- Increased use of the RD 1000 drainage system as a conduit to a larger number of acres has increased the water use efficiency of NCMWC.
- "Closing" the basin (restricting return flows to the river) has allowed NCMWC to use, not only its own, but also the from other river diverters and groundwater users in the sub-basin—this includes the City of Sacramento and Sacramento International Airport.
- During "high river" levels, NCMWC can capture groundwater inflow that occurs along its western border with the Sacramento River.
- As the Company has increased its ability to deliver water in a timely manner to more acres in the northern area, the basin's rice production has become more concentrated in that area. This concentration has helped to improve "flooding times."

Non-contract Period (November – March). Contract No. 0885A does not limit NCMWC from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. In response to increasingly stringent limitations on burning, many of the Company's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. The number of flooded acres has consistently increased since 1994. In 1994, 500 acres were flooded in comparison to 4,000 acres in 1998.

Other Surface Water Sources. NCMWC has water rights to several of the drainage facilities located within or bordering the Company including RD 1000 East Drain, RD 1000 West Drain, and the RD 1000 Main Drain.

Groundwater. The total thickness of the freshwater aquifer increases from a few hundred feet in the east to more than 2,000 feet to the west. The area is located on recent alluvial sediments including: channel, floodplain, basin, and terrace deposits. Flood basin and channel deposits have a maximum thickness in the area of approximately 100 feet. Flood basin sediments are deposited in low-energy environments; therefore, they typically exhibit low permeabilities. Stream channel sediments are deposited in higher energy environments. Because they are coarser grained, these materials generally have high permeabilities.

Underlying recent fluvial deposits are the Riverbank and Modesto Formations. These units consist of terrace deposits that range in thickness from 50 to 75 feet. Permeability of these formations is generally moderate; however, the occasional coarse-grained lenses have high permeability. These sediments are underlain by older deposits of the Laguna and Turlock, and Mehrten Formations (Department, 1978; Department, 2003c).

The Laguna and Turlock Formations underlie the Riverbank and Modesto Formations. These units are exposed along the eastern margin of the basin and dip westward (Page, 1980). Thickness of these formations is generally less than 200 feet. Deposits consist of a heterogeneous assemblage of interbedded silt, clay, and sand with gravel lenses. The coarse-grained deposits yield large quantities of water to wells.

The Mehrten Formation forms the base of the fresh-water aquifer system in the North American Sub-basin. This formation consists of two distinct units. The first unit consists of gray to black andesitic sands and gravels deposited by streams eroding the Sierra Nevadas. The second is a dark gray tuff breccia. Sand and gravel deposits have high yields, while the lower permeability breccias act as confining units (Department, 2003c).

Groundwater quality in the Sacramento Groundwater Basin is generally good and sufficient for agricultural, domestic, and M&I uses. In general, natural groundwater quality is influenced by streamflow and recharge from the surrounding Coast Ranges and Sierra Nevada. Runoff from the Sierra Nevada is generally of higher quality than runoff from the Coast Ranges, because of the presence of marine sediments in the Coast Range (Department, 2003c). The total depth of fresh water in the NCMWC area is approximately 1,400 feet bgs (Berkstresser, 1973). The fresh water is underlain by saline water.

Groundwater movement in the NCMWC area is influenced by the pumping depression present in the southern portion of the American River Sub-basin, groundwater sub-basin number 5-21.64. Groundwater in the southern portion of the Company flows to the southeast, toward the pumping depression, at a gradient of 10 feet per mile. In the northern portion of the Company, groundwater flows to the south, towards the Sacramento River, at a gradient of 4 feet per mile (Department, 2003c). Seasonal fluctuations of groundwater levels in the unconfined portion of the aquifer system ranges from 2 to 6 feet during years of normal precipitation and can range up to 10 feet during drought conditions (Department, 2003b). In the semi-confined portion of the aquifer system, groundwater levels fluctuate 3 to 6 feet annually, up to 25 feet during drought conditions (Department, 2003b). Wells located near recharge sources typically show less of an annual change in groundwater levels.

Past pumping and drought conditions have not historically negatively affected the overall long-term groundwater level trends in NCMWC. Near NCMWC, in a large part of northern Sacramento County immediately to the east of NCMWC, substantial historical M&I pumping stress has resulted in a progressive groundwater-level decline on the order of 1.5 feet per year for the last 50 years. Despite those conditions, which have a slight boundary effect in the southeastern part of NCMWC, the historical lack of groundwater development in NCMWC has resulted in long-term, relatively stable, high groundwater levels in the NCMWC area.

Other Water Supplies. In recent years, NCMWC has relied heavily upon tailwater as an alternate supply to its Sacramento River entitlement. The source of this tailwater has been primarily from inside of the Company, although some tailwater is available from the lands on the western edge of the Company which are adjacent to the Sacramento River (approximately 7,000 acres). High groundwater levels in much of the Company service area also contribute inflow to the drains. Approximately 35,000 ac-ft of tailwater are used annually. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity, pH, and other constituents that affect crop productivity and sustainability.

The Company completed the installation of a recirculation system in 1986, to improve water quality for the City of Sacramento and increase overall efficiency within the Company boundaries. The recirculation system has since provided for the following benefits:

- Improve water quality discharge from RD 1000 pumping plants into the Sacramento River.
- Reduce pumping during the summer months by RD 1000, thus reducing their operation costs.
- Increase water availability to parts of service area with a history of "poor service."
- Reduce costs to customers (drain rate) who install drain pumps to receive tailwater exclusively.
- Reduce diversions and water costs paid (Restoration Fund) for Project Supply.
- Improve water conservation practices through the installation and operation of a Companywide recycling program.
- Improve rice yields by reducing the "holding time" for herbicides on the field level.
- Allow greater flexibility for growers in method and timing of water application and crop selection without the institution of a metered water charge system.

The recirculation system includes 30 pumping stations at various locations that recapture water for reuse either directly into fields or back into the main irrigation canals. During a normal irrigation season, no agricultural drainage water returns to the Sacramento River until after the end of the rice irrigation season (between August 15 and September 1).

2.5.3.4 Water Use

District Water Requirements. Rice is the overwhelmingly predominant crop grown within NCMWC's service area. Other crops include tomatoes and sugar beets, in addition to rotation crops such as wheat and safflower, which are rotated with rice and tomatoes. Rice typically accounts for approximately 70 to 75 percent of the Company's irrigated acreage on an annual basis. Agriculture in NCMWC is under increasing pressure to convert to urbanized, residential use in the face of growth in the greater Sacramento region. Additionally, some of the irrigated acreage for urban developments, such as the airport, use Company water for ornamental landscaping.

As is the case with most of the other water providers, water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. The vast majority of irrigation water requirements are met through the contract surface water supply, although groundwater is used in drought years on an individual grower basis, as well as per agreements with the Company. Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 2-75 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (± percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 2-75
NCMWC Irrigated Acreage – 1995 and 2020 Estimates
Sacramento Valley Regional Water Management Plan

Crop	1995[a, b]	2020[c]
Rice	18,000	13,700
Sugar Beets	3,700	1,800
Corn	1,000	700
Tomatoes	600	500
Other Crops	600	4,600
Total Irrigated Acreage	**23,900**[b]	**21,300**

[a]Values are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: Department, Central District.

[b]Acreages are based on NCMWC's actual deliveries; land use is changing. See Appendix B for further information.

[c]Values are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: Department, Central District.

Figure 2-55 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, some of the Company's rice-growing landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 5,780 acres were flooded in 1999 and 6,700 acres were flooded in 2004, a trend that is expected to continue or increase, assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Urban. As noted above, NCMWC has been experiencing increased growth pressure from the Sacramento area. The Company does not currently provide treated water for M&I, although it does provide water for landscaping. The Company's Board of Directors is currently coordinating with the City and County of Sacramento to accommodate projected urban growth in the Natomas area.

M&I water demand within the American Sub-basin, which includes NCMWC, is anticipated to increase substantially, with additional annual water requirements in the year 2020 expected to increase by 80,000 ac-ft (an increase of approximately 40 percent) compared to 1995 estimated levels (Department, Central District). The majority of this water (in addition to current demands) is assumed to be groundwater. With the exception of the Sacramento Airport M&I demands are not currently being served, the Company does not preclude the possibility of serving such needs in the future.

Environmental. Company lands are currently included in the Natomas Basin Habitat Conservation Plan that has been prepared to address long-term habitat needs for the giant garter snake, the American peregrine falcon, the valley elderberry longhorn beetle, and multiple other state- and federal-listed or threatened species. The preparation of the Natomas Basin Habitat Conservation Plan underscores the continuing resource agency concern with the continued urban development of lands within the NCMWC service area, which currently provide valuable habitat for a number of sensitive species. Adoption and implementation of this habitat conservation plan has placed additional constraints on both agricultural and M&I water use, including mandatory deliveries of water in the winter and cropping requirements. However, implementation of the Natomas Basin Habitat Conservation Plan is expected to limit the amount of additional Company lands that could be converted to urban use.

Approximately 635 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake and other species that use such habitat as discussed above.

Up to 6,700 acres of rice stubble were flooded in 2004, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. Additionally, the Company serves approximately 16,380 acres of privately owned duck clubs within the Company. Of these lands, the

Natomas Basin Conservancy manages approximately 1,031 acres of environmental or wetlands areas within the Company. By 2020 is anticipated that NCMWC will have 1,500 acres of managed marsh/wetlands, and an additional 4,500 acres of agricultural land owned and operated by the Natomas Basin Conservancy.

Groundwater Recharge. Intentional groundwater recharge is not currently practiced in the Company. Incidental groundwater recharge occurs routinely from groundwater percolation resulting from conveyance losses and irrigation application practices.

Topography and Soils. The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter and Sacramento Counties.

Soil profile characteristics in the Sutter and Sacramento County areas of NCMWC are as follows (Appendix C):

- San Joaquin-Cometa: Moderately deep and very deep, level to nearly level, well-drained sandy loam and loam on terraces.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.
- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.
- Sailboat-Scribner-Cosumnes: Somewhat poorly drained and poorly drained silt to clay loam with a seasonal high water table and are protected by levees.
- Egbert-Valpac: Somewhat poorly drained and poorly drained silty clay loam with a high water table throughout the year or during part of the year and are protected by levees.
- Columbia-Cosumnes: Sandy loam to silt loam, somewhat poorly drained soils that are subject to flooding or are protected by levees.
- Clear Lake: Somewhat poorly drained clay that has a seasonal high water table, is protected by levees, and is very deep or deep over a cemented hardpan.
- San Joaquin: Moderately well-drained loam that is moderately deep over a cemented hardpan.

Transfers and Exchanges. NCMWC has been active in the transfer arena, through the partially approved/denied proposed short-term out-of-basin transfer in late 1999 of up to 14,000 ac-ft to the SMWD. NCMWC also completed a successful transfer to the Westlands Water District of 3,000 ac-ft in 1992 and conducted a pilot project transfer with the Mohave Water Agency in 1995 for 2,000 ac-ft. That transfer was used as a "test case" in proceeding on the recently partially denied transfer to SMWD. Other transfers within the sub-basin have included Sacramento County, Placer County, SAFCA, and Sacramento North Area Groundwater Management Authority.

Although NCMWC will likely pursue additional transfers, the Company typically does not have large amounts of surplus water available for transfer given existing crop demands, particularly in dry years. However, the presence of several large municipal users (e.g., City and County of Sacramento, South Sutter Water District, Nevada Irrigation District, and Placer County) may encourage transfers that are mutually beneficial.

Other Uses. No other significant water uses other than those discussed above occur within NCMWC.

2.5.3.5 District Facilities

Diversion Facilities. NCMWC has three main pump stations located on the Sacramento River: Prichard Lake Pumping Plant, Riverside Pumping Plant, and Elkhorn Pumping Plant. NCMWC also diverts water from the Cross Canal at the Northern Main Pumping Plant. The Cross Canal is located along the northern boundary of the service area. Diversions from the Cross Canal generally flow from north to south; water diverted from the Sacramento River generally flows east or south. Table 2-76 summarizes these surface water supply facilities. A separate 75-cfs capacity pump at the Elkhorn Pumping Plant supplies landscape irrigation water for the Sacramento Metropolitan Airport. See Figure 2-56 for a map of NCMWC's major conveyance facilities.

The Company owns groundwater wells, which are rarely used for water supply.

TABLE 2-76
NCMWC Surface Water Supply Facilities
Sacramento Valley Regional Water Management Plan

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Northern Main Pumping Plant	Cross Canal	Pump	NA	37,00
Prichard Lake Pumping Plant	Sacramento River	Pump	NA	10,000
Elkhorn Pumping Plant	Sacramento River	Pump	NA	10,500
Bennett Pumping Plant	Cross Canal	Pump	NA	15,200
Riverside Pumping Plant	Sacramento River	Pump	NA	7,000

Note:

NA = not available

Conveyance System. NCMWC's distribution and conveyance system includes approximately 260 miles of canals and laterals. Two main canals, the Northern Main Canal and the Chappel Main Canal, serve the northern and eastern portion of the Company service area with water from the Northern Main Pumping Plant. The Central Main Canal, the Garden Highway Canals, and their associated laterals serve the central and southern portions of the service area. Table 2-77 summarizes the main distribution facilities.

TABLE 2-77
NCMWC Canals and Laterals
Sacramento Valley Regional Water Management Plan

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Bennett Main Canal	Bennett Pumping Plant (Cross Canal)	NA	No	Sankey Road Ditch	NA
Central Main Canal	Prichard Lake Pumping Plant	NA	No	Plant 13 Pumps/Plant 8 Pumps	NA
Northern Main Canal	Northern Pumping Plant (cross canal)	NA	No	Swimming Hole Diversion	NA
Chappel Main Canal	Northern Main Pumping Plant	NA	No	None	NA
East Drain	East Drain Pumps	NA	No	None	NA
Garden Highway South	Drain Pump No. 3	NA	No	None	NA
Garden Highway North	Elkhorn Pumping Plant	NA	No	None	NA
Reservoir Road	Elkhorn Pumping Plant	NA	No	Airport Drain	NA
State Check Ditch	Plant No. 13 Pumps	NA	No	Del Paso Road	NA
Pullman	Pullman Pumps	NA	No	No. 3	NA
No. 3	Pullman	NA	No	Lateral 3C	NA
No. 8	Central Main Canal	NA	No	Sills Lateral	NA
No. 13	Plant No. 13 Pumps	NA	No	State Check Ditch	NA
GB	Central Main Canal	NA	No	No. 8	NA

Note:

NA = not applicable

Storage Facilities. NCMWC currently has no storage facilities.

Spill Recovery. NCMWC is drained by four main drainage canals: Natomas East Main Drainage, North Drainage, East Drainage, and West Drainage Canals. The Natomas East Main Drainage Canal drains directly into the Sacramento River, just north of its confluence with the American River. The West Drainage Canal and the East Drainage Canal join in the south and drain to the Sacramento River in the southern portion of the Company via a drain pump. In addition, the Company completed the installation of a recirculation system in 1986 to increase water quality for the City of Sacramento and increase overall efficiency of the Company. The recirculation system includes 30 pumping stations at various locations that recapture for use either directly onto fields or back into the main irrigation canals.
Tables 2-78 and 2-79 summarize the main NCMWC drainage facilities.

TABLE 2-78
NCMWC Drain Pump Stations
Sacramento Valley Regional Water Management Plan

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Snake Ditch Pump	Main Drainage Canal	Snake Ditch	NA	NA
San Juan 30 Horse Pump	San Juan Horse Ditch	San Juan Lateral	NA	NA
Plant No. 13 Pumps	West Drainage Canal	No. 13	NA	NA
Plant No. 8 Pumps	East Drainage Canal	H Road Lateral	NA	NA
East Drain Pumps	Lateral of East Drainage Canal	East Drain	NA	NA
T-Drain Pump	T-Drain	Northern Main	NA	NA

Note:

NA = not available

TABLE 2-79
NCMWC Drainage Laterals
Sacramento Valley Regional Water Management Plan

Name	End Spill	Downstream Diverters/Recapture
T-Drain	Northern Main Canal	NA
North Drainage Canal	H1/Pullman Pumps	NA
East Drainage Canal	Natomas East Main Drainage Canal	NA
Airport Drain	West Drainage Canal	NA
West Drainage Canal	Fisherman's Lake/Natomas Main Drainage	NA
Fisherman's Lake	West Drainage Canal	NA
San Juan 30 Horse Ditch	West Drainage Canal	NA
Natomas East Main Drainage Canal	RD 1000 Pumping Plant	NA

During the growing season, drains are managed by NCMWC to deliver water. RD 1000 manages the in the off season (after October 1), when most drainage is returned to the Sacramento River.

2.5.3.6 District Operating Rules and Regulations

NMWC is a private Mutual Water Company as defined in the California Public Utilities Code, Section 2705, formed for the delivery of water to its shareholders at cost. NMWC is subject to local land use controls, including those of Sacramento and Sutter Counties and the City of Sacramento. The service area of the NMWC, as defined by its contract for water with Reclamation, consists of the entire Natomas Basin. Within this defined 55,000-acre service area, NMWC controls surface water rights for over 280 landowners who are shareholders of the Mutual Water Company. NCMWC is governed by a seven-member Board of Directors, which is elected every year by its shareholders.

Water rotation, apportionment, and shortage allocation:

> Policy 25 of NCMWC Water Policies: *All requests for water will be filled on the basis of when the request was submitted and the availability of water in each particular service area. Water requests will be filled as soon as possible and a request submitted before 11:00 a.m. will be filled that same day, when water is available. Requests submitted after 11:00 a.m., may not be filled until the following day, unless it is an emergency situation.*

Use of drainage water:

> Policy 8 of NCMWC Water Policies: *The water within all of the drainage canals is the sole property of the Company. The staff has been directed to maintain the drain canals at a consistent level. The water level for each drainage system is set to maximize the efficiency of the Company pumps which operate out of that system, but prevent drain water from reentering fields that are in the lower parts of that drain system.*

Policies for wasteful use of water:

> Policy 12 of NCMWC Water Policies: *Excessive spillage or dumping of water into the drains must be avoided to prevent the problem of drain level fluctuations. The field staff has been directed to report any spillage that looks to be out of the ordinary or excessive. The Company's permits and contract for water are based upon its ability to assure "Reasonable and Beneficial Use of a Public Resource" and its use of a number of "Best Management Practices." Several of those "practices" involve the reduction and/or elimination of spillage from all crops. You will be notified of any spills that are deemed excessive and be asked to reduce the spills. If management feels that spills continued to be above reasonable levels, it will be forced to reduce or stop the delivery of water to the identified parcel.*

2.5.3.7 Water Measurement, Pricing, and Billing

NCMWC measures water at its five Sacramento River diversion pump stations using flowmeters provided by Reclamation. No flow measurements are taken and recorded internally on any of the main canals or laterals. Adjustments to water flows for delivery purposes are made manually, using a method of approximation. This method is highly labor intensive but has proven successful for improving water management.

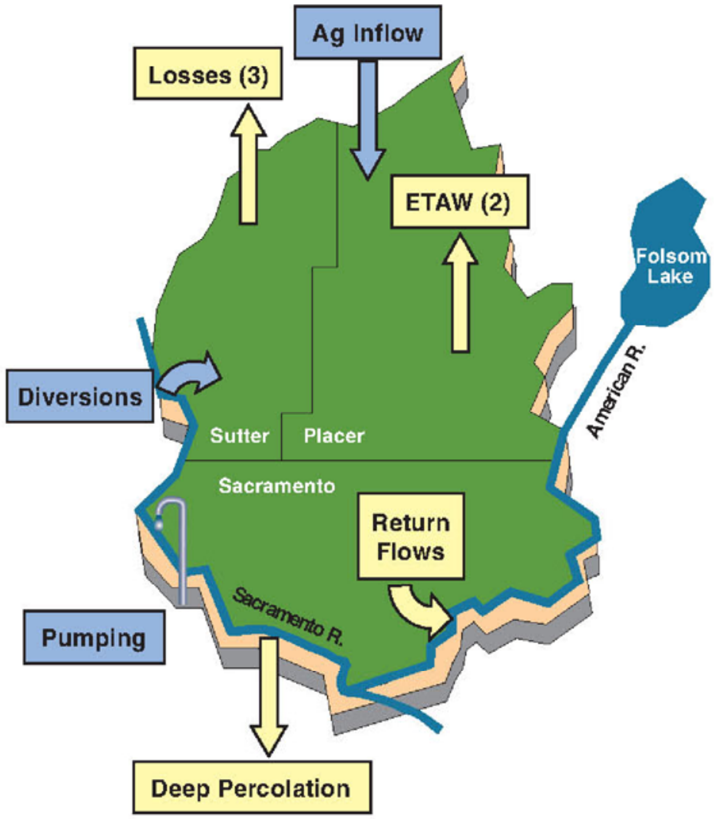
The Company's internal drain pumps and secondary lift pumps are not equipped with any type of measuring device. Delivered water volumes from these facilities are estimated based on power consumption and pump efficiency data. This method is also used to estimate the outflow amounts from RD 1000's drainage pumps into the Sacramento River. Only RD 1000 has the ability to discharge water back into the river.

Through the installation and use of flow measuring devices on its internal pumping plants and in the main canals and laterals, the Company believes there is potential for some level of improved management. It is possible that water savings might occur by eliminating excess water usage through measured water deliveries. These improvements would complement the automation improvements discussed in the previous section.

NCMWC does not meter individual customer turnouts. The Company's current water rate structure does not require the field staff to measure and record the total quantity of water delivered to each turnout. Its rate structure is an annual flat rate, per-acre charge for rice and wild rice crops, with a modified, annual flat rate, per-acre charge for other crops. The modified flat rate varies according to the number of times water is applied to a crop. Crops applying water more often are charged more per acre (unrelated to measurement). The Company also provides a discount to growers extracting their own irrigation water from the drains.

Field measurement and quantification, in combination with an appropriate incentive pricing structure and on-field improvements, may increase the average on-farm efficiency. The effective implementation of such a program would depend on optimal combination of the above components, in addition to basic economic considerations such as the return on investment to the Company and landowners. However, the overall NCMWC efficiency is high and, therefore, it is questionable what benefits are gained from increasing on-farm efficiency.

The installation, maintenance, and reading of meters for the nearly 400 turnouts would represent a prohibitively expensive capital cost to the Company, as well as the assumption of ongoing labor and capital expense. Improved measurement and quantification of deliveries may be possible with improved water level control, as discussed above. This would allow the Company's field staff to begin recording start/stop times and average flow rates for each delivery order.



WATER USE (1)

ETAW (2):	Agricultural	=	305
	M&I	=	201
Fall Flooding		=	9
Wildlife Refuges		=	45
SUBTOTAL		=	560
Other:	Losses (3)	=	34
	Deep Perc	=	111
	Return Flows	=	37
TOTAL		=	743

WATER SUPPLY

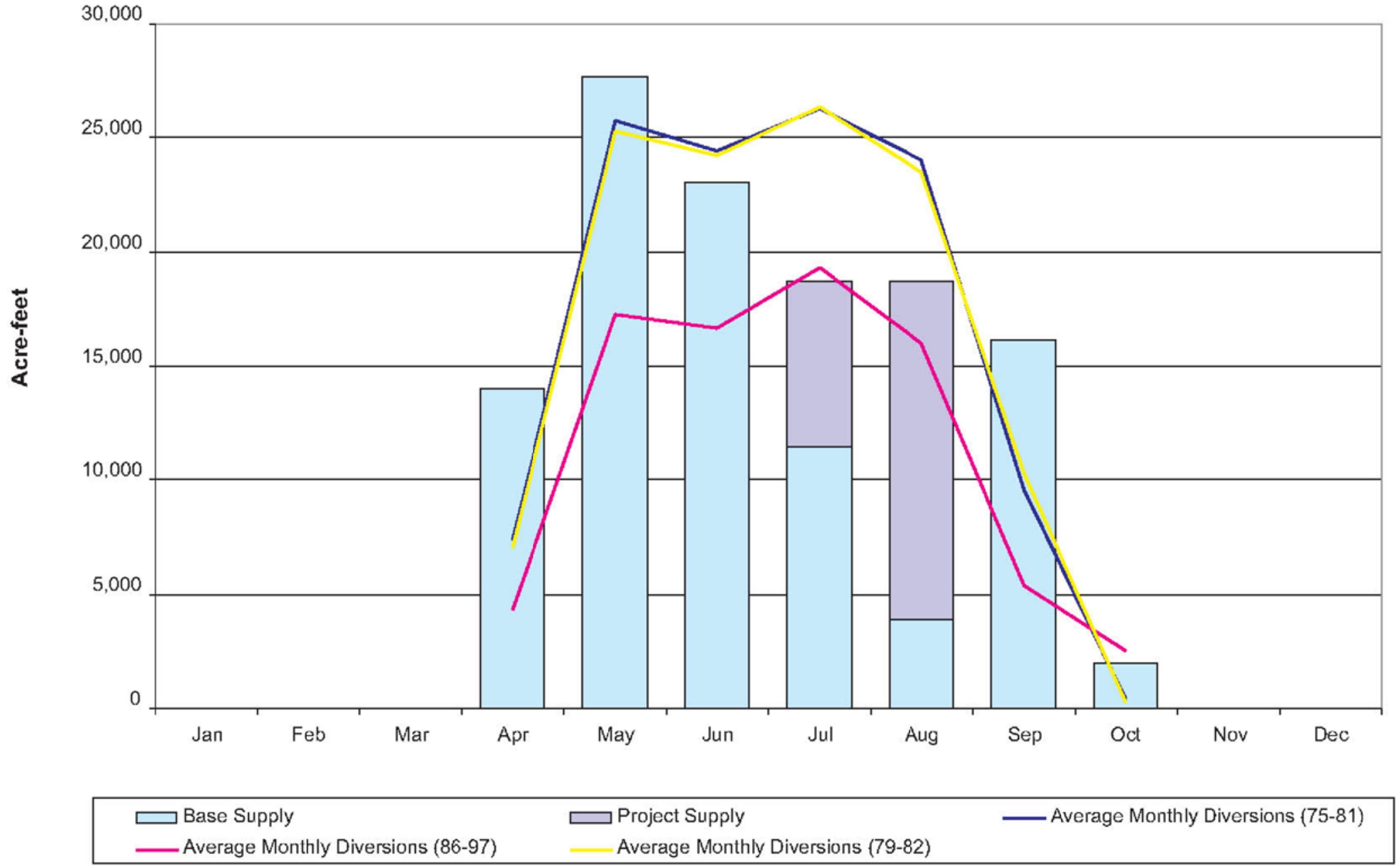
Surface Water Diversions:		
Riparian (4)	=	92
Settlement Contracts:		
Base Supply	=	118
Project Supply	=	18
CVP Water Service Contracts	=	42
Local Surface Water	=	128
SUBTOTAL	=	398
Agricultural Drainage Inflow	=	19
Groundwater Pumping	=	295
TOTAL	=	712

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) American River Water Rights diversions.

FIGURE 2-52
AMERICAN SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

W032005010RDD_708 (8/17/05)

CH2MHILL
In association with
MBK



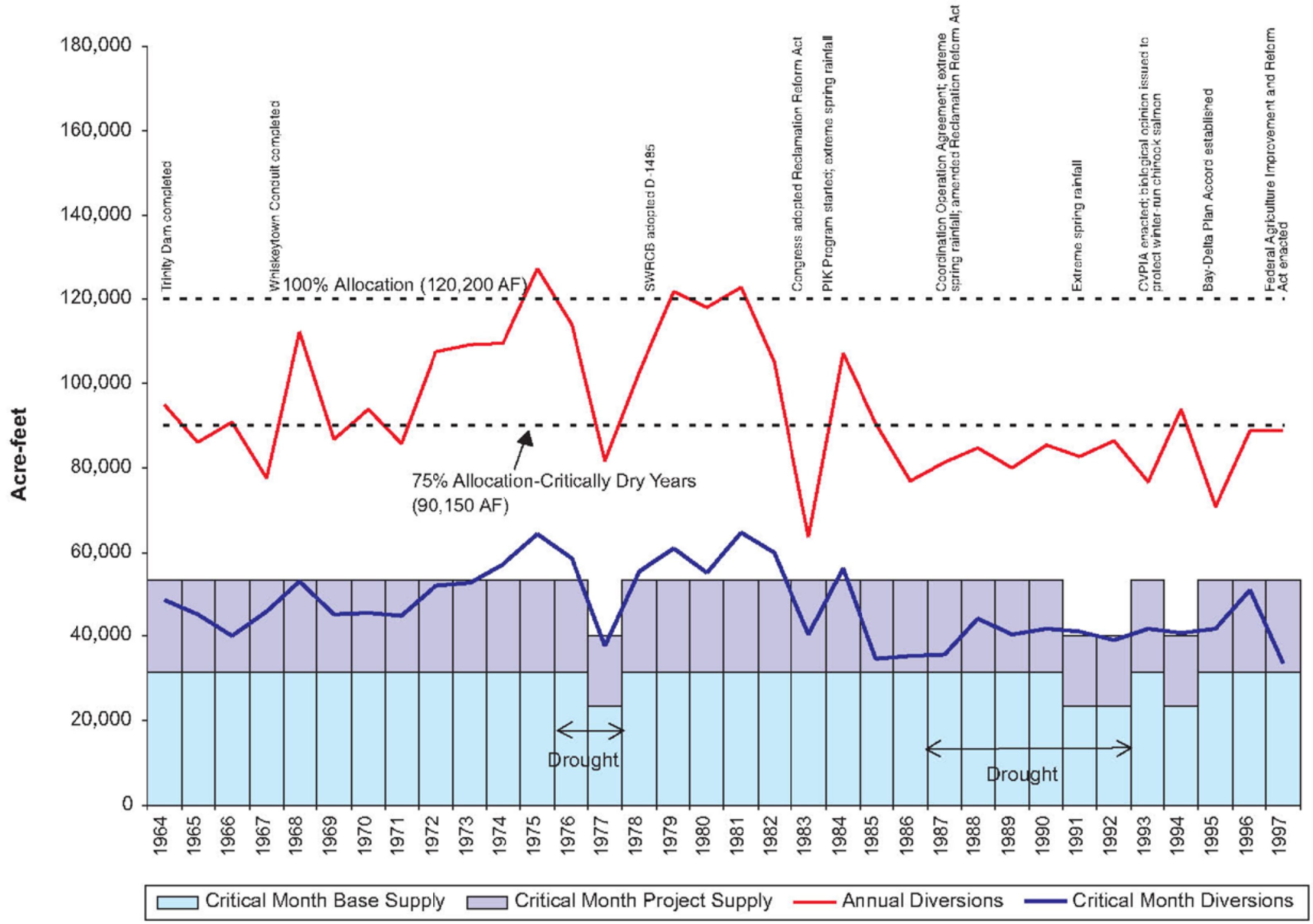
Notes:

1. Critically dry year 1977 is omitted from Average Monthly Diversions (75-81).
2. Critically dry years 1991, 1992, and 1994 are omitted from Average Monthly Diversions (86-97).
3. Monthly diversions based on contract period for April to October.

W032005010RDD_864 (8/17/05)

FIGURE 2-53
NATOMAS CENTRAL MUTUAL WATER COMPANY MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 2-54
NATOMAS CENTRAL MUTUAL WATER COMPANY ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL in association with MBK

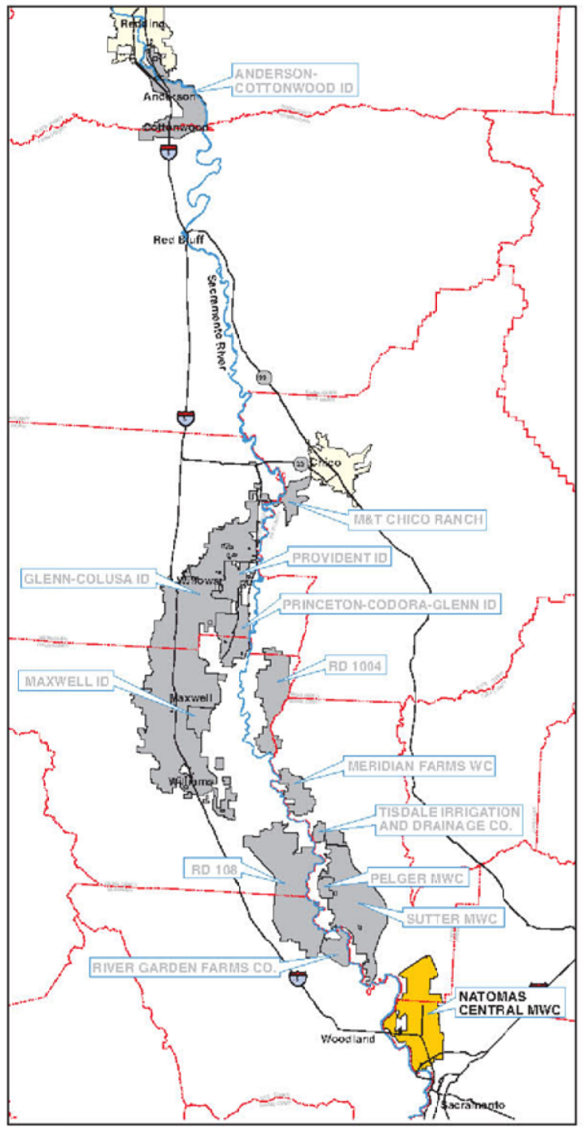
W032005010RDD_73 (8/17/05)

Natomas Central Mutual Water Company

General Manager: Dan Peterson • 2601 West Elkhorn Blvd. • Rio Linda, CA 95673 • (916) 419-5936

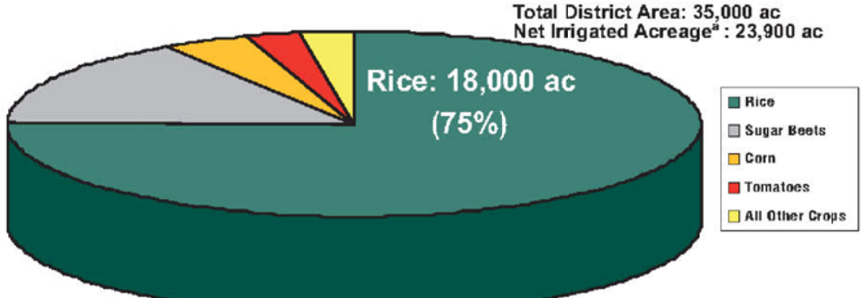
Settlement Contract:	120,200 af
Base Supply:	98,200 af
Project Supply:	22,000 af

Location Map



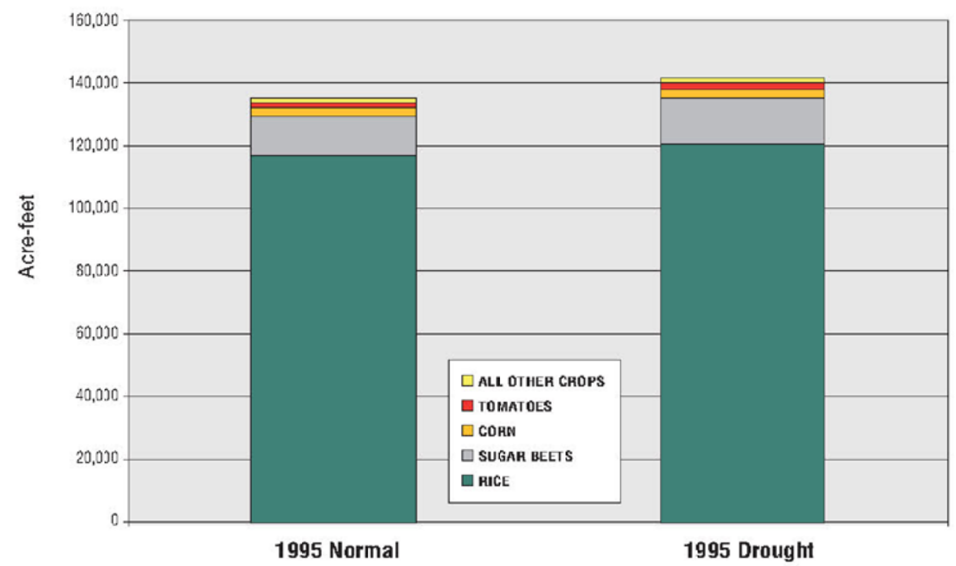
Irrigated Acreage by Crop

Total District Area: 35,000 ac
Net Irrigated Acreage[a] : 23,900 ac

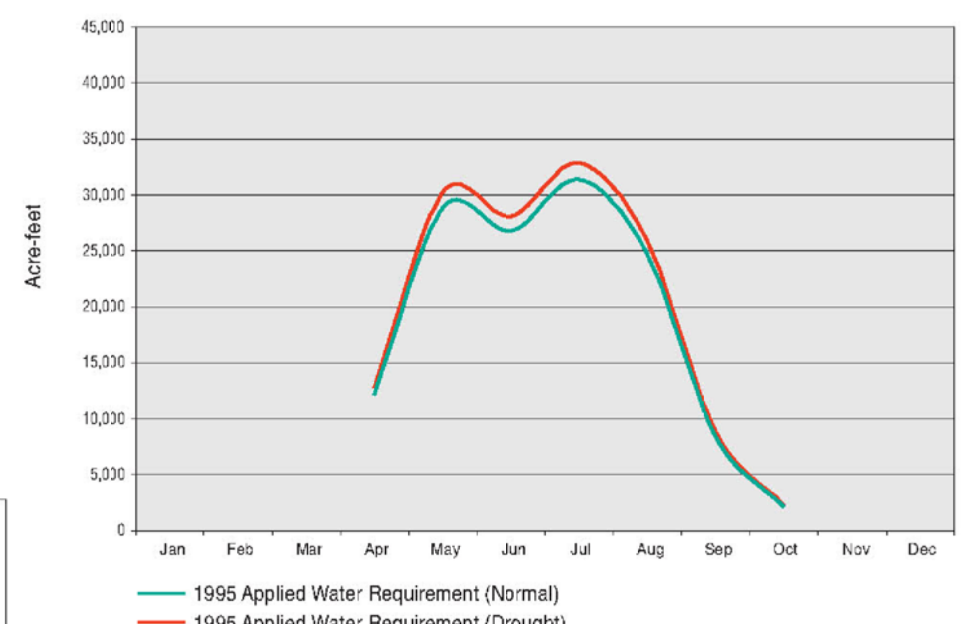


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

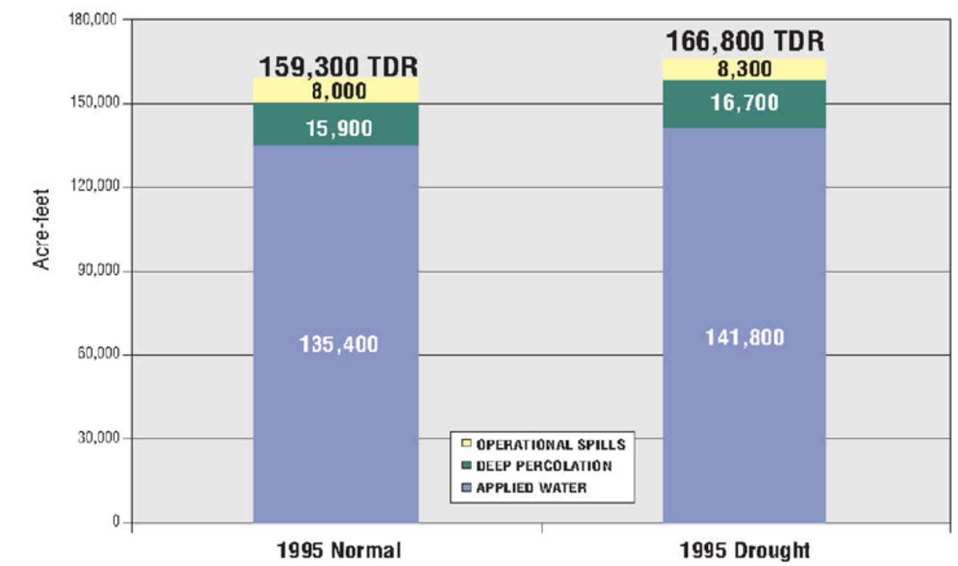


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

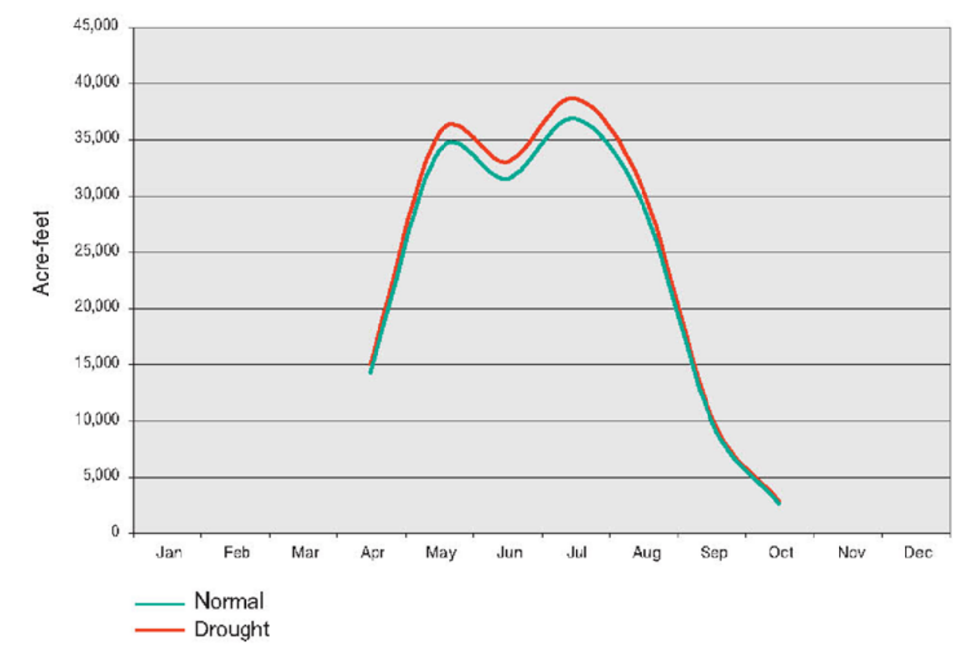


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 10% Deep Percolation Estimates)



NOTES: [a] Natomas' actual deliveries are the basis for revised acreages. Potential acreage within USBR contract service is approximately 35,000 acres.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 2-55
NATOMAS CENTRAL
MUTUAL WATER COMPANY IRRIGATED ACREAGE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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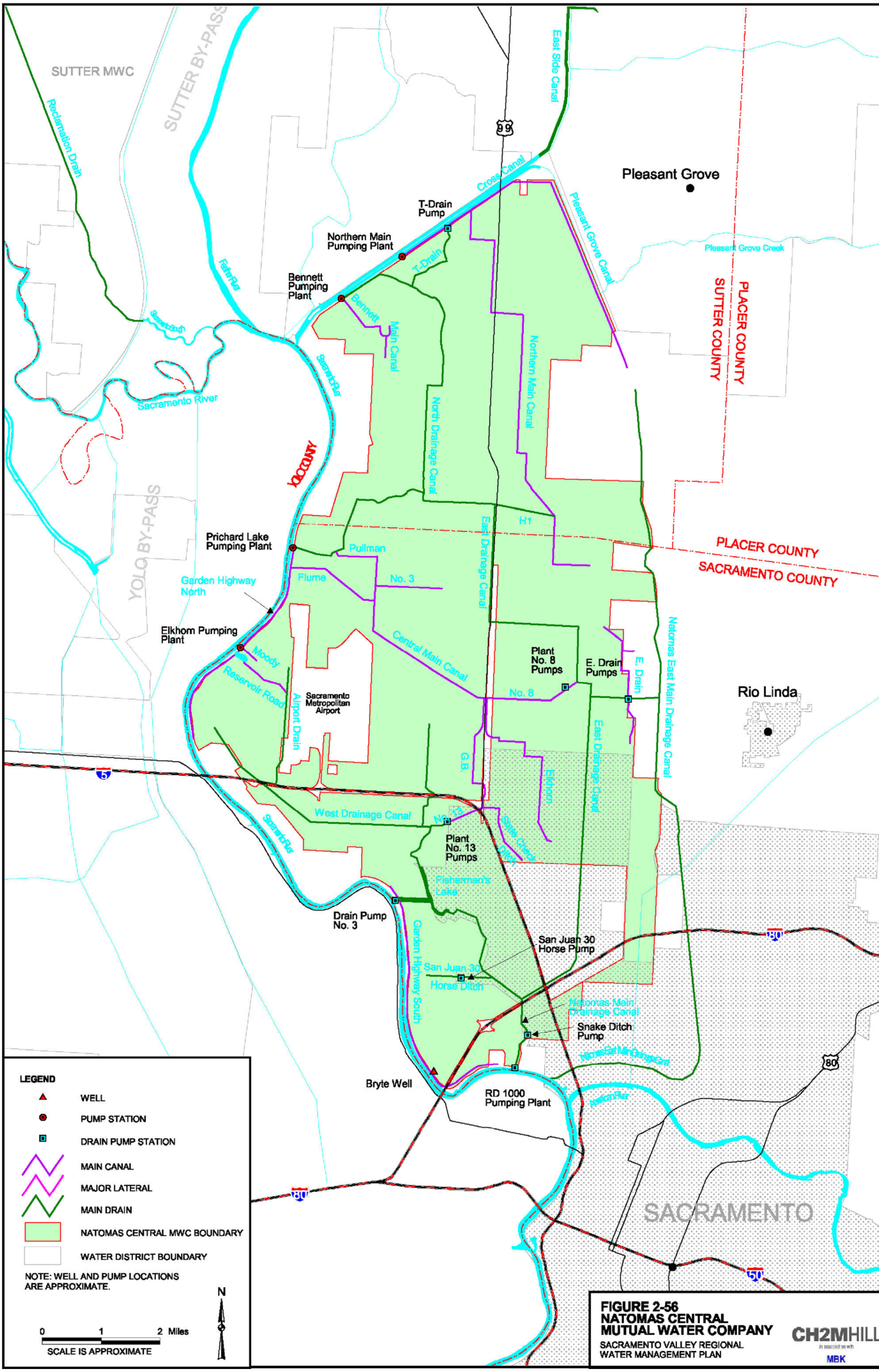

FIGURE 2-56
NATOMAS CENTRAL MUTUAL WATER COMPANY
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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SECTION 3.0

Regional Water Measurement Program

3.1 Plan Identification

As stated in Reclamation's Regional Criteria (Reclamation, 2004):

Each Participating contractor shall implement one of the following measurement options:

1. *Fully measure with a reasonable degree of accuracy the volume of water delivered by each Participating contractor to each of its respective customers, and implement procedures that provide incentives for improved management of water within 5 years of contract renewal; or*
2. *Implement a mutually acceptable water measurement program (including timeframes and budget needs) within 3 years of the renewal of the Participating contractors' contract with Reclamation, with full Implementation within 5 years thereof. This option should be at least as effective as option 1 and will be substantiated based on field documentation derived from the measurement study(s) conducted in relevant Sub-regions. Please attach a description of the study(s) including the study objectives, along with an estimated timeline and budget.*

The participating SRSCs will implement the second option. The first phase of this program is titled the Cooperative Water Measurement Study Work Plan, which was funded by Reclamation and is included as Appendix B.

The next phase of the Cooperative Study will be funded partially through Chapter 7 Proposition 50 funds for the CALFED Water Use Efficiency Program (Section B Agricultural Research and Development Projects), and partially by a Reclamation Water Conservation Field Service Program grant. Coordination of participants and preparation of Cooperative Study components have been ongoing since January 2006. Field study began at the start of the 2006 irrigation season. All Cooperative Study elements are described below.

3.2 Proposed Cooperative Water Measurement Study Measurement Plan Evaluations

The next phase of the Cooperative Study will begin to evaluate the appropriate level of intra-district measurement. As described below, continued demands on the state's finite water resources require that water be used in as efficient a manner as possible. The joint state-federal CALFED program, specifically with respect to the Ag WUE, is working to fund and sponsor research to address the question of appropriate measurement in terms of location, method, cost, and necessity. The Cooperative Study will support this subprogram and will add to the body of knowledge currently being developed across the state. In addition to intra-district approaches, this Cooperative Study would also identify where inter-district and/or sub-basin-level measurement might be prudent and/or potentially preferable.

The proposed Cooperative Study consists of three major components:

- Field Measurement Study
- Water Management and Measurement Interviews
- Delivery Data Analysis

The Field Measurement Study will involve the installation of water measurement instruments on laterals and turnouts of two selected acreages within RD 108. Field data collected over 2 years will be analyzed to compare measurement at the lateral level, turnout level, and district-wide level to provide insights to the issue of appropriate agricultural water measurement.

Water Interviews are proposed to document the numerous factors involved in water delivery decisions and management of the water supply. Three districts were chosen and agreed to participate in this component of the Cooperative Study: SMWC, GCID, and RD 108. Although the SRSCs have unique physical and policy characteristics, interviewing these then is expected to provide a better understanding of current practices that could be observed through most of the Sacramento Valley.

For the Delivery Data Analysis, two other districts where chosen, RD 1004 and SMWC. RD 1004 was chosen due to the transition in 1992 of their charging structure from a "flat rate" per-acre basis to a per-ac-ft basis. This required volume delivered to be measured at each turnout. SMWC shifted from a per-ac-ft billing structure, is measured at each turnout, to a flat rate basis according to the crop and acreage, although volume delivered is still measured at a turnout level.

In addition to evaluating methods of improving water management, the BWMP was used to form a basis for the renewal of the SRSCs' CVP contracts with Reclamation. This Cooperative Study will support the SRSCs and Reclamation in developing a mutually agreeable surface water delivery water measurement program that will be consistent with the proposed regional criteria as part of each of the contracts. To be consistent with regional criteria and to be mutually agreeable to Reclamation, the following questions were identified by Reclamation as part of the Work Plan development:

1. What are the most cost-effective measurement methods that will work satisfactorily under the conditions of the SRSCs' service areas?

2. What are the benefits that are derived from measurement at turnout, lateral, and district levels? Are there potential issues/benefits of pricing water by volume measured at the turnout or customer level?

3. Based on information gained from questions 1 and 2, what are the benefits and costs associated with measurement at the sub-basin, district, lateral, and turnout levels?

The Cooperative Study will address these questions while also supporting the requirements of the proposed regional criteria. The regional criteria make reference to measurement at the customer level within the contractor service area. This study will investigate several levels of measurement, including field-level (turnout-level), which is used interchangeably with customer-level. Costs associated with this study are shown in Table 3-1.

TABLE 3-1
Cooperative Study Budget – Equipment and Labor
Sacramento Valley Regional Water Management Plan

Description	Year 1 (2006-2007) Cost ($)	Year 2 (2007-2008) Cost ($)
TASK 1: Field Measurement Study		
TASK 1.1 Lateral-level Measurement Study	20,000	—
TASK 1.2 Turnout-level Measurement Study	—	22,000
Facility Modifications (pipe extensions, vegetation, or sediment removal)	5,000	5,000
Calibrate/Un-install Equipment	5,000	10,000
Data Collection	35,000	60,000
Data Management and Engineering Analysis	25,000	25,000
TASK 2: Water Management and Measurement Interviews	20,000	15,000
TASK 3: Delivery Data Analysis and Interviews at SMWC and RD 1004	50,000	—
TASK 4: Analyze Field Study Measurement Data from NCMWC		
TASK 5: Benefits and Cost Documentation		
TASK 6: Third-party Review	5,000	8,000
TASK 7: Share Results and Prepare Final Report (includes Annual Summary Reports)	20,000	40,000
TASK 8: Study Coordination and Outreach	25,000	25,000
Total	**210,000**	**220,000**

Note:

This study budget table does not include a contingency or the applicant's administrative costs.

3.3 Plan Selection

Cooperative Study data and analysis results will be distributed to Reclamation, participating districts, other BWMP participants, and the Cooperative Study funding agency in the form of progress reports at the end of both years of the study and a final report as shown on Figure 3-1. The study results will provide science-based information for the issue of water measurement in the Sacramento Valley.

3.3.1 Year 1 (2006-2007) Progress Report

A progress report after Year 1 (2006-2007) will have initial study data, preliminary analyses, and study accomplishments. This report will also document any study refinements that may be necessary to carry out the second year of the proposed initial field study. Potential refinements to the study approach, equipment, or sites would be identified. Suggested refinements from a third-party reviewer (a recognized expert in irrigation water management and measurement) will be included in the report. Potential refinements will be presented to the Cooperative Study Working Group, which includes the participating districts, Reclamation, and the funding source(s), for their consideration and approval.

3.3.2 Year 2 (2007-2008) Progress Report

The second study progress report will contain summaries of data and other information collected during Year 2 (2007-2008) of the study.

3.3.3 Final Report

Following Year 2 (2008), a final report will be prepared that will summarize the purpose and accomplishments of the study and address the three basic questions described in Section 3.2. The final report will include study data and analysis of the field data, existing delivery data, interviews, and other information collected. This analysis will include comparisons of water use based on current measurement practices, lateral-level measurement, field-level measurement, and the potential for inter-district and/or sub-basin-level measurement. An evaluation of the equipment used, including the field performance, ease of operation, and durability, will also be included in the final report. The report will also summarize the real costs of measuring agricultural water supply at various operational levels and the associated labor costs of downloading and managing flow data.

According to this study, in coordination with Reclamation, the SRSCs will establish a mutually acceptable water measurement program.

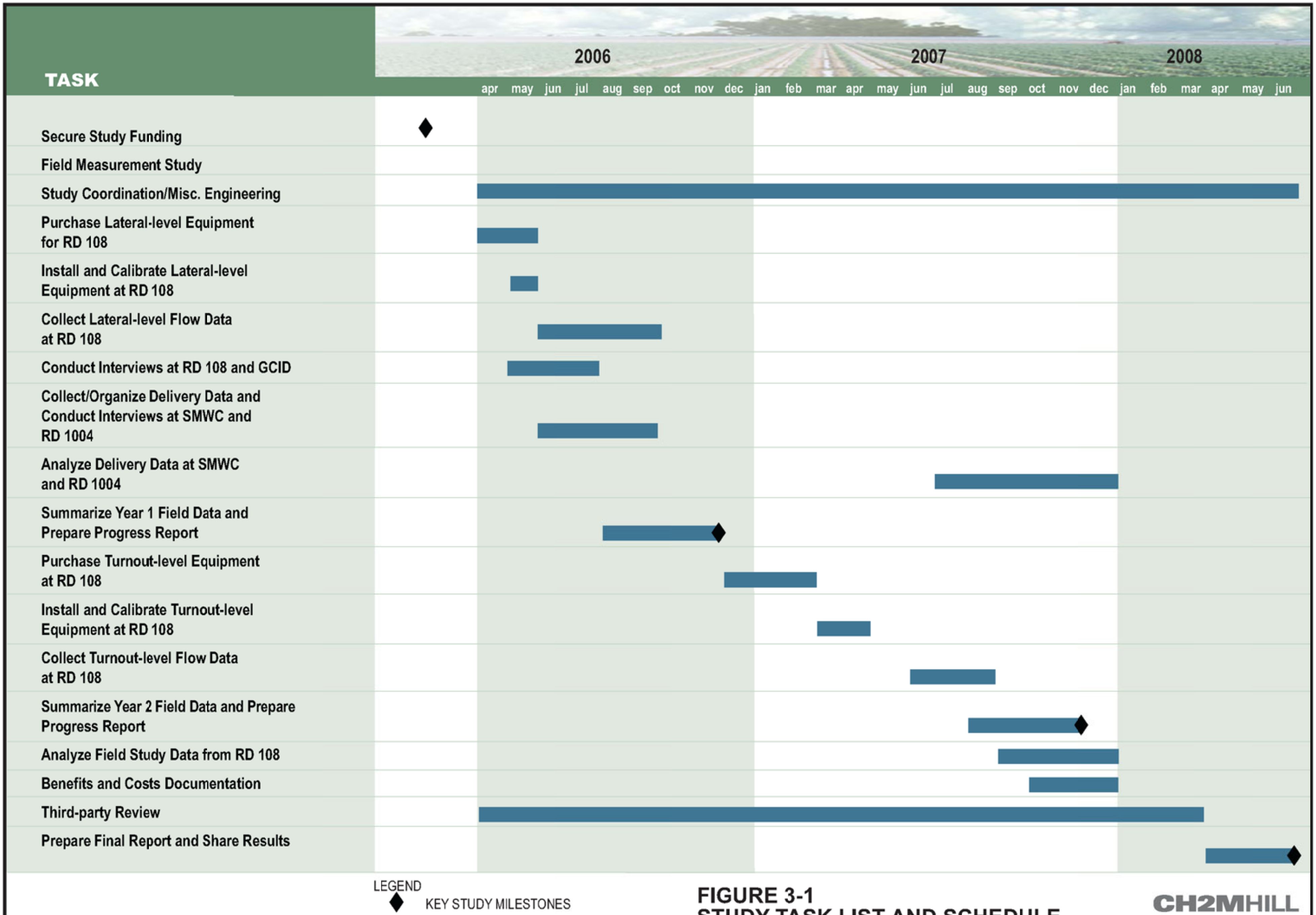

FIGURE 3-1
STUDY TASK LIST AND SCHEDULE
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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WB062006010RDD_02 (10/17/06)

SECTION 4.0

Analysis of Sub-region Water Management Quantifiable Objectives

This section provides background on the development of targeted benefits (TB) and quantifiable objectives (QOs), the need to review applicable TBs and develop QOs with respect to the Regional Criteria, and the identification of applicable and feasible TBs and long-range QOs for each district within each of the sub-regions.

4.1 Development of CALFED Targeted Benefits

In December of 2000, CALFED published *Details of Quantifiable Objectives* (CALFED, 2000). The purpose of this document was to provide the background, purpose, and conceptual approach to the development of QOs and TBs to achieve these goals.

The Water-use Efficiency Element is one element of several elements in the CALFED Bay-Delta Program. It is a cornerstone of the program's water management strategy (Reclamation, 1997). The two primary goals of the Water-use Efficiency Element are to:

1. Encourage more water users and water suppliers to implement locally cost-effective, efficient, water management practices.
2. Provide funding to foster the implementation of practices that are cost effective from a statewide perspective but are not locally cost effective.

The development of TBs and QOs was intended to result in the ability to track and monitor the implementation of CALFED's Ag WUE Incentive Program. After numerous meetings in 2000 with stakeholder groups to review CALFED goals, 196 TBs were identified with specific objectives. TBs were drawn primarily from CALFED documents, the Impaired Water Body List (303d), and discussions with local agricultural representatives. To account for variability in the valley, smaller, generally homogenous areas (sub-regions) were designated to assist in the development of TBs that address their unique nature. As illustrated on Figure 4-1, 21 sub-regions were identified. The TBs identified for each sub-region are discussed below. SRSCs are located within Sub-regions 1, 3, 4, and 7.

QOs are considered the link between CALFED goals and local actions; however, QOs were not developed for many TBs in the 2000 document. Accordingly, potential QOs are identified below are determined appropriate and feasible for each of the TBs.

4.1.1 Purpose

CALFED "recognizes that incentive-driven water use efficiency actions, shaped by local creativity and know-how, are powerful tools for instituting meaningful changes in water management practices" (CALFED, 2000). The voluntary Ag WUE Incentive Program provides incentives to motivate water suppliers and water users to institute practices that can most effectively and efficiently address regional or statewide objectives. The voluntary practices, which are proposed by local participants, are targeted at achieving region-specific benefits in water quality and quantity and in-stream flow and timing. To facilitate this effort, CALFED developed QOs expressed in ac-ft of water for specified locations and times in each of the 21 sub-regions. According to the 2000 Document:

> *The conceptual foundation of the Ag WUE Incentive Program rests on several key elements. Broadly speaking, the Incentive Program is structured to identify, quantify and link specific CALFED goals with practical on-farm and district distribution system water management actions. This approach has coined the terms Targeted Benefit and Quantifiable Objectives as part of a conceptual model to make the Incentive Program a relevant, credible program that can be implemented and measured.*

4.1.2 Targeted Benefits and Quantifiable Objectives

As stated in Reclamation's Regional Criteria:

> *The TBs and the QOs are the cornerstone for the Implementation of agricultural water use efficiency element of the CALFED Program. The TBs are geographically specific in-stream flow and timing, water quality, and water quantity benefits that can potentially and partially be met through irrigation Water Management. The QOs are the CALFED Program's approximation, expressed in ac-ft, of the practical, cost-effective portion of a TB that can be achieved through improving irrigation Water Management. These approximations, have been made for agricultural water users across a Sub-region, and do not necessarily represent the economically feasible portion of a TB that could be achieved at the local agency level.*

In limited cases, it was assumed that irrigated agriculture could institute water management practices that achieve an entire TB for a given sub-region. In most cases, however, the QO identified for the given SRSC will contribute to a portion of a quantitative TB.

4.1.3 Sacramento Valley Water Quality Coalition

The Coalition was formed in 2003 to enhance and improve water quality in the Sacramento River, while sustaining the economic viability of agriculture, functional values of managed wetlands and sources of safe drinking water. The Coalition is comprised of more than 7,500 farmers and wetland managers encompassing more than one million irrigated acres. It is supported by more than 200 agricultural representatives, natural resource professionals, and local governments throughout the region to improve water quality for Northern California farms, cities, and the environment. The vast majority of landowners and farmers within the service areas of the SRSCs participate directly as members of the Coalition and support it by disseminating information. This Coalition assists in meeting TBs in all regions in the Sacramento Valley by monitoring for the presence and levels of constituents such as pesticides, turbidity, salinity and other parameters in irrigation tailwater.

SUB-REGION BOUNDARY

FIGURE 4-1
SUB-REGION BOUNDARIES
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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W032005010RDD_05 (8/17/05)

4.2 Participating Sacramento River Settlement Contractor Identification of Applicable Targeted Benefits and Associated Quantifiable Objectives

This section summarizes the SRSCs' previous efforts in identifying multi-benefit projects and programs, and the associated TB and QO identification process for the participating SRSCs.

4.2.1 Sacramento River Basinwide Water Management Plan

The BWMP was prepared by the SRSCs with assistance and input from the Department and Reclamation. Development of the BWMP, which is the precursor to this Regional Plan, included extensive coordination among the participating districts and companies, as well as with the Department and Reclamation. Finalized in 2004, the BWMP identified potential water management improvements, including sub-basin-level management actions and system improvement (water use efficiency) projects. This planning process was a large step forward toward increasing cross-district communication and recognizing the potential for mutually beneficial projects and operations. A number of recommendations, including potential inter-and intra-district projects and policy actions were identified and summarized in Chapter 8, "Implementation Conclusions and Recommendations," of the BWMP Plan Summary, included in Appendix D. Among the projects and programs identified were water management/groundwater and system improvement projects that were the basis of the projects identified in Section 5. The partnerships, cooperation, and ideas developed as part of the initial phases of the BWMP were a primary catalyst for the Sacramento Valley Water Management Agreement, discussed next.

4.2.2 Sacramento Valley Water Management Agreement and Program

Concerns related to Delta water quality and the potential need for increased flows to the Delta were a major topic of discussion among agricultural, municipal, and environmental interests in the late 1980s and early 1990s. In response to these concerns, the SWRCB adopted a revised water quality control plan in 1995 (i.e., the 1995 WQCP). In July 1998, the SWRCB conducted a water rights hearing to consider how to implement the 1995 WQCP. This administrative action was taken to allocate responsibility for achieving the 1995 WQCP objectives to water right holders, affecting the beneficial uses of the Bay-Delta. The proceedings were divided into eight phases to facilitate testimony, cross-examination, and potential settlements. After the completion of Phases 1 through 7, which involved the San Joaquin Valley and other Delta issues, Phase 8 addressed the responsibility of water right holders within the Sacramento Valley for meeting the 1995 WQCP. Phase 8 was expected to entail years of litigation and judicial review. This extended process would have undermined the progress of emerging regional efforts, including the BWMP and other statewide water management initiatives.

To support an alternative approach, a Short-term Workplan was developed by water district, agency, and consultant staff representing both Northern and Southern California interests, with expertise in project development, engineering, and benefit/impact assessment. Development of the Short-term Workplan, which was completed in 2001, focused on working with willing water districts, companies, and agencies throughout the Sacramento Valley to identify feasible projects that could potentially increase available water supplies. The relationships, potential projects, and operational strategies developed as part of the BWMP were key in creating the Short-term Workplan. This “bottoms-up” approach (i.e., focusing on projects proposed by willing participants) was considered key to the success of any project and the agreement as a whole. Approximately 45 projects were identified and grouped into four primary categories:

- Surface water/groundwater planning (monitoring, inventory, or assessment)
- System improvement (canal lining, tailwater recovery, or improved operations)
- Water management (facilities/programs to use and monitor surface water and groundwater)
- Institutional controls (policy or regulatory constraints)

Based on the identification of a number of potentially feasible projects that were agreed would assist in providing additional water supply flexibility, more than 40 water suppliers in the Sacramento Valley negotiated and executed the Sacramento Valley Water Management Agreement with Reclamation; the Department; USFWS; the California Department of Fish and Game; and the State Water Contractors, which represent water users in Southern California, the Central Coast, and the San Joaquin Valley. Counties throughout the Sacramento Valley supported the agreement and the intent to provide water while ensuring that local needs are met.

Signed in 2002, the Sacramento Valley Water Management Agreement outlined a need for a cooperative regional approach to improve local, regional, and statewide water supply reliability and quality, while providing supplies to help meet water quality standards in the Delta. This need gave rise to the Sacramento Valley Water Management Program (SVWMP). Its proposed implementation would offer relief to water-short areas of the Sacramento Valley, provide additional water supplies for the Delta, and support water transfers to CVP and SWP users. It established a framework to meet water supply, water quality, and environmental needs in the areas of origin and throughout California. On January 31, 2003, the SWRCB officially dismissed the Phase 8 proceedings and allowed the SVWMP to be implemented.

4.2.3 Development of Quantifiable Objectives

As part of the development of this Regional Plan, projects identified in the BWMP and SVWMP were used as the basis for assisting in achieving the TBs. Specific projects developed as part of the SVWMP were carried forward if they were considered feasible and have local support. Some of these projects have recently received partial Water Use Efficiency funding, and others will be submitted for consideration in upcoming funding rounds. In addition, the participating districts and companies continue to encourage and implement water management activities and improvements as discussed in Sections 4 and 5. Regional Plan participants will continue to evaluate and pursue additional regional cooperation and inter-district management opportunities if mutual benefits can be identified and funding sources secured.

Each participating SRSC evaluated the TBs for its respective CALFED sub-region(s) and then identified actions and/or projects that could be undertaken to specify a QO for each TB. The following discussions address the TBs considered to be applicable to each sub-basin, and each SRSC's assessment of the applicability of the TBs. Participating SRSCs have identified current and proposed projects or programs that could contribute to satisfying applicable TBs. In addition, proposed QOs by each SRSC are identified, including estimates of their contributions to the overall QO. A summary of this identification process is provided in Table 4-1.

In many cases, the implementation of projects necessary to meet the potential QOs would require funding beyond the capability of a given district or company to independently support, and/or would result in out-of-district benefits. Funding requests for many of the proposed projects have been submitted to the CALFED Water Use Efficiency Program or Proposition 50, Chapter 8 funding. It may take several years to obtain funding and fully implement these activities, and they may not be fully implemented within the initial 5 years of the SVWMP. It is intended that the QOs identified below represent the maximum estimated water inventory quantity considered to be feasible after all identified projects that contribute to meeting a given QO are implemented. Progress toward implementing projects, including submittal of funding applications, construction (including phasing), and operation, will be identified for each activity and updated in the annual reports.

The method set forth in the Regional Criteria for analyzing QOs is as follows:

> *Annually analyze, at a minimum, one-fifth of the Proposed QOs to determine which Proposed QOs may be implemented. This information will be provided in the Annual Update. At least one Proposed QO should be analyzed for each Sub-region unless all QOs for that Sub-region have already been addressed. The scope and extent of the analysis of each Proposed QO will be dependent upon whether undertaking such analysis is financially feasible for the Participating Contractors based upon their existing resources, and if not, whether there is funding available to the Participating Contractors for that purpose. If undertaking an in-depth and detailed analysis of the Proposed QO is not financially feasible, and funding is not currently available, the Plan shall at a minimum, provide a reconnaissance level analysis. Such an analysis will be based upon existing data and information, including data presented in the Participating Contractors' water inventory. In addition, the Plan shall identify in the Annual Update the efforts that the Participating Contractors will undertake in order to attempt to secure adequate funding to perform a detailed and in-depth analysis of the Proposed QO.*

4.2.4 Redding Sub-basin

The Redding Sub-basin lies within the area described by CALFED as Sub-region 1, Redding Sub-region. The TBs within Sub-region 1 are identified in Table 4-2. The only participating SRSC within this sub-region is ACID.

ACID implements many programs that directly or indirectly meet the objectives of several of the agricultural the Redding sub-region TBs. These programs include, but are not limited to, laser leveling of fields (which began in the 1970s), reuse of tailwater, maintenance of canals, weed abatement programs, forbearance programs, and canal lining projects.

4.2.4.1 Identification of Applicable Targeted Benefits

The TBs considered to be applicable to ACID in the Redding Sub-basin include TBs 6, 7, and 8. Some actions taken to meet QOs relative to TB 6 may also result in meeting QOs relative to TB 7 or TB 8, and vice versa. Reduction in diversion below Keswick (TB 6) could be achieved at a district level by a conjunctive-use program, which potentially would reduce surface diversions by substituting groundwater supply. A conjunctive-use program would also allow for long-term flexibility in diversion timing to increase water supply for beneficial uses on suitable lands (TB 8). A portion of TB 6 can also be met by decreasing nonproductive ET, which is essentially TB 7. Reduction of nonproductive ET can be accomplished by lining canals or by piping water to its destination. Increasing system efficiency through automation and/or the reduction of end of system spills could also contribute to satisfying TB 6.

Unlike many of the districts listed below that can also use drainwater to decrease water use, ACID's options are limited because the majority of the district's lands are used for pasture. ACID's major crops include pasture and hay crops (alfalfa), in which furrow and border check irrigation is commonly used. This method of irrigation does not generally lead to large tailwater runoff except during excessive irrigation application. The soils within ACID are generally well drained; and unlike many of the districts listed below that can implement drainwater reuse to decrease water use, ACID's options are limited because the majority of the district's major crops are pasture and alfalfa where furrow or border check irrigation is commonly used. These methods do not generally result in large tailwater runoff, especially in ACID, which has coarse-textured soils that rapidly percolate surface water before it can reach the end of the fields and be collected for reuse.

4.2.4.2 Determination of Non-applicability

TBs 1, 2, 3, 4, and 5 are not applicable to ACID. These TBs established increased water flow for sources from which ACID does not divert.

Anderson-Cottonwood Irrigation District.

Current Activities for ACID Quantifiable Objectives. As previously noted, TBs 6, 7, and 8 are applicable to ACID. Since the mid-1990s, ACID has developed and begun implementation of an aggressive program to improve water use efficiency, reduce operational spills, and enhance operational flexibility and reliability along the main canal and major laterals (TBs 6 and 8). During the last 9 years, ACID has made more than $14 million in system improvements with funding from numerous sources including the CVPIA, the Anadromous Fish Screen, and CALFED programs. These improvements have included a new fish screen and fish ladders at the main diversion on the Sacramento River, piping of laterals, SCADA improvements, canal lining (TB 7), and operational improvements. ACID has also initiated efforts to manage groundwater conjunctively with its available surface water supply to reduce surface water diversions and make water available to other water purveyors and uses.

TABLE 4-1
Summary of Applicable Targeted Benefits and Proposed Actions
Sacramento Valley Regional Water Management Plan

Targeted Benefit	Analyze	Priority	Implement	CALFED Sub-region	Participating SRSCs	Proposed Action	Maximum Contribution from to QO from Proposed Action (ac-ft)	Locally Beneficial Portion of Action[a]	Action-specific Monitoring Plan	Funding Sources
6) In-stream flow benefit in Sacramento River **7)** Decrease nonproductive ET	2005	2005	2008	1	ACID	Construct pipeline to replace leaky canal lateral	8,700	$5,000	Action-specific monitoring plan will be included in construction contract	Prop 50 award of $144,000 June 2005, for feasibility study
6) In-stream flow benefit in Sacramento River **8)** Provide long-term diversion flexibility	2005	2005	2009	1	ACID	Reduce spill through system automation	20,000	$20,000	Action-specific monitoring plan will be included in construction contract	Prop 50 award of $1.775 million June 2005, for phase 1 of construction
6) In-stream flow benefit in Sacramento River **8)** Provide long-term diversion flexibility	2005	2005	2007	1	ACID	Construct 4 groundwater extraction wells	6,800	$318,000	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
20) In-stream flow benefit in Sacramento River **26, 27, and 28)** Provide long-term diversion flexibility for wetlands, salt-affected soils, and other suitable lands	2005	2005	2008	3	GCID	Design and construct 12 flow measurement devices and 5 main canal check structures	40,000	$408,000[b]	Action-specific monitoring plan will be included in construction contract	Submitted for partial funding from Prop 50, Chapter 8 funding for Integrated Regional Water Management
20) In-stream flow benefit in Sacramento River **26, 27, and 28)** Provide long-term diversion flexibility for wetlands, salt-affected soils, and other suitable lands	2005	2005	2007	3	GCID	Construct 10 groundwater extraction wells	27,300	$761,000	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
20) In-stream flow benefit in Sacramento River **21, 22, and 23)** Reduce pesticides **26, 27, and 28)** Provide long-term diversion flexibility for wetlands, salt-affected soils, and other suitable lands	2005	2005	TBD	3	GCID	Construct 30,000 to 40,000 ac-ft regulating reservoir on Colusa Basin Drain	50,000	$51,000	Action-specific monitoring plan will be included in construction contract	Prop 50 award of $257,000 June 2005
20) In-stream flow benefit in Sacramento River **26, 27, and 28)** Provide long-term diversion flexibility for wetlands, salt-affected soils, and other suitable lands	2005	2005	2006	3	RD 108	Replace five flashboard checks with combination ITRC flap gate and ramp flumes	1,000	$15,000	Action-specific monitoring plan will be included in construction contract	Reclamation Water Conservation Grant will provide $25,000; the remaining $15,000 will be funded by RD 108
20) In-stream flow benefit in Sacramento River **26, 27, and 28)** Provide long-term diversion flexibility for wetlands, salt-affected soils, and other suitable lands	2005	2005	2007	3	RD 108	Install up to five production wells for groundwater management program	8,000	$340,000	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
20) In-stream flow benefit in Sacramento River **26, 27, and 28)** Provide long-term diversion flexibility for wetlands, salt-affected soils, and other suitable lands	2005	2005	2007	3	PCGID	Develop a conjunctive water management program	5,000	TBD[c]	Well output will be monitored	PCGID will fund the program with district monies
20) In-stream flow benefit in Sacramento River **26, 27, and 28)** Provide long-term diversion flexibility for wetlands, salt-affected soils, and other suitable lands	2005	2005	2007	3	PID	Develop a conjunctive water management program	5,000	TBD[c]	Well output will be monitored	PID will fund the program with district monies
30) In-stream flow benefit in Sacramento River **33)** Decrease nonproductive ET	2005	2005	2008	4,5	RD 1004	Line canal	3,500	$120,000[b]	Action-specific monitoring plan will be included in construction contract	Funding will be pursued through future rounds of Water Use Efficiency Grant Funding

TABLE 4-1
Summary of Applicable Targeted Benefits and Proposed Actions
Sacramento Valley Regional Water Management Plan

Targeted Benefit	Analyze	Priority	Implement	CALFED Sub-region	Participating SRSCs	Proposed Action	Maximum Contribution from to QO from Proposed Action (ac-ft)	Locally Beneficial Portion of Action[a]	Action-specific Monitoring Plan	Funding Sources
36) Provide long-term diversion flexibility										
30) In-stream flow benefit in Sacramento River **33)** Decrease nonproductive ET **34, 35, 47, and 48)** Provide long-term diversion flexibility to increase water supply for beneficial use of wetlands and other suitable lands	2005	2005	2006	4,5	RD 1004	Construct two groundwater extraction wells	5,000	$40,000[b]	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
30) In-stream flow benefit in Sacramento River **34 and 35)** Provide long-term diversion flexibility to increase water supply for beneficial use of wetlands and other suitable lands	2005	2005	2006	4	MFWC	Construct one groundwater extraction well	1,500	$70,000	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
30) In-stream flow benefit in Sacramento River **34 and 35)** Provide long-term diversion flexibility to increase water supply for beneficial use of wetlands and other suitable lands	2005	2005	2008	4	SMWC	Recycle Irrigation	25,000	$12,000[b]	Lift pumps that recycle drainage water will be monitored	Funding for feasibility study will be pursued through future rounds of Water Use Efficiency Grant Funding
30) In-stream flow benefit in Sacramento River **33)** Decrease nonproductive ET	2005	2005	2007	4	SMWC	Line canal	1,000	$14,000[b]	Action-specific monitoring plan will be included in construction contract	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
30) In-stream flow benefit in Sacramento River **34 and 35)** Provide long-term diversion flexibility to increase water supply for beneficial use of wetlands and other suitable lands	2005	2005	2007	4	SMWC and RD 1500	Install six production wells for groundwater management program	5,000	$200,000[b]	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
30) In-stream flow benefit in Sacramento River **34 and 35)** Provide long-term diversion flexibility to increase water supply for beneficial use of wetlands and other suitable lands	2005	2005	2006	4	PMWC	Install one production well for groundwater management program	1,000	$57,000	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management
57) In-stream flow benefit in Sacramento River **63)** Decrease nonproductive ET **64 and 65)** Provide long-term diversion flexibility	2005	2005	2007	7	NCMWC	Construct 12 groundwater extraction wells	15,000	$200,000[b]	Well output will be monitored	Submitted for Prop 50, Chapter 8 funding for Integrated Regional Water Management

[a]Cost-benefit analysis will be performed if funding is not received to determine what portion of project, if any, is economically feasible for local agency to undertake. The presentation of these local and external benefits and the associated costs will be included in the annual updates at the time the QOs are analyzed.

[b]Local funding amount varies depending on type and application of project. Historical average of local contribution varies from 5 to 20 percent of project cost provided through in-kind services by the District. Five percent of estimated project cost was used for projects yet to apply for funding. The local contribution for these projects will be updated as funding is sought and acquired.

[c]Project is 100 percent district funded. Exact amount will be determined at project completion.

TABLE 4-2
Targeted Benefits in CALFED Sub-region 1
Sacramento Valley Regional Water Management Plan

Number	Targeted Benefit
1	Provide flow to improve aquatic ecosystem conditions in Battle Creek
2	Provide flow to improve aquatic ecosystem conditions in Bear Creek
3	Provide flow to improve aquatic ecosystem conditions in Clear Creek
4	Provide flow to improve aquatic ecosystem conditions in Cottonwood Creek
5	Provide flow to improve aquatic ecosystem conditions in Cow Creek
6	Provide flow to improve aquatic ecosystem conditions in the Sacramento River below Keswick
7	Decrease nonproductive ET to increase water supply for beneficial uses
8	Provide long-term diversion flexibility to increase water supply for beneficial uses on suitable lands

The farmers within ACID are currently participating in a pilot program with ACID to analyze the effects of sprinkler irrigation versus flood irrigation. The goal of this program is to quantify water savings (on a per-acre basis) that are achievable through increased irrigation efficiencies. Pending results of this program, ACID will seek funding to expand the effort to reduce total water requirements (TB 6).

ACID's four-phase SCADA system installation is expected to be completed in 2005. This automation will and has increased the efficiency of operations and reduced spills throughout the system (TB 6 and 8).

ACID is currently in the second phase of a conjunctive-use water management program. Twelve monitoring wells have been installed and one year of data has been collected to better understand seasonal fluctuations in groundwater elevations in this sub-region. This project is the precursor to establishing production wells to supplement surface diversions as noted below (TBs 6 and 8).

Potential ACID Quantifiable Objectives. As discussed above, ACID is seeking funding through several sources, including Proposition 50, to install 12 groundwater extraction wells to assist in achieving QOs relative to TBs 6 and 8. This will supplement surface flows and provide long-term diversion flexibility with an expected contribution of up to 6,800 ac-ft. ACID is seeking funding to pipe a leaky section of the Churn Creek Lateral to reduce non-productive ET losses by a maximum of 8,700 ac-ft (TB 7). Funding is also being sought to modernize the main canal through the installation of several check structures and lateral gates. Given potential funding limitations, it is anticipated that this project may be completed in phases.

Accordingly, the following maximum QOs have been identified:

- 8,700 ac-ft (TB 7)
- 16,800 ac-ft (TBs 6 and 8)

A summary of these efforts with descriptions and estimated schedules and costs is included in Section 5. As funding applications are submitted and the project is implemented, the total anticipated water quantities associated with each phase will be reported in the *Sacramento Regional Water Management Plan Annual Update* (TBs 6 and 8).

4.2.5 Colusa Sub-basin

The SRSCs in the Colusa Sub-basin fall within the area described by CALFED as Sub-region 3, Sacramento Valley, Colusa Basin. The TBs within this sub-region are identified in Table 4-3.

TABLE 4-3
Targeted Benefits in CALFED Sub-region 3
Sacramento Valley Regional Water Management Plan

Number	Targeted Benefit
20	Provide flow to improve ecosystem conditions in the Sacramento River below Keswick
21	Reduce Group A pesticides to enhance and maintain beneficial uses of water in the Colusa Drain
22	Reduce pesticides to enhance and maintain beneficial uses of water in the Colusa Basin Drain
23	Reduce pesticides to enhance and maintain beneficial uses of water in the Sacramento River
24	Reduce salinity to enhance and maintain beneficial uses of water in the Colusa Basin Drain
25	Decrease nonproductive ET to increase water supply for beneficial uses.
26	Provide long-term diversion flexibility to increase the water supply for beneficial use for suitable lands
27	Provide long-term diversion flexibility to increase the water supply for beneficial use for wetlands
28	Provide long-term diversion flexibility to increase water supply for Sacramento and Delevan National Wildlife Refuges
29	Provide long-term diversion flexibility to increase the water supply for beneficial uses for salt affected soils

The participating SRSCs within the Colusa Sub-basin include the following:

- GCID
- PCGID
- PID
- RD 108

The SRSCs in the Colusa Sub-basin have implemented and continue to implement many programs which serve to meet the objectives of the TBs. These programs include, but are not limited to, laser leveling of rice fields, reuse of tailwater, canal maintenance, weed abatement programs, forbearance programs, canal lining projects, and deferring flooding of fields for rice straw decomposition until after the irrigation season (typically the decomposition process is initiated in October of a given year). Through active participation with the rice industry, the SRWCs and the farmers have worked together to develop new crop varieties and improved farming practices that have resulted in shorter growing seasons and higher yields while using less water. These developments have not been limited to rice; farming practices (including the use of new varieties) have yielded similar success with other crops resulting in the SRSCs using the available supply more efficiently.

4.2.5.1 Identification of Applicable Targeted Benefits

The TBs considered to be applicable to the Colusa Sub-basin include TBs 20, 21, 22, 23, 26, 27, 28, and 29. As is typical with the sub-basins, some actions taken to meet QOs relative to TB 20 (providing flow to improve ecosystem conditions in the Sacramento River in a given stretch) could also result in meeting QOs relative to TBs 26, 27, 28, and 29 and visa versa. A diversion reduction below Keswick (TB 20) could be achieved by many methods. A conjunctive-use program would potentially replace surface diversion with groundwater supply and improve long-term diversion flexibility to allow for increased water supply for various uses (TBs 26, 27, 28, and 29). Increasing system efficiency through automation, spill reduction, or drainwater reuse could also contribute to satisfying TB 20.

4.2.5.2 Determination of Non-applicability

TBs 24 and 25 are not applicable to the SRSCs in the Colusa Sub-basin.

Although TB 25 is applicable at an individual farm level by modifying crop type, crop density, or irrigation methods, these determinations are not made on a district level. Therefore, TB 25 is not applicable to SRSCs.

Glenn-Colusa Irrigation District.

Current Activities for GCID Quantifiable Objectives. The TBs applicable to GCID include TBs 20, 26, 27, 28, and 29. GCID has installed a drainwater recapture system comprised of 18 gravity-flow weir type diversions and 19 drainwater lift pump stations. These systems combined recycle an average of 160,000 ac-ft of irrigation water annually (TBs 20, 26, 27, 28, and 29). Feasibility studies have been conducted to install two additional pump stations when funding becomes available. The Ag WUE Incentive Program funded the *GCID Drainwater Operations Study*, which evaluated two primary alternatives for increasing drainwater reuse:

- Expanding current reuse practices
- Using drainwater regulating reservoirs to increase GCID's ability to match the timing of drainwater supply and irrigation demands, and to manage the timing of drainwater outflows from GCID

Findings from this study indicates a potential increase of drainwater reuse ranging from 25,000 to 75,000 ac-ft per year. This reuse is limited by forbearance agreements with downstream users.

GCID has 28 major check structures on the main canal, of which 14 have been automated. Check structures will eventually be automated as funding is made available. This automation will allow increased system efficiency and a reduction in spill volume (TBs 20, 26, 27, 28, and 29).

GCID has coordinated and implemented conjunctive-use programs and land fallowing programs to make water available for transfer and in-stream flows ranging from 11,000 to 60,000 ac-ft (TBs 20, 26, 27, 28, and 29).

GCID has implemented an ongoing SCADA program to monitor canal water levels, drain recapture sites, main pump station status, and water deliveries to USFWS wildlife refuges (TB 28).

Potential GCID Quantifiable Objectives. To meet the QOs for TBs 20, 26, 27, 28, and 29, GCID is seeking funding to implement a conjunctive water management program. The program will satisfy all, or a portion of, their proposed contribution to the SVWMP for the California Bay-Delta Phase 8 Settlement (Phase 8 Settlement). The conjunctive water management program will provide GCID the flexibility to use groundwater resources (potentially up to 30,000 ac-ft) in lieu of surface water supplies when increased in-stream flows are required to meet water quality standards in the Sacramento Delta. GCID anticipates that construction of 10 new, high-production groundwater wells may be required in the long-term to meet their proposed contribution. Status of the groundwater program and implementation would be reported in the annual *GCID Water Measurement Report*.

GCID is also proposing to construct 12 flow measurement sites with telemetry that would be dedicated to the measurement of GCID system outflows. This project would improve water management within GCID and, conceivably, throughout the sub-basin. As proposed, this project could contribute a maximum of 20,000 ac-ft towards the associated QOs (TBs 20, 26, 27, 28 and 29) with a maximum expected contribution of 40,000 ac-ft upon completion of all phases. Given potential funding limitations, it is anticipated that this project would likely be completed in phases. As funding applications are submitted and the project is implemented, the total anticipated water quantities associated with each phase will be reported in the *Sacramento Regional Water Management Plan Annual Update*.

GCID could also promote its objectives with regard to these TBs through future participation in forbearance programs (as they have done previously), using both private and GCID wells.

GCID is investigating the feasibility of constructing a 30,000 to 40,000 ac-ft regulating reservoir on the Colusa Basin Drain and is seeking funding to identify a footprint, establish general operational parameters, and evaluate environmental challenges for this proposed project. The reservoir would allow for the improved management of up to 50,000 ac-ft of water upon completion. The reservoir would also help regulate peak flows and dampen flow fluctuations from the Colusa Basin Drain. The ability to regulate Colusa Basin Drain flow would provide long-term diversion flexibility and satisfy a QO for TBs 20, 26, 27, 28, and 29. Although pesticide use is primarily determined by individual farms, the storage time provided by these reservoirs would allow chemicals to volatize, and it would dilute drainwater with canal water from the Sacramento River (TBs 21, 22, 23, and 24). The results of the feasibility study (if funded) would be presented in a final report with recommendations for implementation. Given the magnitude of this proposed project, implementation would likely take several years and would also be largely driven by funding availability.

Accordingly, a maximum QO of 50,000 ac-ft has been identified (TBs 20, 26, 27, 28, and 29).

TBs 21, 22, and 23 relate to the reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 3. Decisions concerning pesticide use are made at the farm or individual level and are beyond the control of the SRSCs. GCID will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with estimated schedules, costs, and descriptions is included in Section 5.

Princeton-Codora-Glenn Irrigation District.

Current Activities for PCGID Quantifiable Objectives. In 1999, PCGID, in combination with PID, completed a new pump station that serves both districts. This new station allowed diversions at three other locations along the Sacramento River to be discontinued. This new pump station has SCADA controls that increased operating efficiency. As part of the project, a 0.25-mile stretch of main canal was lined with concrete to reduce nonproductive ET losses (TB 25).

Farmers in the PCGID practice laser leveling of their fields. This practice results in a uniform and efficient distribution of water and a reduction of water demand (TBs 20, 26, 27, and 28).

The PCGID has drilled five wells along its main canal that are capable of producing approximately 3,000 ac-ft of water each year. In conjunction with privately owned wells, these wells have been used to supplement surface water diversions; they have also been used for transfers and forbearance programs in dry years and to provide water for USFWS wildlife refuges (TBs 20, 26, 27, and 28).

PCGID is an active participant in the Glenn County Groundwater Management Plan and closely monitors water levels in an effort to establish safe groundwater yields for pumping within Glenn County. PCGID has installed 10 lift pumps at 4 locations within its boundaries. These pumps are used to recycle approximately 35,000 ac-ft of drainwater annually (TBs 20, 26, 27, and 28).

The PCGID maintenance program includes controlling vegetation along its canals and laterals through both mechanical and chemical means. This program reduces nonproductive ET by an undermined amount (TB 25). The possibility of increasing these efforts is limited due to the practice of maintaining some vegetation for habitat and for stabilization of banks, which are subject to slippage during excessively wet conditions.

Farmers who experience salinity problems monitor their fields for salinity impacts. When problems are identified, PCGID works with these growers to increase freshwater flows (TB 24). The PCGID works to maintain sufficient clean water flows to the Colusa Basin Drain to provide high-quality water for users downstream (TB 24).

Potential PCGID Quantifiable Objectives. To meet the QOs for TBs 20, 26, 27, 28, and 29, PCGID is seeking funding to implement a conjunctive water management program to meet all, or a portion of, its commitment to the *Sacramento Valley Water Management Short-term Workplan.* This program includes the development of two new production wells or the use of three existing district-owned wells and an analysis of the basin response. The potential yield of this project is 5,000 ac-ft of water to help reduce surface diversions and control diversions during critical times (TBs 20, 26, 27, and 29).

A study commissioned by PCGID in the early 1980s identified areas of high seepage losses within its main canal and several laterals. A 1.5-mile section of main canal was identified as a main candidate for concrete lining due to soil type and bank instability. PCGID is also investigating the use of lower cost alternatives such as fabric or plastic where bank stability is suitable (TBs 20, 26, 27, and 29).

Accordingly, a maximum QO of 5,000 ac-ft has been identified (TBs 20, 26, 27, 28, and 29).

TBs 21, 22, and 23 relate to the reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 3. Decisions concerning pesticide use are made at the farm or individual level and are beyond the control of the SRSCs. PCGID will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5.

Provident Irrigation District.

Current Activities for PID Quantifiable Objectives. Farmers within the PID service area practice laser leveling of their fields. This practice results in more a uniform and efficient distribution of water and a reduction in water demand (TBs 20, 26, 27, and 28). PID has drilled four wells which are capable of producing approximately 3,000 ac-ft of water each year. In conjunction with privately owned wells, these wells have been used to supplement PID surface water diversions; they have also been used for transfers and forbearance programs in dry years (TBs 20, 26, 27, and 28). PID is an active participant in the *Glenn County Groundwater Management Plan* and closely monitors groundwater levels in an effort to establish safe, sustainable yields for pumping within Glenn County.

The District has installed 13 lift pumps at six locations within its boundaries to recapture and reuse approximately 40,000 ac-ft of drainwater annually (TBs 20, 26, 27, and 28).

In 2004, for $15,000 the District installed approximately 600 feet of plastic pipe on a section of canal that was known to have high water losses (TBs 20, 26, 27, 28, and 25).

The PID maintenance program includes controlling vegetation along its canals and laterals through both mechanical and chemical means. This program reduces nonproductive ET by an undetermined amount (TB 25). The possibility of increasing these efforts is limited due to the practice of maintaining some vegetation for habitat and for stabilization of banks, which are subject to slippage during excessively wet conditions.

Farmers within the PID who experience salinity problems monitor their fields for salinity impacts. If problems are identified, PID works with these growers to increase freshwater flows (TB 24). PID works to maintain sufficient clean water flows to the Colusa Basin Drain to provide high-quality water for users downstream (TB 24).

Potential PID Quantifiable Objectives. To meet the QOs for TBs 20, 26, 27, 28, and 29, PID is seeking funding to implement a conjunctive water management program that will meet all, or a portion of, its commitment to the Sacramento Valley Water Management Short Term Agreement. This program includes the development of two new production wells or three existing district-owned wells in coordination with an analysis of the basin response. The maximum potential yield of this project is 5,000 ac-ft of water to help reduce surface diversions and control diversions during critical times (TBs 20, 26, 27, and 29). PID plans to pipe another 600-foot section of canal that has high seepage losses. This project will cost approximately $15,000 and result in a savings of approximately 5,000 ac-ft of water.

Accordingly, a maximum QO of 5,000 ac-ft has been identified (TBs 20, 26, 27, 28, and 29).

TBs 21, 22, and 23 relate to the reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 3. Decisions concerning pesticide use are made at the farm or individual level and are beyond the control of the SRSCs. PID will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5.

Reclamation District No. 108.

Current Activities for RD 108 Quantifiable Objectives. In conjunction with an aggressive canal maintenance and weed abatement program, RD 108 has lined canals and laterals with areas of high seepage (TB 25). This program began in the 1970s and has resulted in the lining of approximately 40 miles of canals. To complement this, RD 108 is cooperating with Reclamation and the Yolo and Colusa County Resource Conservation Districts to plant native grasses, rushes, and trees to prevent erosion and stabilize canal and drain banks. RD 108 currently reuses 42,000 ac-ft of drainwater annually (TBs 20, 26, and 27). The amount of drainwater available for reuse depends upon the salinity level of the water. RD 108 maintains a maximum of 400 deciSiemens per meter through a sampling program (TB 24). Although RD 108 primarily controls salinity levels within their area of operation, the monitoring program also has the tangential benefit of controlling salinity in water discharged from the district.

RD 108 has recently installed SCADA components which increase the efficiency of their system and minimize the volume of operation spills (TBs 20, 26, and 27). The SCADA system includes remote monitoring of seven pumping plants and automation of two major canal structures.

RD 108 sponsors various education programs to encourage water conservation including a mobile lab to provide irrigation evaluations and recommendations. Water operator training is conducted inhouse and through the Irrigation Training and Research Center at the California Polytechnical Institute, San Luis Obispo. RD 108 also produces a newsletter, *Water Not*es, to communicate with landowners and water users.

Potential RD 108 Quantifiable Objectives. To meet a QO for TBs 20, 26, 27, 28, and 29, RD 108 is seeking funding to implement a conjunctive water management program that will satisfy all, or a portion of, their commitment to the Phase 8 Settlement. This program includes the development of five production wells and analysis of basin response. The potential yield of this project is 8,000 ac-ft of water that will help reduce surface diversions and control diversions during critical periods. The RD 108 recently received a grant to install several ramp flumes to allow water measurement. These structures will help operators better manage canals to reduce canal spillage and improve on-farm deliveries (TBs 20, 26, 27, and 29).

Accordingly, a maximum QO of 8,000 ac-ft has been identified (TBs 20, 26, 27, 28, and 29).

TBs 21, 22, and 23 relate to the reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 3. Decisions concerning pesticide use are made at the farm or individual level and are beyond the control of the SRSCs. RD 108 will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5.

4.2.6 Butte Sub-basin

The SRSCs in the Butte Sub-basin fall within the areas described by CALFED as Sub-region 4, Mid-Sacramento Valley, Chico Landing to Knights Landing, and Sub-region 5, Feather River and Yuba River. The TBs within these sub-regions are identified in Tables 4-4 and 4-5. The only participating SRSC within the Butte Sub-basin is RD 1004.

TABLE 4-4
Targeted Benefits in CALFED Sub-region 4
Sacramento Valley Regional Water Management Plan

Number	Targeted Benefit
30	Provide flow to improve aquatic ecosystem conditions in the Sacramento River below Keswick
31	Reduce pesticides to enhance and maintain beneficial uses of water in the Sacramento River
83	Reduce pesticides to enhance and maintain beneficial uses of water in the Sacramento Slough
33	Decrease nonproductive ET to increase water supply for beneficial uses for suitable lands
34	Provide long-term diversion flexibility to increase water supply for beneficial uses for suitable lands
35	Provide long-term diversion flexibility to increase water supply for beneficial uses for wetlands
36	Provide long-term diversion flexibility to increase water supply for beneficial uses for Sutter National Wildlife Refuge

TABLE 4-5
Targeted Benefits in CALFED Sub-region 5
Sacramento Valley Regional Water Management Plan

Number	Targeted Benefit
37	Provide flow to improve aquatic ecosystem conditions in Butte Creek
38	Provide flow to improve aquatic ecosystem conditions in the Feather River
39	Provide flow to improve aquatic ecosystem conditions in The Yuba River
40	Reduce Group A pesticides to enhance and maintain beneficial uses of water in the Feather River
41	Reduce pesticides to enhance and maintain beneficial uses of water in the Feather River
42	Reduce salinity to enhance and maintain beneficial uses of water in the Sacramento Slough near Verona
43	Reduce temperatures to enhance and maintain aquatic species populations in Butte Creek
44	Reduce temperatures to enhance and maintain aquatic species populations in the Feather River
45	Reduce temperatures to enhance and maintain aquatic species populations in the Yuba River
46	Decrease nonproductive ET to increase water supply for beneficial uses for affected lands
47	Provide long-term diversion flexibility to increase water supply for beneficial uses for suitable lands
48	Provide long-term diversion flexibility to increase water supply for beneficial uses for wetlands
49	Provide long-term diversion flexibility to increase water supply for beneficial uses for Graylodge Wildlife Management Area

The SRSCs in the Butte Sub-basin have, and continue to implement many programs which serve to meet the objectives of the TBs. These programs include, but are not limited to, laser leveling of rice fields, reuse of tailwater, canal maintenance, weed abatement programs, forbearance programs, and canal lining projects. Through active participation with the rice industry, the SRWCs and the farmers have developed new crop varieties and improved farming practices that have resulted in shorter growing seasons and higher yields while using less water. In addition, other crop varieties have been developed that have resulted in more efficient utilization of the available water supply by the SRSCs.

4.2.6.1 Identification of Applicable Targeted Benefits

This section outlines the efforts proposed by the SRSCs to assist in achieving the remaining TBs in the Butte Sub-basin. The TBs considered to be applicable to Sub-region 4 include TBs 31 and 83. Some actions taken to meet QOs in Sub-region 4 relative to TB 30 may also result in meeting QOs relative to TBs 34 and 35 and visa versa. Likewise, actions taken to meet QOs in Sub-region 5 relative to TB 37 may result in meeting QOs relative to TBs 43, 47, and 48. Actions relative to TBs in Sub-region 4 may result in benefits related to TBs in Sub-region 5. TBs 33 and 46 are also applicable to nonproductive ET losses in conveyance facilities. Therefore, the actions taken by the SRSCs in any one year may result in addressing more than 20 percent of the applicable QOs in the Butte Sub-basin.

4.2.6.2 Determination of Non-applicability

TB36 is not applicable to the SRSCs in the Butte Sub-basin. TB 36 relates to long-term diversion flexibility to increase the water supply for beneficial uses at the Sutter National Wildlife Refuge. Sutter National Wildlife Refuge is located several miles south of the SRSCs in the Butte Sub-basin. The water supply for the Sutter National Wildlife Refuge is derived from the Feather River and Butte Creek. Therefore, changes in diversions from the Sacramento River by the Butte Sub-basin SRSCs would have no direct impact on the water supply available to the Sutter National Wildlife Refuge.

The SRSCs in the Butte Sub-basin lie west of Butte Creek. Therefore, TBs 38, 40, 41, and 44, which pertain to the Feather River, TBs 39 and 45, which pertain to the Yuba River, and TB 49, which pertains to the Graylodge Wildlife Management Area, are not applicable to these SRSCs.

Reclamation District No. 1004.

Current Activities for RD 1004 Quantifiable Objectives. The TBs applicable to RD 1004 include TBs 30, 33, 34, 35, 37, 42, 46, 47, and 48. RD 1004's fish screen project, completed in 1999, included approximately 0.5 mile of the main canal being piped and an additional 1.5 miles of the canal being concrete lined. RD 1004 estimates this project resulted in approximately 3,000 ac-ft of water saved (TBs 46 and 33).

Privately owned wells within RD 1004 are used to supplement the water supply in dry years (TBs 34, 35, 47, and 48). RD 1004 began a metering program in 1992; water is measured at the turnout level and sold by volume. Under RD 10004's pricing policy, growers are charged 6 ac-ft of water per acre of land for rice and 3 ac-ft of water per acre of land for waterfowl habitat. Growers who divert less than the duty amount receive a refund for the unused portion, and those who use more water are charged for the additional use (TBs 30, 34, 35, 47, and 48).

RD 1004 operates a closed system and recycles approximately 20 percent of its annual supply (TB 30). A majority of the drainwater is used to provide water to wetland areas within the district (TBs 35 and 48). Due to the recycling program, very little of the drainage flows into Butte Creek.

Potential RD 1004 Quantifiable Objectives. To assist in meeting the QOs relative to Sub-region 4 (TBs 30, 34, and 35) and Sub-region 5 (TBs 37, 47, and 48), RD 1004 proposes installing district-owned wells to provide a supplemental groundwater supply providing a maximum of 5,000 ac-ft of additional water supply. If funding can be obtained, RD 1004 plans to add lift stations in the northern portion of its service area to expand its recirculation system. Long-term flexibility to meet QOs relative to TBs 30, 34, 35, 37, 47, and 48 may also be achieved through voluntary crop shifting and future forbearance programs. Forbearance programs have occurred in the past because of water demand in other areas of the state with less secure water supplies and water rights.

To meet QOs relative to TB 33 and 46, RD 1004 proposes lining a 3-mile section of its main canal to reduce water loss where seepage is excessive, conserving a maximum of 3,500 ac-ft of water. This project may also assist in meeting QOs for the Butte Sub-basin regarding TBs 30, 34, and 35 (Sub-region 4) and TBs 37, 47, and 48 (Sub-region 5). In addition, RD 1004 will continue its canal maintenance program which involves cleaning vegetation from its supply and drainage ditches.

Accordingly, the following maximum QOs have been identified:

- 3,500 ac-ft (TBs 30, 33, and 46)
- 5,000 ac-ft (TBs 30, 33, 34, 35, 37, 43, 47, and 48)

TBs 31 and 83 relate to a reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 4. Decisions relating to pesticide usage are made at the farm or individual level and are beyond the control of the SRSCs. RD 1004 will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5.

4.2.7 Sutter Sub-basin

The Sutter Sub-basin lies within the area described by CALFED as Sub-region 4, Mid-Sacramento Valley, Chico Landing to Knights Landing. The TBs within Sub-region 4 are identified in Table 4-6.

The participating SRSCs within the Sutter Sub-region are:

- SMWC
- PMWC
- MFWC

The SRSCs in the Sutter Sub-basin have implemented and continue to implement many programs that serve to directly or indirectly meet the objectives of many of the TBs identified for the Mid Sacramento Valley Sub-region. These programs include, but are not limited to, laser leveling of rice fields (which began in the 1970s), reuse of tailwater, canal maintenance, weed abatement programs, forbearance programs, canal lining projects, and deferring flooding of fields for rice straw decomposition until after October.

TABLE 4-6
Targeted Benefits in CALFED Sub-region 4
Sacramento Valley Regional Water Management Plan

Number	Targeted Benefit
30	Provide flow to improve aquatic ecosystem conditions in the Sacramento River below Keswick
31	Reduce pesticides use to enhance and maintain beneficial uses of water in the Sacramento River
83	Reduce pesticides same to enhance and maintain beneficial uses of water in the Sacramento Slough
33	Decrease nonproductive ET to increase water supply for beneficial uses for suitable lands
34	Provide long-term diversion flexibility to increase water supply for beneficial uses for suitable lands
35	Provide long-term diversion flexibility to increase water supply for beneficial uses for wetlands
36	Provide long-term diversion flexibility to increase water supply for beneficial uses for Sutter National Wildlife Refuge

Canal lining projects have been conducted where areas of high losses have been identified. Recent conditions, including but not limited to, apparent water losses and power costs have caused irrigation districts and water companies to identify canal segments that may benefit from lining or piping. A 10-year demonstration project conducted by Reclamation in Oregon, Montana, Idaho, and Oklahoma found lining to be between 70 and 90 percent effective in reducing seepage, depending on the material used. The savings in water depend on the section being lined.

Through active participation with the rice industry, the SRWCs and the farmers have worked together to develop new crop varieties and improved farming practices that have resulted in shorter growing seasons and higher yields while using less water. Farmers have also provided data to the rice industry, universities, and extension services; and they have participated in tests of various rice varieties and practices. In addition, other crops have undergone improvements that have resulted in the SRSCs using the available water supply more efficiently. An example is the tomato, which was once grown from seed and is now transplanted. Although the benefit has not been quantified, this practice results in a shorter growing season and a decrease in water demand.

4.2.7.1 Identification of Applicable Targeted Benefits

The TBs considered to be applicable to the Sutter Sub-basin include TBs 30, 31, 33, 34, 35, and 83. Some actions taken to meet QOs relative to TB 30 may also result in meeting QOs relative to TBs 34 and 35 and visa versa. Diversion reduction below Keswick (TB 30) could be achieved at a district level by a conjunctive-use program which potentially would replace surface diversion with groundwater supply. A conjunctive-use program would also allow for a long-term flexibility in diversion timing to increase water supply for beneficial uses on suitable lands (TB 34), including wetlands (TB 35). A portion of TB 30 can also be met by decreasing nonproductive ET in their conveyance systems (TB 33) by lining canals or piping water to its destination. Increasing system efficiency, including the reuse of drainwater, would contribute to satisfying TB 30. Therefore, the actions taken by the SRSCs in any year may result in addressing more than twenty percent of the applicable QOs for the sub-basin.

4.2.7.2 Determination of Non-applicability

TB 36 was determined to be not applicable to the SRSCs in the Sutter Sub-basin.

TB 36 provides long-term diversion flexibility to increase the water supply for beneficial uses for Sutter National Wildlife Refuge. The majority of the refuge lies within the Sutter Bypass to the east of the SRSCs in the Sutter Sub-basin. A small portion of the refuge lies east of the east levee of the Sutter Bypass. The water supply for Sutter National Wildlife Refuge is currently derived from the Feather River and Butte Creek. Reclamation is investigating potential methods and approaches to convey water to the refuge, including identifying reliable additional water supplies (Level 4) to allow for optimal management of the refuge in conformance with the Central Valley Project Improvement Act. At present, none of the participating SRSCs possess conveyance facilities to provide additional water supplies, nor have they been considered as a potential water supply source (through willing water sales). Therefore, changes in diversions from the Sacramento River by the Sutter Sub-basin SRSCs would have no direct impact on the water supply available to the Sutter National Wildlife Refuge.

Sutter Mutual Water Company.

Current Activities for SMWC Quantifiable Objectives. SMWC sponsors three projects in the SVWMP in an effort to work regionally to meet water supply and water quality objectives set forth by CALFED, the Phase 8 Settlement, the Department, and Sacramento Valley water purveyors. The projects provide canal linings for Laterals F and S (TB 33), a drainwater recapture study (and eventual implementation if deemed economically and technically viable), and the Joint Sutter Basin Groundwater Management Program (anticipated to potentially produce up to 5,000 ac-ft of groundwater supply from SMWC). These projects would allow flexibility in surface diversion timing and quantity (TBs 30, 34, and 35). Forbearance programs in the past have provided water to other areas of the state with less secure water supplies and water rights. SMWC will continue its canal maintenance program, which involves the cleaning of vegetation from its supply and drainage ditches.

Potential SMWC Quantifiable Objectives. To assist in meeting QOs relative to TBs 30, 33, 34, and 35, SMWC is seeking funding for water-use efficiency projects (e.g., lining exceptionally leaky laterals and drainwater recapture system expansion) and supply programs to improve flexibility (e.g., through a proposed groundwater management program for up to 5,000 ac-ft of potential groundwater supply). RD 1500 and SMWC, in cooperation with PMWC, have applied for funding assistance through various state grant rounds including the Department, the Ag WUE Incentive Program in 2000, 2001, and 2002, and AB 303, the Local Groundwater Assistance Program in 2000, 2002, 2004, and 2005. To date SMWC and RD 1500 have not received funding through any of these programs. Preliminary estimates indicate a potential to conserve approximately 10,000 to 20,000 ac-ft annually through increased drainwater recapture and minor system improvements.

SMWC and other SVWMP proponents are working with the Northern California Water Association to seek funding for the SVWMP under a Proposition 50 application to be submitted this year. Additional funding under future rounds to the Proposition 50 grant process will also be pursued, as well as other potential federal and state water use efficiency funding sources as they become available. Long-term flexibility to meet QOs relative to TBs 34 and 35 may also be improved through voluntary crop shifting and future forbearance programs on an annual basis depending on the available water supply, crop prices, and grower interest.

Accordingly, the following maximum QOs have been identified:

- 1,000 ac-ft (TBs 30 and 33)
- 30,000 ac-ft (TBs 30, 34, and 35)

TBs 31 and 83 relate to a reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 4. Decisions relating to pesticide usage are made at the farm or individual level and are beyond the control of the SRSCs. SMWC will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5. The funding obtained, the status of construction projects, the progress of studies underway, and the water quantities conserved or produced will be reported in the *Sacramento Regional Water Management Plan Annual Update*.

Pelger Mutual Water Company.

Current Activities for PMWC Quantifiable Objectives. As with other companies in the Sutter Sub-basin the TBs applicable to PMWC are TBs 30, 33, 34, and 35. In 2003, PMWC lined a 2,500 foot section of canal to reduce nonproductive ET (TB 30). This section of the canal was determined to have high seepage losses into adjoining agricultural lands and visible surface seepage into a parallel drainage canal. This project was funded solely by PMWC with funds designated for conservation projects. PMWC has plans to extend the lining project an additional 2,500 feet.

Potential PMWC Quantifiable Objectives. As discussed above, to meet QOs relative to TBs 30, 34, and 35, PMWC is participating with SMWC in funding requests submitted through RD 1500 to study the development of a drainwater recapture system within the southern Sutter Basin. PMWC is also participating with SMWC in a funding request through RD 1500 to develop a groundwater management program. PMWC is pursuing funding through the Sacramento Valley Water Management Short Term Agreement for a company-owned well. This well, together with existing land owner wells could be used in a conjunctive-use program to allow increased flexibility in diversion timing (TBs 34 and 35) and conserve up to 1,000 ac-ft annually (TB 30). Long-term flexibility to meet QOs relative to TBs 34 and 35 may also be facilitated by voluntary crop shifting and future forbearance programs.

In order to meet a QO relative to TB 33, PMWC will continue its canal maintenance program, which involves the cleaning of vegetation from its supply and drainage ditches.

The company is seeking an estimated $56,000 to line an additional 2,500 feet of canal. PMWC is also evaluating other canals within its service area and will consider additional projects on a priority basis. Canal lining projects might also assist in meeting QOs for the PMWC regarding TBs 30, 34, and 35.

Accordingly, a maximum QO of 1,000 ac-ft has been identified (TBs 30, 34, and 35).

TBs 31 and 83 relate to a reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 4. Decisions relating to pesticide usage are made at the farm or individual level and are beyond the control of the SRSCs. PMWC will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5. The funding obtained, the status of construction projects, the progress of studies underway, and the water quantities conserved or produced will be reported in the *Sacramento Regional Water Management Plan Annual Update*.

Meridian Farms Water Company.

Current Activities for MFWC Quantifiable Objectives. MFWC currently has an aggressive canal maintenance program (TB 33).

Potential MFWC Quantifiable Objectives. The TBs applicable to MFWC include TBs 30, 33, 34, and 35. MFWC can assist in meeting QOs relative to TBs 30, 34 and 35 through greater tailwater reuse and canal maintenance programs. MFWC has recently developed a company-owned well to help satisfy its commitment regarding the Sacramento Valley Water Management Short Term Agreement. MFWC is seeking funding to develop a groundwater management plan and conjunctive-use program and a fish screen project that will include upgrading the diversion pumps and replacing a portion of unlined ditch with a pipeline (TB 33).

Accordingly, a maximum QO of 15,000 ac-ft has been identified (TBs 57, 63, 64, and 65).

TBs 31 and 83 relate to a reduction in the use of pesticides to enhance and maintain beneficial uses of water within Sub-region 4. Decisions relating to pesticide usage are made at the farm or individual level and are beyond the control of the SRSCs. MFWC will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5. The funding obtained, the status of construction projects, the progress of studies underway, and the water quantities conserved or produced will be reported in the *Sacramento Regional Water Management Plan Annual Update*.

4.2.8 American Sub-basin

The only participating SRSC within the American Sub-basin is NCMWC. It falls within the area described by CALFED as Sub-region 7, Lower Sacramento River below Verona. The TBs within Sub-region 7 are identified in Table 4-7.

NCMWC has implemented and continues to implement many programs that serve to directly or indirectly meet the objectives of many of the TBs identified for the Mid Sacramento Valley Sub-region. These programs include, but are not limited to, laser leveling of rice fields (which began in the 1970s), reuse of tailwater, canal maintenance, weed abatement programs, forbearance programs, canal lining projects and deferred flooding of fields for rice straw decomposition until after October.

Canal lining projects have been conducted as areas of high losses have been identified. Recent conditions including, but not limited to, apparent water losses and power costs, have irrigation districts and water companies taking a closer look at areas that may benefit from lining or piping. A 10-year demonstration project conducted by Reclamation in Oregon, Montana, Idaho, and Oklahoma found lining to be between 70 and 90 percent effective in reducing seepage depending upon the material used. The savings in water would be dependent upon the losses in the section being lined.

TABLE 4-7
Targeted Benefits in CALFED Sub-region 7
Sacramento Valley Regional Water Management Plan

Number	Targeted Benefit
55	Provide flow to improve ecosystem conditions in the American River
56	Provide flow to improve ecosystem conditions in the Bear River
57	Provide flow to improve ecosystem conditions in the Sacramento River below Keswick
58	Reduce pesticides to enhance and maintain beneficial uses of water in the Natomas East Main Drain
59	Reduce pesticides to enhance and maintain beneficial uses of water in the Sacramento River
60	Reduce pesticides to enhance and maintain beneficial uses of water in the Natomas Drain
61	Reduce temperatures to enhance and maintain aquatic species populations in the American River
62	Reduce temperatures to enhance and maintain aquatic species populations in the Bear River
63	Decrease nonproductive ET to increase water supply for beneficial uses.
64	Provide long-term diversion flexibility to increase the water supply for beneficial uses for suitable lands
65	Provide long-term diversion flexibility to increase the water supply for beneficial use for wetlands

Through active participation with the rice industry, the SRWCs and the farmers have worked together to develop new crop varieties and improved farming practices that have resulted in shorter growing seasons and higher yields while using less water. In addition, other crops have been developed that have resulted in the SRSCs using the available supply more efficiently.

4.2.8.1 Identification of Applicable Targeted Benefits

This section outlines the efforts proposed by NCMWC to assist in meeting the remaining TBs in the American Sub-basin. The applicable TBs within the American Sub-basin are TBs 57, 58, 59, 63, 64, and 65. Some actions taken to meet QOs in Sub-region 7 relative to

TB 57, such as conjunctive-use water management plans, may also result in meeting QOs relative to TBs 64 and 65 and visa versa. Therefore, the actions taken by NCMWC may result in addressing more than 20 percent of the applicable QOs for the sub-basin.

4.2.8.2 Determination of Non-applicability

TBs 55, 56, 60, 61, and 62 are not applicable to NCMWC. NCMWC does not divert water from the American River or Bear River. Therefore, TBs 55, 56, 61, and 62, which pertain to these rivers are not applicable.

Natomas Central Mutual Water Company.

Current Activities for NCMWC Quantifiable Objectives. The TBs applicable to NCMWC include TBs 57, 63, 64, and 65. While nonproductive ET losses (TB 63) are primarily affected by on-farm decisions such as crop type, crop density, and irrigation methods, NCMWC has an aggressive weed control program for its access roads and canal banks. Two sections of canal have been concrete lined. These sections, 4,106 and 1,170 feet in length, were originally lined in the 1960s. After the 1986 high-water event, these canal sections were relocated for flood protection reasons and the relocated sections were provided with concrete lining. The canal replacement took place in 1987.

NCMWC also continues to reuse drainwater recirculated throughout the system to reduce overall diversions (TB 57) and allow for increased diversion flexibility (TB 64). Due to salinity concerns, NCMWC is considering altering its closed system because it cannot legally control discharges by others into the drain system used for recirculation during the irrigation season. Third-party discharges into the closed system result in both drain management challenges and water quality concerns. An alternative to abandoning the closed system is to construct a reservoir that can store excess drainwater for reuse at a later time. NCMWC has considered this option, was prohibitively expensive for NCMWC to undertake alone.

Potential NCMWC Quantifiable Objectives. To assist in meeting a QOs relative to Sub-region 7 (TBs 57, 64, and 65), NCMWC is seeking funding to implement a conjunctive-use program that will meet all, or a portion of, the water demands in the Sacramento Valley Water Management Short Term Agreement. This demand will be met with a maximum expected contribution of 15,000 ac-ft of in-lieu groundwater production. NCMWC anticipates that construction of new, high-production groundwater wells may be capable of producing water for such a need. NCMWC can meet a QO for TBs 64 and 65 through future forbearance programs and a conjunctive-use program that may include both landowners and new production wells.

Accordingly, a maximum QO of 15,000 ac-ft has been identified (TBs 57, 63, 64, and 65).

TBs 58 and 59 relate to the reduction in pesticide use to enhance and maintain beneficial uses of water within Sub-region 7. Decisions relating to pesticide usage are made at the farm or individual level and are beyond the control of the SRSCs. NCMWC will seek to enlighten individual farmers about the grower education programs, newsletters, and involvement in the Coalition. Pesticide application is being evaluated and addressed by the Coalition as described in Section 4.1.3, and the SRSCs are supporting this effort by disseminating information and participating in focus groups as requested.

A summary of these efforts with schedules, estimated costs, and descriptions is included in Section 5. The funding obtained, the status of construction projects, the progress of studies underway, and the water quantities conserved or produced will be reported in the *Sacramento Regional Water Management Plan Annual Update*.

SECTION 5.0

Identification of Actions to Implement and Achieve Proposed Quantifiable Objectives

This section summarizes the specific actions that will be undertaken by participating SRSCs to address the proposed QOs that were developed as a result of substantial previous efforts, described in Section 4. Proposed programs and projects are organized according to their associated sub-basin and described, including the estimated cost and implementation schedule.

The identification of activities and potential projects that contribute to improved water management across the region will continue to evolve. As described in Section 4, the development of the BWMP, which is the precursor to this Regional Plan and the SVWMP, was a large step forward toward increasing cross-district communication and recognizing the potential for mutually beneficial projects and/or operations. As part of the development of this Regional Plan, projects identified in the BWMP and the SVWMP were used as the basis for assisting in meeting the QOs. Some of these projects have recently received partial Water Use Efficiency funding, and others will be submitted for consideration in upcoming funding rounds. In addition, each of the water districts and companies participating in this Regional Plan continue to encourage and implement water management activities and improvements as discussed in this section and in Section 4. In addition to these specific projects, each contractor will continue to support grower education programs including helping make information available related to farm herbicide use and salinity management. As discussed in Section 3 of this document, the SRSCs are working in cooperation with Reclamation in evaluating appropriate measurement practices for each contractor and will be evaluating current and potential future water pricing approaches. Regional Plan participants will continue to evaluate and pursue additional regional cooperation and inter-district management opportunities if mutual benefits can be identified and funding sources secured.

Some of the proposed projects have already received funding either through the designated agency, the participating SRSC, or a combination of both. Many of the remaining projects will commence when funding is available. Projects that require funding to commence will document their efforts to secure this funding in the *Sacramento Regional Water Management Plan Annual Update*. Many of the projects proposed below will likely take several years to fully implement. Although many of these projects will provide greater flexibility for water delivery and increased reliability, efficiency, and control of system operation, the majority of the benefits will accrue to in-stream uses and result in increased CVP operational flexibility. The projects identified will also greatly assist in meeting the QOs. The SRSCs are dedicated to providing in-kind services and support to make these and future projects occur.

According to Reclamation, Mid-Pacific Region, in the *Regional Criteria for Evaluating Water Management Plans for the Sacramento River Contractors:*

> *Implementation of any Proposed QOs will be dependent upon whether such Implementation is economically and financially feasible for the Participating Contractors based upon their existing resources, and if not, whether there is funding available to the Participating Contractors for that purpose. If such Implementation is not economically feasible, and funding is not currently available, the Plan shall identify in the Annual Update the efforts that the Participating Contractors will undertake in order to attempt to secure adequate funding.*

5.1 Redding Sub-basin

Table 5-1 lists and describes potential projects in the Redding Sub-basin.

TABLE 5-1
Potential Projects in the Redding Sub-region
Sacramento Valley Regional Water Management Plan

Project Title	District	Sub-basin	Description	Potential QO (ac-ft)	Applicable TBs
ACID Churn Creek Lateral Improvements	ACID	Redding	Construct a pipeline to replace a leaky canal lateral in a section east of the Sacramento River	8,700	6, 7
ACID Main Canal Modernization Project	ACID	Redding	Construction to automate the system to reduce diversions spills	20,000	6, 8
ACID Conjunctive Use Program	ACID	Redding	Construct 4 groundwater extraction wells	6,800	6, 8

5.2 ACID Churn Creek Lateral Improvements Project

5.2.1 Project Description

ACID proposes to modify its Churn Creek lateral system to more effectively deliver water. The project will have an estimated water savings of up to 8,700 ac-ft and enable landowners to more efficiently apply water (potentially using 3 to 4 times less applied water than under current conditions). A new pipeline would be installed from the pumping plant on the Sacramento River, east to the current junction box structure at Smith Road. The pipeline would extend along the three existing canal laterals that begin at Smith Road, replacing each. Additionally, a canal lateral that begins immediately east of Interstate 5 would be replaced with a pipeline. In total, 14 miles of pipeline would be installed (1.4 miles to replace the existing Churn Creek lateral and 12.6 miles of appurtenant laterals.

This pipeline will be the key component to a new pressurized system to serve the Churn Creek Bottom area and replace the existing unlined open ditch. A pressurized system will allow landowners to modify irrigation practices to significantly reduce water consumption.

This project would also upgrade the current pumping station, located on the Sacramento River, to provide adequate pressure and flow. Two options will be examined for this upgrade. The first option would be to upgrade the existing pumps to provide gravity flow to turnouts located on the lateral. This option includes installing pumps at each turnout to supply the desired pressure and flow for sprinkler systems. The other option is to replace the existing pumps at the pump station to provide necessary pressure and flow to all the ACID turnouts.

5.2.2 Schedule

The project schedule shown in Table 5-2 will commence upon appropriation of funding. The proposed schedule assumes that funding requests and appropriations occur within one phase. This project would likely be completed in phases. Depending on the actual availability of funding, the implementation time frame for completion of tasks could extend beyond the schedule shown in Table 5-2.

TABLE 5-2
ACID Churn Creek Lateral Improvements Project Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Feasibility	Phase 1 of a feasibility study was completed in 2003; given project conditions and assumptions have changed to some degree, an update of the current feasibility study would be required before commencing design.
Pilot Program	Ongoing for 2005 irrigation season; co-operative program between Reclamation and ACID.
Environmental Document	Programmatic document is in progress and will be completed by spring 2006. Supplemental documentation and permitting is expected to be required during design.

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■	■										
Permitting		■	■	■								
Construction					■	■	■	■	■	■		

5.2.3 Cost and Funding Sources

The estimated total cost for the Churn Creek Lateral Improvement feasibility study is $123,000. ACID is seeking grant monies through the state to conduct the proposed study. A grant application was submitted to the state in January 2005 under the Water Use Efficiency Program. Project costs, including design, permitting, and construction, will be estimated at the order-of-magnitude level. The cost estimate will be refined during final design. Project status will be updated in the *Sacramento Regional Water Management Plan Annual Update*.

5.3 ACID Main Canal Modernization Project

5.3.1 Project Description

ACID proposes several improvements along its main canal in order to conserve water and more efficiently use its surface water resource. This project would likely be completed in phases. The project includes the following five primary improvements:

- Lining five critical canal segments that have high seepage (approximately 2 miles)
- Installation of four new automated check structures

- Installation of 12 new automated turnouts with measurement flumes
- Construction of two siphons to replace leaky structures at stream crossings
- Install SCADA facilities to improve control and efficiency of the modernized ACID Main Canal

These improvements could result in a combined estimated annual water savings of approximately 20,000 ac-ft when completed.

5.3.2 Schedule

The project schedule shown in Table 5-3 will commence upon appropriation of funding. The proposed schedule assumes that funding requests and appropriations occur within one phase. This project would likely be completed in phases. Depending on the actual availability of funding, the implementation timeframe for completion of tasks could extend beyond the schedule shown in Table 5-3.

TABLE 5-3
ACID Main Canal Modernization Project Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	**Project Status – Ongoing and Completed Work**												
Feasibility Study	Completed.												
Environmental Document	Programmatic document is in progress and will be completed by spring 2006. Supplemental documentation and permitting is expected to be required during design.												
	Project Duration – Work to be Completed												
	Year 1				**Year 2**				**Year 3**				**Year 4**
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**
Final Design	■	■											
Permitting		■	■	■									
Construction					■	■	■	■	■	■	■	■	■

5.3.3 Cost and Funding Sources

The estimated construction cost for the ACID Main Canal Modernization Project was $10.8 million in 2002. This order-of-magnitude cost was determined as part of a feasibility study (Phase 1A, April 2002). Using a standard assumption of 4 percent escalation, this project is now estimated to cost approximately $12.3 million. The cost estimate will be refined during final design. ACID is seeking grant monies through the state to implement this project. Project status will be presented in the *Sacramento Regional Water Management Plan Annual Update*.

5.4 ACID Conjunctive Water Management Program

5.4.1 Project Description

ACID is advancing a conjunctive water management program that would responsibly and efficiently develop a vastly underutilized, full groundwater basin that is subject to extensive natural recharge. As an active participant on the Redding Area Water Council and in the SVWMP, ACID recognizes the need to conjunctively manage surface water and groundwater resources to meet projected regional demands and satisfy the Phase 8 Settlement Agreement. The project would be needed to meet peak demands during drought years, and it could provide additional benefits during normal and wet years. Any solution to water supply and reliability needs here, in the area of origin, would potentially result in water supply, water quality, and environmental benefits to the Redding Sub-basin and the Bay-Delta region.

ACID has a Sacramento River diversion and an extensive conveyance system throughout the west side of the Redding Sub-basin, which overlies a highly productive aquifer. This combination of attributes offers ACID a unique opportunity to provide regional solutions to the sub-basin, which does not meet projected water supply demands in dry years, especially during CVP cut-back years. The program would accomplish the following goals and objectives:

- Establish a groundwater monitoring network
- Establish a groundwater production program that would provide up to 6,800 ac-ft/yr of supplemental water supply to offset surface water diversions from the Sacramento River
- Satisfy the water supply and reliability needs of agricultural water users in the ACID service area
- Help satisfy the water supply and reliability needs of in-basin water users in the Redding Basin Water Resources Management Plan
- Contribute to the Sacramento River Phase 8 Settlement Agreement

5.4.2 Schedule

The project schedule shown in Table 5-4 will commence upon appropriation of funding.

TABLE 5-4
ACID Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Install Groundwater Monitoring Infrastructure	In progress; 13 monitoring wells are currently installed, providing up to 2 years of collected baseline data
Feasibility and Pre-design	In progress; to be completed by late summer 2005
Groundwater Management Planning	Ongoing since the late 1990s
Environmental Document	In progress; to be completed by spring 2006

Project Duration – Work to be Completed

	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■	■										
Permitting	■	■	■									
Construction		■	■	■	■	■	■					
Implementation	●——►				For at least 10 years assuming there is no demonstrated impact to sustainability							

5.4.3 Cost and Funding Sources

The cost for the development of the ACID conjunctive water management program is estimated to be $3.2 million. ACID is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.5 Colusa Sub-basin

Table 5-5 lists and describes potential projects in the Colusa Sub-basin.

TABLE 5-5
Potential Projects in the Colusa Sub-basin
Sacramento Valley Regional Water Management Plan

Project Title	District	Sub-basin	Description	Potential QO (ac-ft)	Applicable TBs
GCID Main Canal Modernization Project (Flow Measurement Devices in Main Canal, Lateral System, and Drain Outflow Points/ GCID Existing Automation Program)	GCID	Colusa	Design and construction of 12 flow measurement devices at previously identified system outflow points; design and construction of five main canal check structures.	40,000	20, 26, 27, 29
GCID Conjunctive Water Management Program	GCID	Colusa	Development of a ground-water program consistent with GCID and regional objectives, inclusive of both groundwater monitoring and extraction. Extraction could result from pumping of privately owned or District wells.	27,300	20, 26, 27, 29
GCID Colusa Basin Drain Regulating Reservoir	GCID	Colusa	Construct a 30,000 to 40,000 ac-ft regulating reservoir on the Colusa Basin Drain.	50,000	20, 21, 22, 23, 26, 27, 29
RD 108 Flow Control and Measurement Project	RD 108	Colusa	Replace 5 Flashboard Checks with combination ITRC flap gate and ramp flume	1,000	20, 26, 27, 29
RD 108 Conjunctive Water Management Program	RD 108	Colusa	Installation of up to five production wells for groundwater management program.	8,000	20, 26, 27, 29
PCGID Conjunctive Water Management Program	PCGID	Colusa	Development of a conjunctive water management program.	5,000	20, 26, 27, 29
PID Conjunctive Water Management Program	PID	Colusa	Development of a conjunctive water management program.	5,000	20, 26, 27, 29

5.6 GCID Main Canal Modernization Project

5.6.1 Project Description

This project is expected to conserve a maximum of 40,000 ac-ft of water annually.

GCID proposes constructing 12 flow measurement sites with telemetry that would be dedicated to the measurement of GCID system outflows. This project would improve water management within GCID and, conceivably, throughout the sub-basin.

GCID further proposes to continue automating its main canal structures to increase water-use efficiency. Operational spills would be reduced by replacing four check structures and constructing a tainter gate downstream of the Stony Creek Siphon. The check structures identified for demolition, replacement (using radial gates), and automation include Tuttle Check, Able Check, Lurline Creek Check, and Spring Creek Check. The main canal conveys water year-round; however, many of the laterals do not require year-round deliveries. Canal bypasses would maintain main canal flows and deliveries during construction. When possible, measurement devices on the laterals would be installed outside of the irrigation season.

5.6.2 Schedule

The project schedule shown in Table 5-6 will commence upon appropriation of funding. The construction of this project will be executed in phases and is not expected to be completed in its entirety within the duration of this plan.

TABLE 5-6
GCID Main Canal Modernization Project Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Feasibility and Pre-design	Completed as part of the wildlife refuge water supply.
Environmental Document	Programmatic document is in progress and will be completed by spring 2006. Supplemental documentation and permitting is expected to be required during design.

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■	■										
Supplemental Environmental Documentation and Permitting		■	■									
Construction			■	■	■	■	■	■	■	■	■	■

5.6.3 Cost and Funding Sources

The estimated construction cost for all phases of the GCID Main Canal Modernization Project was $8.7 million in 2001. Using a standard assumption of 4 percent escalation, this project is now estimated to cost approximately $10.2 million. GCID is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.7 GCID Conjunctive Water Management Program

5.7.1 Project Description

GCID is moving forward with the expansion and development of an existing conjunctive water management program. GCID has evaluated the need for conjunctive management of its groundwater and surface water resource on a yearly basis for the last two decades. In years of constrained surface water supply (due to infrastructure failures or drought years), GCID has worked with its landowners to develop annual voluntary groundwater programs (e.g., the 2001 Forbearance Program). GCID is formalizing its groundwater programs into a conjunctive water management program that would provide for the coordinated operation of a network of existing and planned groundwater wells within the GCID service area. The system would be comprised of private groundwater wells, one existing GCID well, and up to 10 planned GCID wells. The total production of the program is expected to be approximately 30,000 ac-ft of water per year. Implementation of the program will be flexible as prescribed in an operating plan (to be developed) allowing the water to be produced in various scenarios ranging between: (1) private wells may provide a maximum of 15,000 ac-ft, and up to 8 GCID wells (1 existing and 7 proposed wells) will provide a maximum of 15,000 ac-ft, and (2) up to 11 GCID wells (1 existing and 10 proposed wells) will provide up to 30,000 ac-ft of groundwater. GCID has agreements with approximately 100 private landowners (approximately 180 participating wells) as part of past voluntary conjunctive water management programs. These private wells may participate in the program in any given year in accordance with negotiated agreements and the operating plan. The program would operate on an annual basis as required by in-basin users, out-of-basin users, or the Phase 8 Settlement Agreement.

5.7.2 Schedule

The project schedule shown in Table 5-7 will commence upon appropriation of funding.

TABLE 5-7
GCID Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Install Groundwater Monitoring Infrastructure	In progress since the 1990s with Glenn County and more recently with SVWMP and Colusa County
Installation of Groundwater Production Infrastructure	In progress; one to two wells will be installed in 2005 as part of a pilot program
Groundwater Management Planning	Ongoing since late 1990s
Environmental Document	In progress; to be completed by spring 2006

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■	■										
Permitting	■	■										
Construction		■	■	■	■	■	■					
Implementation	●——→ For at least 10 years assuming there is no demonstrated impact to sustainability											

5.7.3 Cost and Funding Sources

The cost for the development of the GCID Conjunctive Water Management Program is estimated to be $7.2 million. GCID is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.8 GCID Colusa Basin Drain Regulating Reservoir Project

5.8.1 Project Description

GCID proposes to help regulate peak flows in the Colusa Basin Drain and dampen large fluctuations in flow by constructing a 30,000- to 40,000-ac-ft regulating reservoir. The reservoir facilities will include a pump station on the Colusa Basin Drain, a Colusa Basin Drain bypass channel, an outlet control system, water quality and flow volume instrumentation, and a water quality laboratory. This project is currently in the feasibility stage and is not expected to be completed during the duration of this plan. The project will potentially provide the following benefits:

- Create up to 50,000 ac-ft of available water (TB 20)
- Volatize chemicals and dilute drain water with GCID canal water from the Sacramento River (TBs 21, 22, 23, and 24)
- Regulate Colusa Basin Drain flows to increase water supply reliability (TBs 26, 27, 28, and 29)

5.8.2 Schedule

The project schedule shown in Table 5-8 will commence upon appropriation of funding.

TABLE 5-8
GCID Colusa Basin Drain Regulating Reservoir Project Schedule
Sacramento Valley Regional Water Management Plan

	Project Duration											
	Year 1				Year 2				Year 3			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4
Feasibility Study	■	■	■									
Environmental Document				To be determined during feasibility study								
Design				To be determined during feasibility study								
Construction				To be determined during feasibility study								
Implementation				To be determined during feasibility study								

5.8.3 Cost and Funding Sources

The estimated cost for the feasibility study portion of this project is $500,000. An order-of-magnitude cost estimate for design and construction is $250 million. The cost estimate will be refined during the final design. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*. GCID is seeking funds to conduct the study from state and federal sources in addition to working with the Sacramento Valley Water Management Program. Should the regulating reservoir be deemed economically and technically viable project by project partners, additional funding will be pursued.

5.9 RD 108 Conjunctive Water Management Program

5.9.1 Project Description

The RD 108 proposes to develop a conjunctive water management program that will provide the flexibility to pump and convey groundwater in lieu of some of its surface water supply. Initially, RD 108 will develop a groundwater project with a project capacity of up to 8,000 ac-ft per year. Five groundwater production wells would be located within the service area near RD 108's existing canals. Additionally, existing groundwater monitoring wells would be retrofit with dataloggers. The production wells would likely have capacities that range from 2,000 to 3,500 gpm. This project would help RD 108 meet the following objectives:

- Increase RD 108 water supply reliability and flexibility
- Increase in-stream flows during dry years
- Increase in-basin water supply reliability and flexibility
- Help satisfy the requirements of the Phase 8 Settlement Agreement

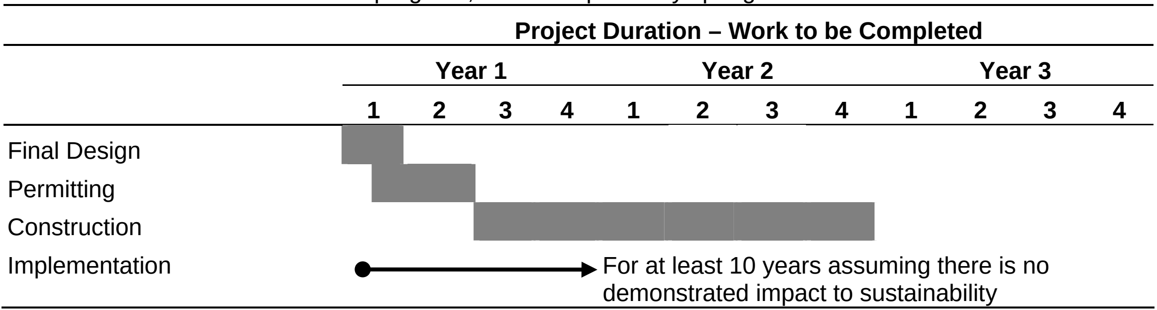
5.9.2 Schedule

The project schedule shown in Table 5-9 will commence upon appropriation of funding.

TABLE 5-9

RD 108 Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Install Groundwater Monitoring Infrastructure	In progress; 12 monitoring wells are currently installed by the Department, numerous multi-completion monitoring wells in Glenn County; more wells are planned by Colusa County and SVWMP
Pre-design	In progress; to be completed by late summer 2005
Groundwater Management Planning	Ongoing; accomplished in conjunction with Glenn County, Colusa County, and District activities
Environmental Document	In progress; to be completed by spring 2006



5.9.3 Cost and Funding Sources

The cost for the development of the RD 108 Conjunctive Water Management Program is estimated to be $3.7 million. RD 108 is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.10 RD 108 Flow Control and Measurement Project

5.10.1 Project Description

RD 108 is replacing five flashboard checks with a combination ITRC flap gate and ramp flume. The ITRC flap gates will improve water-level control resulting in a maximum expected savings of 500 ac-ft of water annually. The downstream ramp flume will replace the existing flashboard check structure and provide accurate water measurement.

5.10.2 Schedule

The schedule in Table 5-10 will commence pending the irrigation schedule for 2005.

TABLE 5-10
RD 108 Flow Control and Measurement Project Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Duration – Ongoing and Completed Work											
	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■											
Permitting	■											
Construction		■										
Implementation	●	→	→	→	For at least 20 years, the minimum expected life of the facilities							

5.10.3 Cost and Funding Sources

The total project cost for the RD 108 Flow Control and Measurement Project is estimated to be $40,000. A Reclamation Water Conservation Grant will provide $25,000; the remaining $15,000 will be funded by RD 108.

5.11 PCGID Conjunctive Water Management Program

5.11.1 Project Description

The PCGID proposes to develop a conjunctive water management program that will provide up to 5,000 ac-ft of groundwater supply that could be used in lieu of a similar quantity of diverted surface water. PCGID proposes using three existing, district-owned groundwater production wells or possibly installing two new district wells. Program goals include the following:

- Increase system reliability for in-basin users
- Increase system flexibility for in-basin users
- Contribute to satisfying the requirements of the Phase 8 Settlement Agreement

New wells would only be installed if the three existing wells that the PCGID has identified are determined insufficient to meet the needs of the program (e.g., production is low or there are air quality issues). PCGID, as a participant in the Sacramento Valley Water Management Program, Glenn County groundwater management, and Colusa County groundwater management, is seeking to establish appropriate levels of groundwater monitoring for successful and responsible management of the groundwater resource.

5.11.2 Schedule

The project schedule shown in Table 5-11 will commence upon appropriation of funding.

TABLE 5-11
PCGID Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Install Groundwater Monitoring Infrastructure	In progress; accomplished in conjunction with SVWMP, Glenn County, and Colusa County
Pre-design	In progress; to be completed by late summer 2005
Groundwater Management Planning	Ongoing since the late 1990s
Environmental Document	In progress; to be completed by spring 2006

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■											
Permitting	■											
Construction		■										
Implementation	→	→	→	→	For at least 10 years assuming there is no demonstrated impact to sustainability							

5.11.3 Cost and Funding Sources

PCGID will fund the program with district monies. If PCGID decides to install new groundwater production wells instead of using existing wells, they will not seek public funding. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.12 PID Conjunctive Water Management Program

5.12.1 Project Description

The PID proposes to develop a conjunctive water management program that will provide up to 5,000 ac-ft of groundwater supply that could be used in lieu of a similar quantity of diverted surface water. PID proposes using three existing, district-owned groundwater production wells or possibly installing two new district wells to help achieve the goals of the program, which include the following:

- Increase system reliability for in-basin users
- Increase system flexibility for in-basin users
- Contribute to satisfying the requirements of the Phase 8 Settlement Agreement

New wells would only be installed if the three existing wells that PID has identified are determined to not meet the needs of the program (e.g., production is low or there are air quality issues). PID, as a participant in the Sacramento Valley Water Management Program, Glenn County groundwater management, and Colusa County groundwater management, is seeking to establish appropriate levels of groundwater monitoring for successful and responsible management of the groundwater resource.

5.12.2 Schedule

The project schedule shown in Table 5-12 will commence upon appropriation of funding.

TABLE 5-12
PID Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Install Groundwater Monitoring Infrastructure	In progress; accomplished in conjunction with SVWMP, Glenn County, and Colusa County
Pre-design	In progress; to be completed by late summer 2005
Groundwater Management Planning	Ongoing since late 1990s
Environmental Document	In progress; to be completed by spring 2006

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■											
Permitting	■											
Construction		■										
Implementation	●———	———	———	———►	For at least 10 years assuming there is no demonstrated impact to sustainability							

5.12.3 Cost and Funding Sources

The PID will fund the program with district monies. If PID decides to install new groundwater production wells instead of using existing wells, they will not seek public funding. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.13 Butte Sub-basin

Table 5-13 lists and describes potential projects in the Butte Sub-basin.

TABLE 5-13
Potential Projects in the Butte Sub-basin
Sacramento Valley Regional Water Management Plan

Project Title	District	Sub-basin	Description	Potential QO (ac-ft)	Applicable TBs
RD 1004 Canal Lining Project	RD 1004	Butte	Extend canal lining on approximately 1.5 miles of the main canal; the first 0.5 mile of main canal is a lined channel which dumps into an unlined slough.	3,500	30,33, 46
RD 1004 Conjunctive Water Management Program	RD 1004	Butte	Installation of two extraction wells.	5,000	30, 33, 34, 35, 37, 43, 47, 48

5.14 RD 1004 Canal Lining Project

5.14.1 Project Description

This project is expected to conserve an estimated 10 to 15 percent of RD 1004's diverted surface water (approximately 5,600 to 8,400 ac-ft per year). The project would promote water conservation by extending the lined portion of the RD 1004 Main Canal by approximately 1.5 miles. This project is the next phase of a traditional water use efficiency program started by RD 1004 in the late 1990s, when they lined approximately 0.5 mile of the uppermost portion of the main canal. The RD 1004 Main Canal is subject to considerable conveyance losses through seepage, resulting in delivery inefficiencies. RD 1004 estimates that it currently loses as much as 60 cfs (the equivalent production of one pump) through the upper reaches of its main canal.

5.14.2 Schedule

The project schedule shown in Table 5-14 will commence upon appropriation of funding.

5.14.3 Cost and Funding Sources

The cost for the development of the RD 1004 Canal Lining Project is estimated to be $3 million. The cost estimate will be refined during the final design. RD 1004 is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

TABLE 5-14
RD 1004 Canal Lining Project Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Phase 1 – New Diversion and Canal Lining	Completed
Environmental Document	In progress; to be completed by spring 2006; supplemental documentation (to be identified in the environmental impact report or environmental impact statement) may be required during final design

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
Quarter	1	2	3	4	1	2	3	4	1	2	3	Q4
Final Design	■	■										
Permitting and Environmental	■	■	■									
Construction				■	■	■	■	■	■			
Potential Mitigation	●→	→	→		If mitigation for sensitive habitat or species is identified, mitigation monitoring may be required for up to 3 years.							

5.15 RD 1004 Conjunctive Water Management Program

5.15.1 Project Description

RD 1004 proposes to develop a conjunctive water management program that will provide up to 5,000 ac-ft of groundwater supply that could be used in lieu of a similar quantity of diverted surface water. The RD 1004 would install two groundwater production wells, with capacities estimated between 2,500 and 4,500 gpm, to help achieve the goals of the program, which include the following:

- Increase system reliability for in-basin users
- Increase system flexibility for in-basin users
- Contribute to satisfying the requirements of the Phase 8 Settlement Agreement

RD 1004, as a participant in the Sacramento Valley Water Management Program, is seeking to establish appropriate levels of groundwater monitoring for successful and responsible management of the groundwater resource.

5.15.2 Schedule

The project schedule shown in Table 5-15 will commence upon appropriation of funding.

5.15.3 Cost and Funding Sources

The cost for the development of the RD 1004 Conjunctive Water Management Program is estimated to be $1 million. RD 1004 is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

TABLE 5-15
RD 1004 Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Identification of Appropriate Groundwater Monitoring Locations	In progress; accomplished in conjunction with the SVWMP
Pre-design	In progress; to be completed by late summer 2005
Groundwater Management Planning	Ongoing; accomplished in conjunction with the District and the counties
Environmental Document	In progress; to be completed by spring 2006

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4
Final Design	■											
Permitting		■										
Construction			■	■								
Implementation	●——	———	———	——►	For at least 10 years assuming there is no demonstrated impact to sustainability							

5.16 Sutter Sub-basin

Table 5-16 lists and describes potential projects in the Sutter Sub-basin.

TABLE 5-16
Potential Projects in the Sutter Sub-basin
Sacramento Valley Regional Water Management Plan

Project Title	District	Sub-basin	Description	Potential QO (ac-ft)	Applicable TBs
MFWC Conjunctive Water Management Program	MFWC	Sutter	Installation of one ground-water production well	1,500	30,34,35
SWWC Irrigation Recycling Project	SMWC and RD 1500	Sutter	Feasibility analysis of a tailwater recovery system	25,000	30,34,35
SWWC Canal Lining	SMWC	Sutter	Canal lining to reduce diversions and eliminate spills	1,000	30,33
SMWC and RD 1500 Joint Sutter Basin Groundwater Management Program	SMWC and RD 1500	Sutter	Groundwater investigation; installation of 12 monitoring wells and 6 production wells	5,000	30,34,35
PMWC Conjunctive Water Management Program	PMWC	Sutter	Construction of one ground-water production well	1,000	30,34,35

5.17 MFWC Conjunctive Water Management Program

5.17.1 Project Description

The MFWC proposes to develop a conjunctive water management program that will provide up to 1,500 ac-ft of groundwater supply that could be used in lieu of a similar quantity of diverted surface water. The MFWC would install one groundwater production well with an estimated capacity between 2,000 and 3,500 gpm to help achieve the goals of the program, which include the following:

- Increase system reliability for in-basin users
- Increase system flexibility for in-basin users
- Contribute to satisfying the requirements of the Phase 8 Settlement Agreement

The MFWC, as a participant in the Sacramento Valley Water Management Program and through Sutter County is seeking to establish appropriate levels of groundwater monitoring for successful and responsible management of the groundwater resource.

5.17.2 Schedule

The project schedule shown in Table 5-17 will commence upon appropriation of funding.

TABLE 5-17
MFWC Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Groundwater Management Planning	Ongoing; accomplished in conjunction with Sutter County and the Department
Preliminary Design	In progress; to be complete by late summer 2005
Environmental Document	In progress; to be completed by spring 2006

	Project Duration – Work to be Completed											
	Year 1				**Year 2**				**Year 3**			
Quarter	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Final Design	■											
Permitting		■										
Construction			■									
Implementation	●→				For at least 10 years assuming there is no demonstrated impact to sustainability							

5.17.3 Cost and Funding Sources

The cost for the development of the MFWC Conjunctive Water Management Program is estimated to be $800,000. The MFWC is seeking public assistance to implement this project through the SVWMP and California State Proposition 50 grants. The development and implementation of this Program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.18 SMWC Irrigation Recycling Project

5.18.1 Project Description

SMWC proposes to conduct a feasibility study that would examine the benefits and costs of increasing the recapture and recycle of drainage. A full scale drainage recapture program would enhance and maximize the use of applied surface water for irrigation purposes and minimize summer drainage that must be pumped out of the Sutter Basin. The project would require construction of check structures and lift pumps in the RD 1500 Main Drainage Channel and return drainage to the Main Irrigation Canal for redistribution in the service area.

A reconnaissance investigation of the potential to recycle irrigation runoff in the SMWC service area was completed in 1997 with the finding that a formal feasibility report would be justified. The investigation found that 80 percent of the drainage water in the SMWC service area is generated upstream of the Bohanon Control Structure located in the RD 1500 Main Drain, meaning that the facility and similar structures placed upstream with lift pumps could effectively return larger quantities of drainwater for recycling. The initial estimates of water savings to the basin through increased drainage recapture/recycle were on the order of 25,000 ac-ft per year.

5.18.2 Schedule

The project schedule shown in Table 5-18 will commence upon appropriation of funding.

TABLE 5-18
SMWC Irrigation Recycle Project Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work											
Reconnaissance Investigation	Complete											
	Project Duration – Work to be Completed											
	Year 1				**Year 2**				**Year 3**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Feasibility Study	■	■										
Design		■	■	■	■							
Environmental Documentation and Permitting			■	■	■							
Construction						■	■	■	■			

5.18.3 Cost and Funding Sources

The estimated cost for the feasibility study is $300,000. An order-of-magnitude cost estimate for design and construction of the project will be developed as part of the feasibility study. The cost estimate will be refined during the final design. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*. SMWC is seeking funds to conduct the study from state and federal sources in addition to working with the Sacramento Valley Water Management Program. Should the program be deemed a economically and technically viable by project partners, additional funding for the project will be pursued.

5.19 SMWC Canal Lining Project

5.19.1 Project Description

SMWC proposes lining approximately 1.3 miles of its lateral system. This project is expected to conserve 500 to 1,000 ac-ft of water per year. The canal lining would include one 0.6-mile section along Lateral F and one 0.7-mile section along Lateral D. Both of these sections are currently subject to significant seepage and annual bank failures.

5.19.2 Schedule

The project schedule shown in Table 5-19 will commence upon appropriation of funding.

TABLE 5-19
SMWC Canal Lining Project Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	**Project Status – Ongoing and Completed Work**											
Environmental Document	In progress; to be completed by spring 2006											
	Project Duration – Work to be Completed											
	Year 1				**Year 2**				**Year 3**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Design	■											
Permitting	■											
Construction	■	■	■									

5.19.3 Cost and Funding Sources

The cost for the development of the SMWC Canal Lining Project is estimated to be $350,000. The cost estimate will be refined during the final design. SMWC is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.20 SMWC and RD 1500 Joint Sutter Basin Groundwater Management Program

5.20.1 Project Description

SMWC, in partnership with RD 1500, proposes installing six groundwater production wells with an estimated capacity of 1,000 to 1,500 gpm, pumped over a 153-day period. This project is expected to provide a maximum annual contribution of 5,000 ac-ft of water supply. Also installed as part of this project would be six multi-completion groundwater monitoring wells. This project would help SMWC meet the following objectives:

- Increase SMWC water supply reliability and flexibility
- Increase in-stream flows during dry years

- Increase in-basin water supply reliability and flexibility
- Contribute to satisfying the requirements of the Phase 8 Settlement Agreement

5.20.2 Schedule

The project schedule shown in Table 5-20 will commence upon appropriation of funding.

TABLE 5-20
SMWC and RD 1500 Joint Sutter Basin Groundwater Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	**Project Status – Ongoing and Completed Work**
Pre-design	In progress; to be completed by late summer 2005
Groundwater Management Planning	Ongoing; accomplished in conjunction with RD 1500, SVWMP, and Sutter County
Environmental Document	In progress; to be completed by spring 2006

	Project Duration – Work to be Completed											
	Year 1				**Year 2**				**Year 3**			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Install Groundwater Monitoring Infrastructure	This task will be Ongoing as additional monitoring infrastructure is continually installed; the first priority will be the six monitoring wells associated with the proposed 5,000 ac-ft project.											
Final Design	■											
Permitting		■										
Construction		■	■	■	■	■						
Implementation	→ For at least 10 years assuming there is no demonstrated impact to sustainability											

5.20.3 Cost and Funding Sources

The cost for the development of the program is estimated to be $5 million. SMWC is seeking public assistance to implement this program through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.21 PMWC Conjunctive Water Management Program

5.21.1 Project Description

The PMWC proposes to develop a conjunctive water management program that will provide up to 1,000 ac-ft of groundwater supply. The water could be used in lieu of a similar quantity of diverted surface water. The PMWC would install one groundwater production well with a capacity estimated between 1,500 and 2,500 gpm to help achieve the following goals:

- Increase system reliability for in-basin users
- Increase system flexibility for in-basin users
- Contribute to satisfying the requirements of the Phase 8 Settlement Agreement

PMWC, as a participant in the Sacramento Valley Water Management Program and through Sutter County, is seeking to establish appropriate levels of groundwater monitoring for successful and responsible management of the groundwater resource.

5.21.2 Schedule

The project schedule shown in Table 5-21 will commence upon appropriation of funding.

TABLE 5-21
PMWC Conjunctive Water Management Program Schedule
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing and Completed Work
Groundwater Management Planning	Ongoing; accomplished in conjunction with RD 1500, Sutter County, and the Department
Preliminary Design	In progress; to be complete by late summer 2005
Environmental Document	In progress; to be completed by spring 2006

	Project Duration – Work to be Completed											
	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Final Design												
Permitting												
Construction												
Implementation					For at least 10 years as long as there is no demonstrated impact to sustainability							

5.21.3 Cost and Funding Sources

The cost for the development of the PMWC Conjunctive Water Management Program is estimated to be $660,000. The PMWC is seeking public assistance to implement this project through the SVWMP and California State Proposition 50 grants. The development and implementation of this program will be documented in the *Sacramento Regional Water Management Plan Annual Update*.

5.22 American Sub-basin

Table 5-22 lists and describes potential projects in the American Sub-basin.

TABLE 5-22
Potential Projects in the American Sub-basin
Sacramento Valley Regional Water Management Plan

Project Title	District	Sub-basin	Description	Potential QO (ac-ft)	Applicable TBs
NCMWC Conjunctive Use Project	NCMWC	American	Utilization of existing groundwater production wells, monitoring and analyzing results.	15,000	

5.23 NCMWC Conjunctive Water Management Program

5.23.1 Project Description

The NCMWC proposes to develop a conjunctive water management program that will provide the flexibility to pump and convey groundwater in lieu of some of its surface water supply. This program will be implemented in phases. The initial phase will involve installation of six new wells and installation and upgrade of the infrastructure to connect the new wells and 13 existing wells to NCMWC's system. The proposed groundwater production wells would likely have capacities that range from 2,500 to 3,500 gpm. This project would help NCMWC meet the following objectives:

- Increase district water supply reliability and flexibility
- Increase in-stream flows during dry years
- Increase in-basin water supply reliability and flexibility
- Help meet the requirements of the Phase 8 Settlement Agreement

5.23.2 Schedule

The project schedule shown in Table 5-23 will commence upon appropriation of funding.

TABLE 5-23
NCMWC Conjunctive Water Management Program
Sacramento Valley Regional Water Management Plan

Project Tasks	Project Status – Ongoing/Completed Work
Groundwater Management Planning and Monitoring	Ongoing
Environmental Document	In progress; to be completed by spring 2006; supplemental documentation may be required

	Project Duration –to be Completed Work											
	Year 1				Year 2				Year 3			
	1	2	3	4	1	2	3	4	1	2	3	4
Design	■	■										
Environmental Documentation/ Permitting		■	■									
Construction				■	■	■						
Implementation	●——	——	——	——►	For at least 10 years assuming there is no demonstrated impact to sustainability of the Basin							

5.23.3 Cost and Funding Sources

The cost for the development of the NCMWC Conjunctive Water Management Program would be approximately 5 million. NCMWC is seeking public funding to help implement this Program through the SVWMP and state and federal agencies. The development and implementation of this Program will be documented in the Regional Plan Annual Report.

SECTION 6.0

Establishment of Monitoring Program

The purpose of this section is to document the current water quality and flow measurement capabilities of each participating SRSC and propose a plan to monitor progress in satisfying QOs resulting from the implementation of water projects. As described in Section 4.0 of this document, QOs were developed by evaluating and identifying the potential quantity of water that could potentially be made available given the implementation of various projects considered to be feasible. Monitoring the performance of each project will be guided by the development of project-specific performance and monitoring plans including mapping monitoring locations. The primary method of monitoring a project's contribution to a QO is flow measurement at the diversion point on the Sacramento River. SRSCs currently monitor their diversions during specific time periods. Changes to river diversions can be quantified and compared with similar water years, including changes in the timing of diversions. It is proposed that baseline flows be identified using recent and historical diversion records by year type, and that future monitoring use a combination of diversion measurement and projected water made available in mutual agreement between the project proponent and Reclamation. The status of baseline and monitoring development and mapping will be documented in each annual Regional Plan update. The current status for monitoring flow within each district/company as discussed in Section 2 is summarized below:

Redding Sub-basin:

- ACID: ACID's main river diversions (Lake Redding and Churn Creek) have meters installed and operated by Reclamation, which provide both flow rate and total volume of flow. At major lateral headgates, the district measures flow rates manually using weir or gate head-flow tables. Flows at field turnouts are measured using canal headgate position tables. Drain pump flows are not metered, but the total volume pumped is estimated using power consumption and pump efficiency history. Estimates of flow rate at turnouts are made based on canal headgate position relationships.

Colusa Sub-basin:

- GCID: The district diverts water from a primary pumping plant on the Sacramento River, 2 interties with the Tehama-Colusa Canal, and 19 drain pumping stations. These sources are continuously monitored via remote electronic metering. Flow within the district is monitored as follows: 116 lateral spill sites checked twice per day, 18 gravity diversion weirs monitored twice per day, 12 drain outflow measurement sites monitored daily, 54 turnout sites with meters monitored continuously, and 24 turnout sites without meters monitored 2 to 3 times each day. The district also continuously monitors its 12 metered sites that deliver water to refuges.

  Main canal flows are measured using meters at key points, including a new acoustic measuring device at the recently constructed Stony Creek siphon. Main laterals and sub-laterals that serve field turnouts are metered. District drain pumps and the single district groundwater well are metered. Turnouts to fields are measured and totaled by service area using the measurements for the service lateral that serves each area. Lateral spills are measured and totaled using lateral stage measurement and weir equations. Drain outflows from the district are measured and recorded using a combination of weirs and meters.

- PID: The district currently measures flows at the main pump stations with flow meters. District wells and drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts. Flow rates at turnouts are estimated using head-flow relationships for the turnout orifices or weirs.
- PCGID: The district currently measures flows at the main pump stations with flow meters. District wells and drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts. Flow rates at turnouts are estimated using head-flow relationships for the turnout orifices or weirs.
- RD 108: The district has eight metered pumping plants that divert from the Sacramento River. These plants deliver water into four autonomous irrigation systems. Water in these systems is controlled by flashboard weirs that are monitored by ditch tenders 2 to 3 times daily using ITRC scales to determine flow rates. These irrigation systems deliver to approximately 700 submerged orifice turnouts that are monitored when system conditions change using tables to analyze flow using differential head levels and orifice size.

Butte Sub-basin:

- RD 1004: The district measures flow and quantity at its river diversion pump stations using flow meters. Canal and lateral flow rates are measured using meters and totalizers installed at intermediate points such as road culverts. The one district well is metered. Drain pump flows are estimated using power consumption and pump efficiency data. The only operations level that is not metered is the drain pumps, although the power consumption records and efficiency data provide fairly accurate estimates of total volumes pumped. RD 1004 has flow meters installed on its customer turnouts. The meters are read and cleaned regularly, generally every 2 days. The district uses the meter data to record flow rates and total volume delivered at each turnout.

Sutter Sub-basin:

- MFWC: The company has seven separate water delivery systems within the district. These delivery systems have a total of 91 flashboard weirs, which the ditch tender uses in conjunction with eight flow meters on river and drain diversions to maintain control of the district. The weirs and flow meters are monitored continuously throughout the day.
- SMWC: The company currently measures flows at the main pump stations using flow meters and pump flowcharts. Flows at lateral headgates are measured using headgate position. Drain lift pump flows are measured using power consumption records and capacity information. Drainage leaving the company is measured using a Department formula for the main drainage discharge pump station. Flow rates at each turnout can be measured using canal stage and turnout gate position. The volume can be measured using the flow rate and time of delivery (typically 24 hours).

- PMWC: The company currently measures flows at the main pump stations using flow meters. Flows at lateral headgates are measured using headgate position. Drain pump flows are measured with meters. The three wells each have flow meters installed. Review of the PMWC's records for the last 10 seasons shows that the existing water measurement program is effective in matching supply and demand and accounting for the flow of water at key points in the system. PMWC currently measures the flow rate and the total quantity of water delivered at each turnout. Flow rates are measured using canal stage and turnout gate position. The volume of delivery is measured based on the flow rate and time of delivery.

American Sub-basin:

- NCMWC: The company measures water at its five Sacramento River diversion pump stations using flow meters provided by Reclamation. No flow measurements are taken and recorded internally on any of the main canals or laterals. Adjustments to water flows for delivery purposes are made manually, using a method of approximation. The NCMWC's internal drain pumps and secondary lift pumps are not equipped with any type of measuring device. Delivered water volumes from these facilities are estimated using power consumption and pump efficiency data. This method is also used to estimate the outflow amounts from RD 1000's drainage pumps into the Sacramento River. Only RD 1000 has the ability to discharge water back into the river.

6.1 Proposed Water Measurement Programs

In addition to current monitoring practices, two water measurement programs are currently in progress to determine the appropriate level of additional water measurement at the SRSC level, within the SRSC service areas, and at the sub-basin level.

The Cooperative Study described in Section 3 is fully funded through two funding programs: (1) Chapter 7, Proposition 50 funds for the CALFED Water Use Efficiency Program (Section B, Agricultural Research and Development Projects); and (2) a Water Conservation Field Service Program grant from Reclamation. The study will help determine the appropriate level of agricultural water measurement for SRSCs to promote efficient water management and meet the regional criteria requirements.

Starting in the 2006 irrigation season and continuing through the 2007 irrigation season, the steps detailed in the Cooperative Study (see Appendix B) will be completed. These steps include conducting interviews with SRSCs, analyzing existing delivery data, purchasing and installing measurement equipment for the pilot study, and analyzing pilot study results. Cooperative Study approaches and conclusions will be reviewed by a third-party agricultural water-use expert. The SRSCs will coordinate with Reclamation to implement the study and then develop a mutually agreeable surface water delivery measurement program that will be consistent with the regional criteria as part of each contract.

The *Sub-basin-level Water Measurement Study* (see Appendix A) investigated Sacramento Valley sub-basin outflow sites. This initial feasibility study evaluated existing facilities and methods of outflow measurement in the following four sub-basins:

- Colusa Sub-basin
- American Sub-basin
- Butte Sub-basin
- Sutter Sub-basin

As a result of the study, changes to existing measurement facilities have been recommended to improve the understanding of the quantity and timing of sub-basin outflow and the sub-basin water balance. Partial funding for the 2-year initial implementation phase of the measurement program has been recommended for funding through Chapter 7, Proposition 50 funds for the CALFED Water Use Efficiency Program (Section B, Agricultural Research and Development Projects). When program funding is complete, the SRSCs intend to work with the Department to purchase and install equipment and calibrate new and existing measuring devices to improve outflow measurement accuracy in these sub-basins.

In coordination with Reclamation and the Department, water measurement annual reports will be provided during the implementation phase of the *Sub-basin-level Water Measurement Study*. The annual reports will document the improvements that have been made and the effectiveness of the devices installed. The data collected will be used for sub-basin-level water balance calculations. A key component of the annual reports is an evaluation of how the data can be used in future water management operations.

The results and recommendations from the *Sub-basin-level Water Measurement Study* will allow SRSCs to develop a coordinated approach to water measurement and monitoring at the sub-basin level. This includes potentially using common databases or central data storage, maintenance of facilities, and management of water in the Sacramento Valley.

Some projects, such as canal lining, require localized measurement to establish the baseline usage and gauge project effectiveness. If localized measurements are not already established in the SRSCs, appropriate measurements will be determined during the initial phase of the project. Overall contribution to a QO will be measured by a reduction in diversion quantity or timing as measured at the diversion point.

Continuation of the two studies described above will provide useful information and data to assist in the implementation of an overall water measurement program. The program will meet the requirements of regional criteria, improve the understanding of quantity and timing of inflows and outflows at various levels of SRSC agricultural water operations, and provide information necessary to monitor benefits consistent with CALFED QOs.

6.2 Water Quality and the Sacramento Valley Water Quality Coalition

The Sacramento Valley Water Quality Coalition (Coalition) was formed in 2003 to enhance and improve water quality in the Sacramento River, while sustaining the economic viability of agriculture, functional values of managed wetlands, and sources of safe drinking water.

The Coalition is composed of more than 7,500 farmers and wetlands managers encompassing more than 1 million irrigated acres and supported by more than 200 agricultural representatives, natural resource professionals, and local governments throughout the region to improve water quality for Northern California farms, cities and the environment.

The Coalition developed and submitted its Regional Plan for Action to the SWRCB and the Central Valley Regional Water Quality Control Board (RWQCB) in June 2003. To effectively implement the Monitoring and Reporting Program Plan (MRPP), the Coalition and 10 sub-watershed groups signed a Memorandum of Agreement that defines the respective roles and responsibilities of the sub-watershed groups, as well as Northern California Water Association, Ducks Unlimited, and the Coalition for Urban Rural Environmental Stewardship, to implement the Regional Plan for Action. Additionally, the Coalition signed a Memorandum of Agreement with the California Rice Commission to coordinate the respective programs in the Sacramento River Basin. Although water districts are typically not direct members of the Coalition, many districts and companies have encouraged landowners to join and have assisted in grower education through newsletters or communicating information and updates. The Coalition is continuing to pursue partnerships with municipalities and urban areas in the region that are developing stormwater management plans and facing increasingly more stringent effluent limitations.

To implement the Regional Plan for Action and to meet the Water Board's regulations, the Coalition prepared and submitted two documents on April 1, 2004, that serve as the foundation for a phased water quality management program: (1) a Watershed Evaluation Report and (2) an MRPP. The Watershed Evaluation Report is a comprehensive watershed assessment prepared by local agricultural representatives, wetlands managers, and natural resource professionals. The Watershed Evaluation Report provides a detailed description of the landscape in each of the 10 Coalition sub-watershed areas, including cropping patterns, soil quality, water quality issues, management practices, implementation, and pesticide use. The Coalition is required by the RWQCB to monitor major drainages to establish baseline data. Currently, the Coalition monitors some intermediate drainages, and others will be monitored on a rotation basis over a 5-year period.

The ultimate output of the Watershed Evaluation Report is a drainage prioritization table for each sub-watershed area. Using Department land-use survey data, the entire 21-county region was divided into nearly 250 geographic areas. The Coalition evaluated raw acreage numbers for orchard, annual, and pasture crops (excluding short- and long-grain rice), respectively, in each drainage area, and then multiplied these raw acreages by a weighting factor, with orchards receiving the greatest emphasis and pasture the least. Adding each of these weighted acreages in each sub-watershed area produced an index that was used as the primary criterion for ranking a drainage area. The Coalition also evaluated diazinon, chlorpyrifos, copper, and pyrethroid use in each drainage area and used this data as the second criterion. The third criterion was the existence of **impaired water bodies** listed under the so-called 303(d) list. Each sub-watershed group then evaluated the ranked drainages in their sub-watershed, and depending on their local knowledge of the hydrology and current issues, selected monitoring sites for the initial sampling. Following extensive review by the Water Board and considerable discussion and negotiation regarding the details of the Coalition MRPP, the Water Board issued a Conditional Approval on December 2, 2004. The waiver was recently renewed for 5 years and will expire in 2011.

The Coalition completed its Quality Assurance Project Plan, including sampling site specifics and sampling follow-up methodologies. If sampling reveals significant and persistent toxicity as defined in the MRPP or exceedances of relevant water quality objectives, then a diagnostic approach will be used to expand monitoring activities upstream to identify the general source of toxicity or cause(s) of exceedances. If the magnitude and duration of the toxicity or water quality objective exceedance is sufficient to warrant implementation of management practices, then the Coalition will mobilize its partners at the sub-watershed area level to work with growers to implement practices intended to improve water quality. The Coalition will determine the spatial distribution of crops associated with the identified constituent of concern in the affected sub-watershed area. The County Agricultural Commissioners and other local partners will then organize management practices workshops with growers. If water quality problems persist, the Coalition will engage County Agricultural Commissioners in the implementation of a Mandatory Product Stewardship Program.

This program, requested by the County Agricultural Commissioners and the California Department of Pesticide Regulation, engages the pesticide registrants and charges them with a more specific management practice outreach program directly associated with their product. The Coalition plans to move through this response strategy with Water Board oversight through communications reports and semiannual reports, thereby providing the Water Board information sufficient to take stricter action if necessary.

The Coalition has prioritized 10 sub-watersheds in the Sacramento River watershed according to potential relative impact on water quality using three main data sources: drainage mapping, land use, and pesticide use. Of the 10 sub-watersheds, 3 sub-watersheds were categorized as high priority, and 4 were categorized as medium priority. The sub-watersheds were further evaluated by drainage. Of the 244 drainages within the 10 sub-watersheds, 42 drainages were identified as medium or high priority.

The Coalition has identified numerous priority drainages and is involved in the monitoring of 32 sites in 2006 (see Table 6-1). Figure 6-1 shows the location of those sites proposed for monitoring in 2006. To ensure compliance with the Irrigated Lands Waiver Program, monitoring of priority drainages will rotate over time. Appendix F is the full monitoring plan for 2006 and 2007, which was provided as an attachment to the Coalition's amended MRPP. Monitoring results for 2006 are summarized in the Semi-Annual Irrigation Season Monitoring Report, which is included as Appendix G to this document.

The following several management plans were initiated as a result of 2005 and 2006 water quality data collection.

6.2.1 *E. coli* Monitoring Plan

This sampling plan is designed to evaluate the causes of exccedances of *E. coli* Basin Plan objectives observed in the Solano/Yolo Sub-watershed during monitoring for the Yolo Bypass Program and the Coalition monitoring for the Irrigated Lands Program. As a result of these exceedances, the Coalition has agreed to conduct this pilot study to investigate bacterial sources in this sub-watershed. This pilot study is part of a broader management plan provided to the Water Board January 6, 2006, to address exceedances of several water quality parameters. This monitoring plan will be implemented in July 2006, pending plan and Quality Assurance Project Plan approval by the Water Board.

6.2.2 Diazinon Management Plan

The Coalition submitted its Diazinon Runoff Management Plan for Orchard Growers in the Sacramento Valley to the Water Board on January 19, 2006. The plan was approved by the Water Board in March 2006. In fulfillment of the requirements set forth in the plan, the Coalition submitted the 2006 Annual Report on June 1 summarizing the 2005-2006 monitoring objectives, location and results, outreach efforts, grower survey follow-up, and management practices effectiveness.

TABLE 6-1
Sacramento Valley Water Quality Coalition 2006 Monitoring Locations
Sacramento Valley Regional Water Management Plan

Map Index	Sub-watershed	Site Name	Latitude	Longitude
1	Pit River	Pit River at Pittville	41.0454	-121.3317
2	Pit River	Fall River at Fall River Ranch Bridge	41.0351	-121.4864
3	Pit River	Pit River at Canby Bridge	41.4017	-120.931
4	Shasta/Tehama	Burch Creek at Woodson Ave Bridge	39.90528	-122.18368
5	Colusa Basin	Stony Creek on Hwy 45 near Rd 24	39.71005	-122.00404
6	Colusa Basin	Colusa Drain near Maxwell Rd	39.2756	-122.0862
7	Colusa Basin	Stone Corral Creek near Maxwell Rd	39.2751	-122.1043
8	Colusa Basin	Rough and Ready Pumping Plant (RD 108)	38.86209	-121.7927
9	Colusa Basin	Colusa Basin Drain above KL	38.8121	-121.7741
10	Colusa Basin	Butte Creek at Gridley Rd Bridge	39.3619	-121.8927
11	Placer/Nevada/S Sutter/ N Sacramento	Coon Creek at Striplin Rd	38.8661	-121.5803
12	Butte/Yuba/Sutter	Butte Slough at Pass Rd	39.1873	-121.90847
13	Butte/Yuba/Sutter	Wadsworth Canal at South Butte Rd	39.15337	-121.73435
14	Butte/Yuba/Sutter	Pine Creek at Nord Gianella Rd	39.78114	-121.98771
15	Butte/Yuba/Sutter	Sacramento Slough	38.7833	-121.6338
16	Solano/Yolo	Z Drain – Dixon RCD	38.4157	-121.6752
17	Solano/Yolo	Toe Drain at NE corner of Little Holland	38.3491	-121.645
18	Solano/Yolo	Tule Canal at I-80	38.57	-121.58
19	Upper Feather River	Spanish Creek above confluence with Greenhorn Creek	39.96777	-120.91643
20	Upper Feather River	Middle Fork Feather River at County Rd A-23	39.81892	-120.39179
21	Upper Feather River	Indian Creek downstream from Indian Valley	40.0507	-120.97406
22	Lake/Napa	McGaugh Slough at Finley Rd East	39.00417	-122.86233
23	Lake/Napa	Pope Creek upstream from Lake Berryessa	38.64637	-122.36424
24	Lake/Napa	Capell Creek upstream from Lake Berryessa	38.48252	-122.24107
25	El Dorado	North Canyon Creek	38.7604	-120.7102
26	Sacramento/Amador	Cosumnes River at Twin Cities Rd	38.29098	-121.38044
27	Sacramento/Amador	Dry Creek at Alta Mesa Rd	38.248	-121.226
28	Sacramento/Amador	Big Indian Creek at Bridge	38.5498	-120.8478
29	Solano/Yolo	Shag Slough at Liberty Island Bridge	38.30677	-121.69337
30	Shasta/Tehama	Andersen Creek at Ash Creek Rd	40.418	-122.2136
32	Solano/Yolo	Ulatis Creek at Brown Rd	38.307	-121.794
33	Butte/Yuba/Sutter	Gilsizer Slough at George Washington Rd	39.009	-121.6716
34	Shasta/Tehama	Burch Creek at Rawson Rd		

Note:
In summer 2006, the Coalition will work with the Water Board to update their Monitoring Program Plan for 2007.

The following are results from the first year of this multi-year effort:

- All sites were in compliance with load-based total maximum daily load (TMDL) objectives, and most samples were in compliance with the concentration-based TMDL objectives for diazinon. These results indicate that the combination of changes in diazinon use patterns, changes in management practices, and modifications to labeling have been successful in reducing in-stream ambient diazinon concentrations and loads to below historically observed levels that have resulted in these waters being listed as impaired.
- The recently finalized National Water Criteria for diazinon and the proposed Basin Plan objective for the San Joaquin River have significant implications for the TMDL for diazinon for the Sacramento and Feather Rivers. These objectives may be used to modify the targets of the TMDL or potentially to re-evaluate the need to list the Sacramento and Feather Rivers as 303(d)-listed impaired water bodies. The affected water bodies already appear to comply with potential TMDL targets that would be based on these new criteria. At a minimum, future compliance should be more easily achieved. This issue is currently being considered by Water Board staff responsible for implementation of the TMDL.
- Landowners and crop advisors have indicated a strong interest in learning more about Best Management Practices for diazinon. Over 700 landowners and crop advisors have attended nine outreach presentations given in the fall and winter of 2005, prior to the dormant-season spraying initiated in December 2005 and January 2006. The outreach presentations focused on the diazinon label changes and the finalized diazinon TMDL. Information on available Best Management Practice options to best protect surface waters from the potential impacts of dormant-season runoff from diazinon alternatives, specifically pyrethroid insecticides, was also included during the presentations.
- Of the 335 surveys mailed in 2005, 211 surveys were completed and returned to the Coalition by August 26, 2005. The survey results were submitted as part of the Diazinon Management Plan in January 2006. The Coalition worked with County Agricultural Commissioners to identify the 124 nonrespondents and to determine the reason for their failure to respond or fully complete a survey. As a result of the follow-up, 11 additional surveys were completed by growers. The remaining surveys were not completed for various reasons, including the grower no longer farmed, the grower did not respond to attempts to contact them, or the grower refused to complete the survey.
- Other management practices are currently being evaluated in the Sacramento Valley for their effectiveness in reducing or eliminating runoff of dormant-orchard sprays. The Best Management Practice evaluations are being performed through grant funding provided by SWRCB.

6.2.3 Yolo County Technical Report

The Water Board requested a technical report for boron, conductivity, dissolved oxygen, *E. coli* and fecal coliform bacteria, and Selenastrum toxicity that were observed to exceed numeric or narrative Basin Plan limits at several monitoring sites in Yolo County. The sites identified were monitored as part of the City of Woodland's Yolo Bypass Program in late

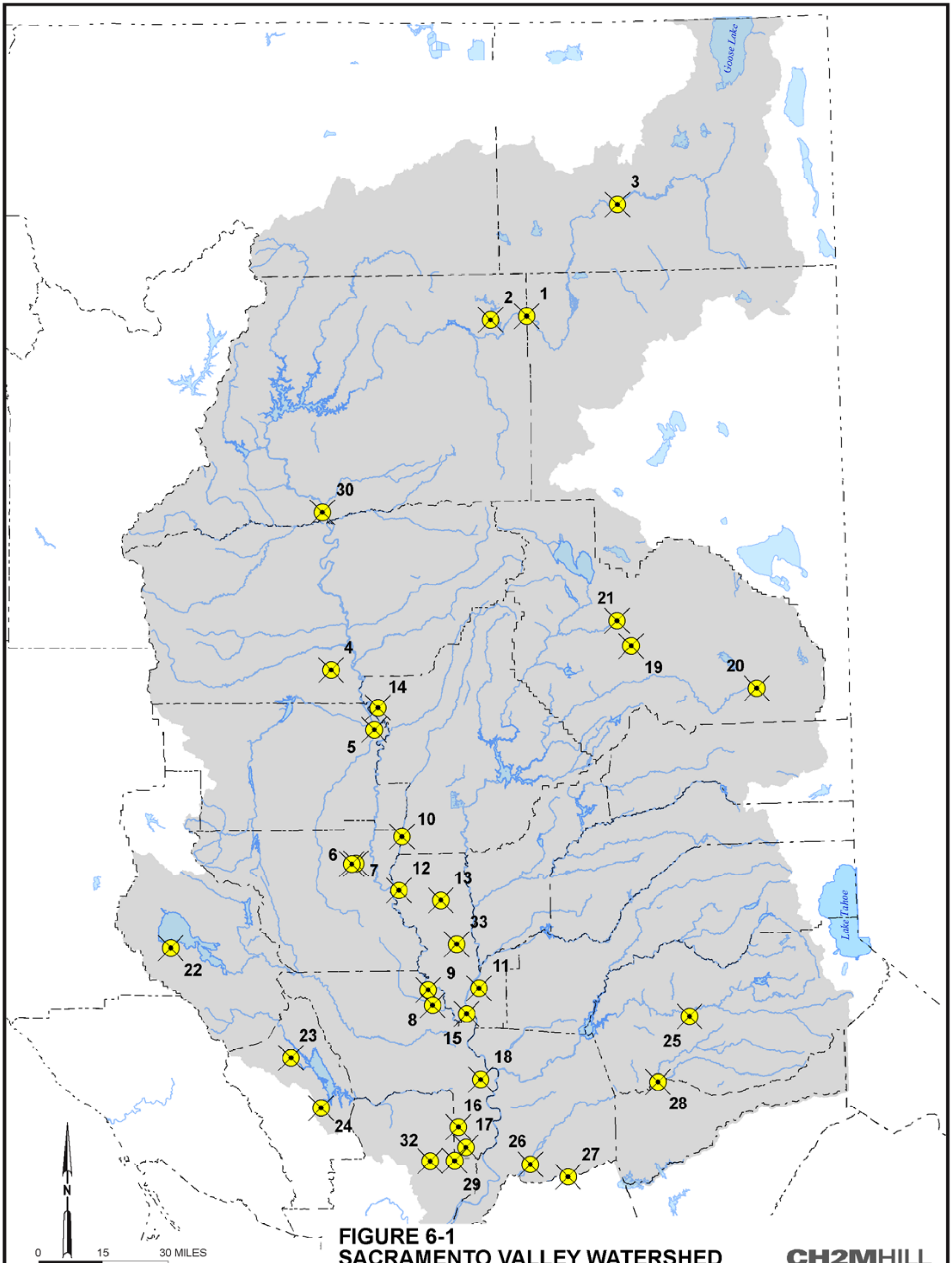


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FIGURE 6-1
SACRAMENTO VALLEY WATERSHED COALITION MONITORING SITES 2006
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

CH2MHILL
in association with
MBK

2003 and 2004, which included sites on Cache Creek, Putah Creek, Ridge Cut, and Willow Slough.

A technical report was submitted on January 27, 2006, calling for an evaluation of existing/ future management practice effectiveness in achieving water quality objectives and a detailed approach to be taken in identifying the causes of toxicity and water quality exceedances within the sub-watershed. Implementation will begin in summer 2006.

Updates of this Regional Plan for Action will be included in the annual updates to the Regional Plan.

6.2.4 Localized Monitoring

Some projects, such as tailwater return, require localized measurement to establish the baseline water quality levels and gauge project effectiveness. If localized monitoring is not already established in the Coalition's monitoring program, a monitoring plan will be developed during the initial phase of the project design. Overall contribution to a QO will measure improvements in water quality in the monitored area. The monitoring plan will identify monitoring locations and monitoring frequency for water quality.

SECTION 7.0

Proposed Budget and Allocation of Regional Costs

This 3-year water conservation budget (see Tables 7-1 and 7-2) is based on estimates of staff time and materials used for conservation efforts by each of the participating SRSCs.

TABLE 7-1
Estimated Amount Spent Last Year
Sacramento Valley Regional Water Management Plan

Budget Item	Total Budget, Including Staff Time ($)
Year 2004-2005	
Conservation staff	351,500
Measurement	350,500
CIMIS	1,500
Water quality	49,000
Agricultural education program	9,000
Quantity pricing	0
Policy changes	214,000
Contractor's pumps	687,000
Irrigation system maintenance	3,550,000
Facilitate financing of on-farm systems	0
Line or pipe canals/install reservoirs	235,000
Delivery flexibility	240,000
District spill/tailwater system	16,000
Optimize conjunctive use	535,000
Automate canal structures	61,000
Customer pump testing	0
Total	**6,299,500**

TABLE 7-2
Projected Budget and Staff Time Summary for the Next 2 Years
Sacramento Valley Regional Water Management Plan

Budget Item	Total Budget, Including Staff Time ($)
Year 2005-2006	
Conservation staff	366,000
Measurement	365,000
CIMIS	1,500
Water quality	51,000
Agricultural education program	9,000
Quantity pricing	0
Policy changes	222,500
Contractor's pumps	714,500
Irrigation system maintenance	3,692,000
Facilitate financing of on-farm systems	0
Line or pipe canals/install reservoirs	244,500
Delivery flexibility	249,500
District spill/tailwater system	16,000
Optimize conjunctive use	556,500
Automate canal structures	63,500
Customer pump testing	0
Total	**6,551,500**
Year 2006-2007	
Conservation Staff	380,500
Measurement	379,500
CIMIS	1,500
Water Quality	53,000
Agricultural Education Program	9,500
Quantity pricing	0
Policy changes	231,500
Contractor's pumps	743,500
Irrigation system maintenance	3,839,500
Facilitate financing of on-farm systems	0
Line or pipe canals/install reservoirs	254,500
Delivery flexibility	259,500
District spill/tailwater system	16,500
Optimize conjunctive use	579,000
Automate canal structures	66,000
Customer pump testing	0
Total	**6,813,500**

The proposed budget for the annual update assumes a level of effort that includes quarterly conference calls or meetings with participating SRSCs, semi-annual meetings with

Reclamation, and work necessary to prepare the *Sacramento Valley Regional Water Management Plan Annual Update*. The expenses proposed in Table 7-3 assume minimal travel is required and there will be minimal revisions to the Preliminary Draft Regional Plan. The budget does not include production costs and expenses associated with these items.

TABLE 7-3
Annual Budget for Regional Plan Implementation and Update
Sacramento Valley Regional Water Management Plan

Classification	Hours	Rate ($)	Total ($)
Regional Plan Coordinator(s)[a]	60	120.00	7,200.00
Staff/Consultant	100	100.00	10,000.00
Labor Sub-total			17,200.00
Expenses[b] (15 percent of total)			2,580.00
Total			**19,780.00**

[a]Labor hours would be provided as in-kind services

[b]Expenses include office space, equipment and supplies, vehicle expenses, annual update production costs, and meeting expenses

SECTION 8.0

Regional Plan Coordination

Quarterly conference calls or meetings will be attended by the representatives listed in Table 8-1. Any issues that may not affect an individual SRSC, but may impact the region or sub-basin will be addressed at this time. A current list of conservation coordinators for each participating SRSC will be provided with the Regional Plan Annual Update.

TABLE 8-1
Regional Plan Conservation Coordinators
Sacramento Valley Regional Water Management Plan

District/Company	Conservation Coordinator	Phone	Email
ACID	Stan Wangberg	530-365-7329	acidstan@sbcglobal.net
GCID	Ben Pennock	530-934-8881	bpennock@gcid.net
PID	Lance Boyd	530-934-4801	lboyd52@aol.com
PCGID	Lance Boyd	530-934-4802	lboyd52@aol.com
RD 108	Lewis Bair	530-437-2221	lewisbair@hughes.net
RD 1004	Jack Baber	530-458-7459	rd1004@colusanet.com
MFWC	(vacant)	530-696-2456	(vacant)
SMWC	Max Sakato	916-365-0187	xminusmax@aol.com
PMWC	Scott Tucker	530-735-9355	pelgerwater@direcway.com
NCMWC	(vacant)	916-419-5936	(vacant)
Regional Plan Coordinator	Lewis Bair	530-437-2221	lewisbair@hughes.net

SECTION 9.0

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Appendix A
Sub-basin-level Water Measurement Study

TECHNICAL MEMORANDUM

July 2003

Sacramento River Basinwide Water Management Plan
Sub-basin-level Water Measurement Study

A CALFED Agricultural Water Use Efficiency Program Grant Study

Prepared by

CH2MHILL

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Executive Summary

Background

The Sacramento River Settlement Contractors and U.S. Bureau of Reclamation are currently completing the Sacramento River Basinwide Water Management Plan. Among the numerous water management improvement options evaluated in the Basinwide Water Management Plan, water measurement was identified as an area requiring additional investigation to promote continued reuse and optimal management of water supplies. To assess the potential for improved water measurement, this Sub-basin-level Water Measurement Study (Measurement Study) was undertaken. Because the Measurement Study, as originally proposed, was not fully funded, the scope of work was refined to focus on evaluating sub-basin outflow. An improved understanding of sub-basin outflow, in terms of quantity and timing, would help support regional water management in the Sacramento Valley.

Measurement Study Objectives

The objectives of the Measurement Study are as follows:

- Investigate and document the existing sub-basin outflow water measurement facilities.
- Evaluate and recommend facility improvements to achieve higher levels of accuracy and/or data collection if deemed appropriate.
- Provide cost estimates for recommended measurement facility improvements.
- Identify potential issues of implementing a regional approach to water measurement operations, data collection, and use.
- Identify the potential benefits of improved sub-basin-level water measurement.

Relationship to CALFED Objectives and Other Regional Efforts

Consistent with the Basinwide Water Management Plan, this Measurement Study recommends the implementation of an ongoing Sub-basin-level Water Measurement Program (Measurement Program). The proposed Measurement Program would contribute to the goals of the CALFED Bay-Delta Program. Implementation of a coordinated Measurement Program would be consistent with CALFED's Water Use Efficiency Program by assisting with water use efficiency evaluation at the sub-basin level. The proposed Measurement Program would also have benefits that support overall Sacramento Valley water management and goals of the CALFED Watershed Management Program. In addition, this Measurement Program is complementary to the Sacramento Valley Water Management Agreement, which is a cooperative basinwide approach to providing supplies to help meet water quality standards in the Delta while providing supply to water-short regions of the Sacramento Valley and for transfer to Central Valley Project and State Water Project users.

Recommendations for Outflow Measurement Improvement

The Measurement Study evaluated existing facilities and methods of outflow measurement in the following four Sacramento Valley sub-basins: the Colusa Sub-basin, the American Sub-basin, the Butte Sub-basin, and the American Sub-basin. Due to limited funding and the complexity of the Redding Sub-basin, it was excluded from this Measurement Study. The Measurement Study focused on areas served mostly by Sacramento River Settlement Contractors; therefore, the Measurement Study addresses only portions of the outflow from the Colusa, American, Butte, and Sutter Sub-basins. Details of the areas covered by the Measurement Study and the existing measurement methods and facilities are provided in this technical memorandum.

Based on this Measurement Study, changes are suggested to existing measurement facilities and methods to improve the understanding of the quantity and timing of sub-basin outflow. The total estimated cost to implement all of the measurement improvements recommended in this Measurement Study is approximately $155,000. The annual operations and maintenance costs associated with data collection and processing, calibration, and general upkeep of the measuring and logging equipment are estimated to be approximately $60,000. It is recommended that funding on the order of approximately $275,000 be sought to implement an initial 2-year phase of the Measurement Program. These funds would be used to purchase and install equipment where needed and calibrate new and existing measuring devices to improve or ensure the accuracy of outflow measurement within the four Sacramento Valley sub-basins identified above. In addition, these funds would provide for the operation and maintenance of the measuring devices for the first 2 years of the proposed Measurement Program. Longer-term implementation would require $60,000 annually (in today's dollars) for operation and maintenance.

Implementation Benefits

Implementation of the Measurement Program would provide an improved understanding of sub-basin outflow, which, in turn, would assist in water balance analyses. In addition, the outflow information would lead to the following potential benefits, which are consistent with CALFED Quantifiable Objectives:

- Improved understanding of sub-basin outflow to evaluate opportunities for improved management
- Coordinated management of sub-basin outflow
- Maximized benefits from other regional actions
- Possible integration with future sub-basin-level water quality monitoring program
- Confirmation or revision of CALFED Quantifiable Objectives

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Introduction and Background

Measurement of agricultural water supplies is essential to water management, particularly in a climate of increasing water demands from growing urban areas and environmental purposes. Changing demands on finite and highly variable water supplies in the Sacramento Valley have led to the need for a greater understanding of the water balance.

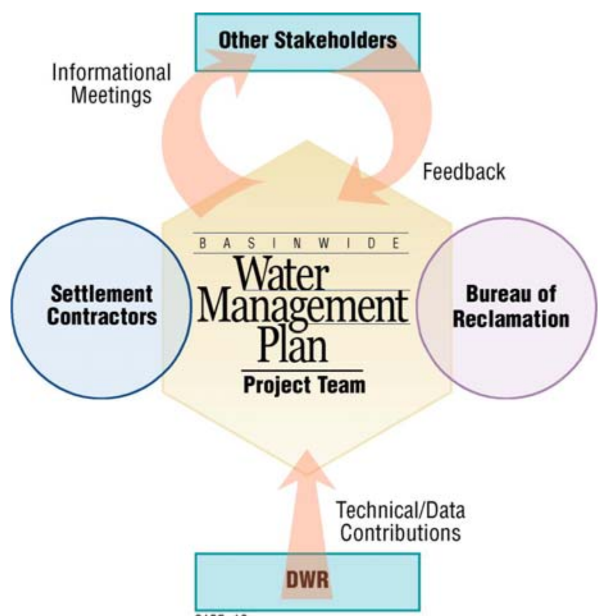
Although the majority of total water demands in the Sacramento Basin continue to come from agriculture, other factors continue to complicate water use management, including increasing water demands from urban areas, more focused attention to environmental uses, and improved hydrologic understanding of the Sacramento Valley region and the Sacramento-San Joaquin River Bay-Delta system (the Delta or Bay-Delta).

The Sacramento River Settlement Contractors (SRSC) and U.S. Bureau of Reclamation (Reclamation) are currently completing the Sacramento River Basinwide Water Management Plan (BWMP). The primary objectives of the BWMP include the following:

1. Provide a common set of data to serve as the basis of contract renewal negotiations
2. Document district, sub-basin, and basin-wide water requirements and supplies
3. Identify management tools and potential approaches to match water supply and requirements while identifying opportunities for environmental enhancement

Among the numerous water management improvement options evaluated in the BWMP, water measurement was identified as an area requiring additional investigation. Given the relatively high degree of water reuse both within and between districts, the BWMP recommended that water management and associated measurement at a sub-basin level should be further evaluated to promote continued reuse and optimal management of inter-district water use. To assess the potential for improved water management and, accordingly, measurement at a sub-basin level in the Sacramento Valley, this Sub-basin-level Water Measurement Study (Measurement Study) was initiated. This Measurement Study is a step toward implementing the Sub-basin-level Water Measurement Program (or Measurement Program) that focuses on increasing the accuracy of the accounting of sub-basin inflow and outflow.

This technical memorandum summarizes the findings of the Measurement Study, which was funded by a CALFED Water Use Efficiency (WUE) Program grant. This



technical memorandum also summarizes a preliminary investigation of potential measurement locations, facilities, and associated implementation issues, which would allow for water measurement for up to five Sacramento Valley sub-basins that are addressed in the Sacramento Valley BWMP. Reclamation District (RD) 108 received a $100,000 grant from the CALFED WUE Program on behalf of the BWMP participants in response to a proposal to evaluate the implementation of a Sub-basin-level Water Measurement Program. The original Measurement Study proposal included an extensive evaluation, design, permitting, and construction program totaling approximately $7.5 million. Included within the proposal was a feasibility study to identify potential locations, appropriate structures and devices, permitting requirements, implementation issues, and related estimated costs.

Because the full program and related feasibility study were not fully funded, the scope of work was refined to maximize the available funds toward gaining the greatest understanding of a potential Measurement Program. In general, the major diversions from the Sacramento River into the sub-basins are measured by the SRSCs and Reclamation. Other inflows in many cases have not been quantified, but are thought to represent a smaller fraction of the overall water supply. Because outflow data are much less available and generally considered the largest uncertainty in sub-basin water balances, this Measurement Study focuses on evaluating sub-basin outflow during the irrigation season.

Measurement Study Objectives

Development of the Measurement Study objectives grew out of an understanding of Sacramento River Valley hydrology. The majority of the irrigated lands are part of a hydraulic system where agricultural return flows run downstream to other water users or return to the river for subsequent diversion.

Hydrologic Characteristics of the Sacramento Basin

Generally, the Sacramento Basin may be characterized as a "flow-through" system, in that the vast majority of the water that is not consumptively used eventually returns to the river. Water used for irrigation is returned to the river via drains that carry surface runoff away from fields. Water may also percolate into the ground, where it recharges groundwater supplies. Groundwater levels remain high in the Sacramento Valley. In some areas, groundwater is tributary or adds to the river flows during normal or wet years. Excess groundwater may also enter nearby drains and return to the river system as drainwater.

All of the water returned to the river system is reused by downstream water users or is used to meet Delta outflow requirements. Therefore, the actions of upstream users can have a considerable effect on agricultural users and other entities located downstream. Although water from the river is used efficiently, the timing of diversions and return flows may affect water availability at other locations in the system, necessitating effective water management.

Agricultural water requirements are met through both surface water and groundwater supplies, as well as reused or recirculated drainwater. Each sub-basin may meet its specific requirements using the optimal combination of sources, depending on basin-specific needs and characteristics. The Sacramento River and its tributaries are the primary sources of surface water for users in the Sacramento Valley. All sources must be recharged by precipitation, which can vary significantly from year to year. Flows within the Sacramento River are also influenced by the operation of the Shasta, Keswick, and Oroville Dams, and other climatic and infrastructure requirements. Water rights and contractual allocations also dictate the use of surface water.

Although SRSCs primarily rely on surface water, groundwater is also used to augment surface supplies, particularly during dry periods. Major aquifers in the Sacramento Basin include the Redding Groundwater Basin and the Sacramento Valley Groundwater Basin. In general, groundwater is a minor source of supply because of relatively higher pumping and equipment costs. Areas with less senior and less reliable water rights rely on groundwater more extensively. Groundwater is also a significant domestic supply source for individual farmsteads and small towns. The American Sub-basin is the most groundwater-dependent sub-basin within the Sacramento Basin mostly due to urban groundwater use in the Sacramento metropolitan area (Reclamation, 2001).

Drainwater is another important source of water and is provided by runoff from fields and groundwater seepage into the drains. The source of this water is mainly diverted water from the Sacramento River upstream of the drainwater user. Although not a new source of water, reuse of drainwater allows water users to manage the timing and quantity of water delivered, providing flexibility and maximizing water use efficiency in a region. Because of extensive water reuse within and between districts, water use efficiencies in the Sacramento Basin sub-basins have been estimated to be as high as 90 percent. Conservation programs have been developed by several SRSCs. Many of these conservation programs rely on recirculation and reuse of drainwater and reduced river diversions. However, these practices can substantially impact downstream users and are limited by leaching and associated crop salinity tolerances. Therefore, good communication across sub-basins is necessary to avoid conflicts. Water quality concerns resulting from drainwater reuse also impacts management practices.

Water measurement practices vary widely within sub-basins in terms of mechanical operation, target accuracy, and level of distribution system. Measurement techniques depend on several factors, including the type of delivery, scheduling, presence of channel lining, component of recycled water, irrigation method, available funding, and site-specific constraints.

Study Objectives

This Measurement Study builds on the BWMP investigations to improve water measurement as one means of improving water management in the Sacramento Valley. The objectives of the Measurement Study are as follows:

- Investigate and document the existing sub-basin outflow water measurement facilities
- Evaluate and recommend facility improvements to achieve higher levels of accuracy and/or data collection if deemed appropriate
- Provide cost estimates for recommended measurement facility improvements

- Identify potential issues of implementing a regional approach to water measurement operations, data collection, and use
- Identify the potential benefits of improved sub-basin-level water measurement

Scope of Measurement Study

The scope of this Measurement Study includes preliminary steps toward the implementation of a Measurement Program in the Sacramento Valley. Work on this project was funded by a grant received by RD 108 from the CALFED WUE Program on behalf of the BWMP participants to conduct a preliminary investigation of potential measurement locations, facilities, and associated implementation issues on a sub-basin level. Consistent with the BWMP, the sub-basins included in this Measurement Study are as follows (see Figure 1-1):

- Colusa Sub-basin
- American Sub-basin
- Butte Sub-basin
- Sutter Sub-basin
- Redding Sub-basin

The Redding Sub-basin was excluded from this first phase of Measurement Study due to its complexity and the limited budget. It is recommended that future efforts evaluate the Redding Sub-basin with respect to the potential for measuring outflows and internal sub-basin water management in concert with the ongoing Redding Area Water Council/Shasta County investigations.

Currently, the majority of the surface water supply available to each of the sub-basins is derived from the Sacramento River. Water diverted by the SRSCs is measured by the SRSCs and Reclamation. In many cases, other inflows have not been quantified, but in general are thought to represent a small fraction of the overall water supply. Outflow data are much less available and generally are considered the largest uncertainty in estimating a sub-basin-level water balance in the Valley.

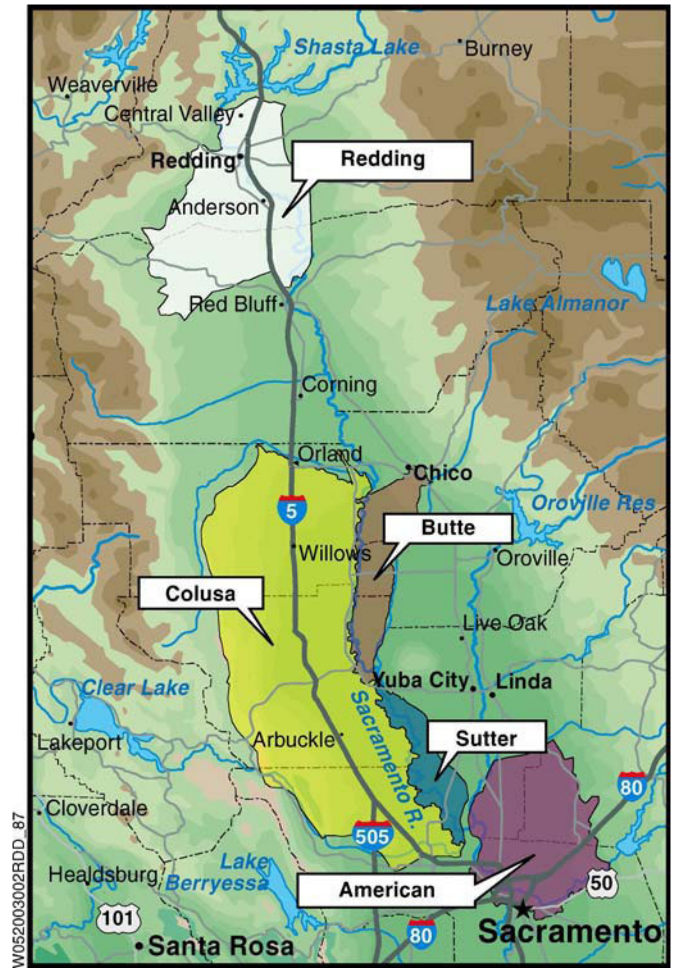


Figure 1-1
Sub-basins

Accordingly, outflow measurement sites were the focus of the investigation with respect to potential locations and facilities. Existing measurement locations and the entity responsible for their operation were documented. This Measurement Study also recommends improvements to increase the accuracy of sub-basin outflow measurement. In addition, issues were identified for implementing a Sub-basin-level Water Measurement Program related to funding, operation and maintenance (O&M), sub-basin coordination, and data sharing.

Data Collection Approach

Sub-basin coordinators (SRSC district/company managers) were identified as part of this Measurement Study to bring in local expertise and to review study findings. The coordinators also facilitated data collection and field visits to each of the sites.

First, sub-basin coordinators provided existing data on existing and potential measurement locations. Examples of data collected include existing facility locations, maps, and historical flow data. Sources of data also included SRSCs, reclamation districts, California Department of Water Resources (DWR), and other sources, as appropriate. Additional information was collected from several sources regarding potential implementation issues relating to the installation and operation of sub-basin-level water measurement facilities.

Next, locations were visited and reviewed, and potential measurement sites and facilities were identified and prioritized. These sites were chosen because they are considered critical points for outflow measurement, and increased accuracy of such measurement would afford water management benefits to SRSCs and water users throughout the Sacramento Valley. The outflow measurement site locations in this preliminary study are listed below (individual sub-basin maps showing the outflow measurement site locations are presented later in this section):

- Colusa Sub-basin
  - Knights Landing Outfall Gates
  - Knights Landing Ridge Cut
- American Sub-basin
  - RD 1000 Outflow
- Butte Sub-basin
  - RD 1004 Outflow
- Sutter Sub-basin
  - RD 1500 Outflow
- Redding Sub-basin
  - Measurement sites were not identified for the Redding Sub-basin in this preliminary study

Reconnaissance-level preliminary costs were developed for the facilities determined to be most appropriate for a given outflow location. Appropriate facilities may consist of new facilities, modification of existing facilities, or both. A potential time frame for implementation at each point was identified, noting any anticipated implementation issues that could arise at each site.

Relationship to CALFED Objectives and Other Regional Efforts

CALFED Bay-Delta Program

The proposed Measurement Program would contribute to the goals of the CALFED Bay-Delta Program. CALFED aims to restore ecological health and improve water management for beneficial uses of the Bay-Delta, which includes the entire Sacramento River watershed. Implementation of a coordinated Sub-basin-level Water Measurement Program would be consistent with the goals of CALFED's WUE Program and the Watershed Management Program.

The goal of the WUE Program is to make the best use of existing water supplies by defining appropriate water measurement techniques, certifying best management practices, and refining quantifiable objectives for agricultural water use efficiency. This program would assist in evaluating water use efficiency at the sub-basin level and would contribute to quantifiable improvements in water management by studying the feasibility of implementing more accurate water measurement at the sub-basin level.

The proposed coordinated Measurement Program, which is a component of the ongoing BWMP activities, would have benefits that support overall Sacramento Valley water management and goals of the CALFED Watershed Management Program. This Measurement Program aims to improve water measurement and make the data available for water operations and long-term planning. Improved sub-basin-level data may support improved use of existing water supplies, operational flexibility, and coordinated management.

Sacramento Valley Water Management Agreement

This Measurement Study is also complementary to the Sacramento Valley Water Management Agreement (SVWMA), which was signed in 2002 to avoid litigation related to Phase 8 Hearings of the State Water Resources Control Board for the Bay-Delta Water Quality Control Plan. The SVWMA is a cooperative basinwide approach to providing supplies to help meet water quality standards in the Delta, while providing supply to water-short regions of the Sacramento Valley, and for transfer to Central Valley Project and State Water Project users.

This Measurement Study also has been proposed as a short-term and long-term component of the SVWMA. Implementation of a coordinated Sub-basin-level Water Measurement Program will not provide direct water supply yield, but may assist in evaluating overall water use efficiency in the Valley and provide re-routed flows to help meet CALFED's quantifiable objectives. A sub-basin approach to water measurement may also facilitate cooperative management of Sacramento Valley water resources.

Other Local and Regional Management Plans

Within the Colusa Sub-basin, water users began coordinated sub-basin management through the transfer of water among users and the continued evaluation of the conjunctive use of surface water and groundwater. These efforts have resulted in improved communication among the water users within the sub-basin. Improved management will assist in sustaining long-term production agriculture and is based on the collective knowledge of historical flows and water needs within the sub-basin, together with a mutual desire to optimize water management. This Measurement Program would assist these water users in optimizing water management and ensuring sustainable agriculture within the sub-basin.

Within the American Sub-basin, management efforts have begun through the Sacramento Area Water Forum, of which Natomas Central Mutual Water Company (NCMWC) is a member. Various potential groundwater and conjunctive use projects are being investigated by the Sacramento Groundwater Authority and the American River Basin Cooperating Agencies. This project complements these efforts.

Sub-basin Descriptions

The scope of the BWMP and this Measurement Study includes 3,500 square miles in the Sacramento Basin from Shasta Dam to the confluence of the Sacramento and American Rivers. The American and Feather Rivers are included to the extent that they contribute as major tributaries to the Sacramento River. The BWMP identified five hydrologic sub-basins that included the service areas of the SRSCs who participated in the BWMP. The boundaries of each of the sub-basins were developed based on existing DWR data and hydrologic boundaries.

The sub-basins, shown on Figure 1-1, are as follows:

- Colusa Sub-basin
- American Sub-basin
- Butte Sub-basin
- Sutter Sub-basin
- Redding Sub-basin (included in the BWMP, but not investigated as part of this Measurement Study)

For the purpose of the BWMP and this Measurement Study, water management and strategy development are recommended to be conducted on a sub-basin level for several reasons.

First, this approach allows relationships between users to be maximized within each sub-basin. Managing on this scale allows greater opportunity for accurately matching supplies and demands and is consistent with actual water management practices in the Sacramento Valley. However, the approach is encompassing enough to allow management variations within sub-basins for the most optimal use of resources and best opportunity to meet regulatory requirements. This management level also encourages stakeholder participation and creativity in developing solutions to supply-and-demand discrepancies. The sub-basins defined in the BWMP and used in the Measurement Study are detailed below.

Colusa Sub-basin

The Colusa Sub-basin represents the west side of the Sacramento Valley and is bounded on the east by the Sacramento River and by the coastal mountain range to the west. Stony Creek is the northern boundary, and Cache Creek is the southern boundary. Figure 1-2 shows the extent of the Colusa Sub-basin.

Surface water accounts for approximately 60 to 65 percent of the water used in Colusa Sub-basin. (Contractually, SRSCs account for 50 to 55 percent of total water supply, and water service contractors contribute 5 to 10 percent.) Additionally, 20 percent of the water need is supplied by groundwater, and 17 percent by drainwater. Drainwater reuse is extensive, and drainwater from upstream districts makes up a significant fraction of the drainwater used to contribute to total supply (Reclamation, 2001).

The Colusa Basin Drain is the main drainage channel for the Colusa Sub-basin. On average, about 250,000 acre-feet (ac-ft) is discharged through the Knights Landing Outfall Gates each year. A wet year could see discharges of up to 700,000 ac-ft. Average daily flows typically range from 600 cubic feet per second (cfs) for flood flow to 15 cfs during dry months. However, during rice drainage operations, 1,000 cfs is typical; and flows over 2,000 cfs have been recorded.

The Knights Landing Ridge Cut channel extends from the Colusa Basin Drain (approximately 0.5 mile upstream from the outfall structure) to the Yolo Bypass. The channel provides flood relief for the drain canal in winter (20,000 cfs design capacity) and also conveys irrigation water in the summer. Several irrigation pumps divert water from the Ridge Cut channel. The channel is wide with little slope, and the

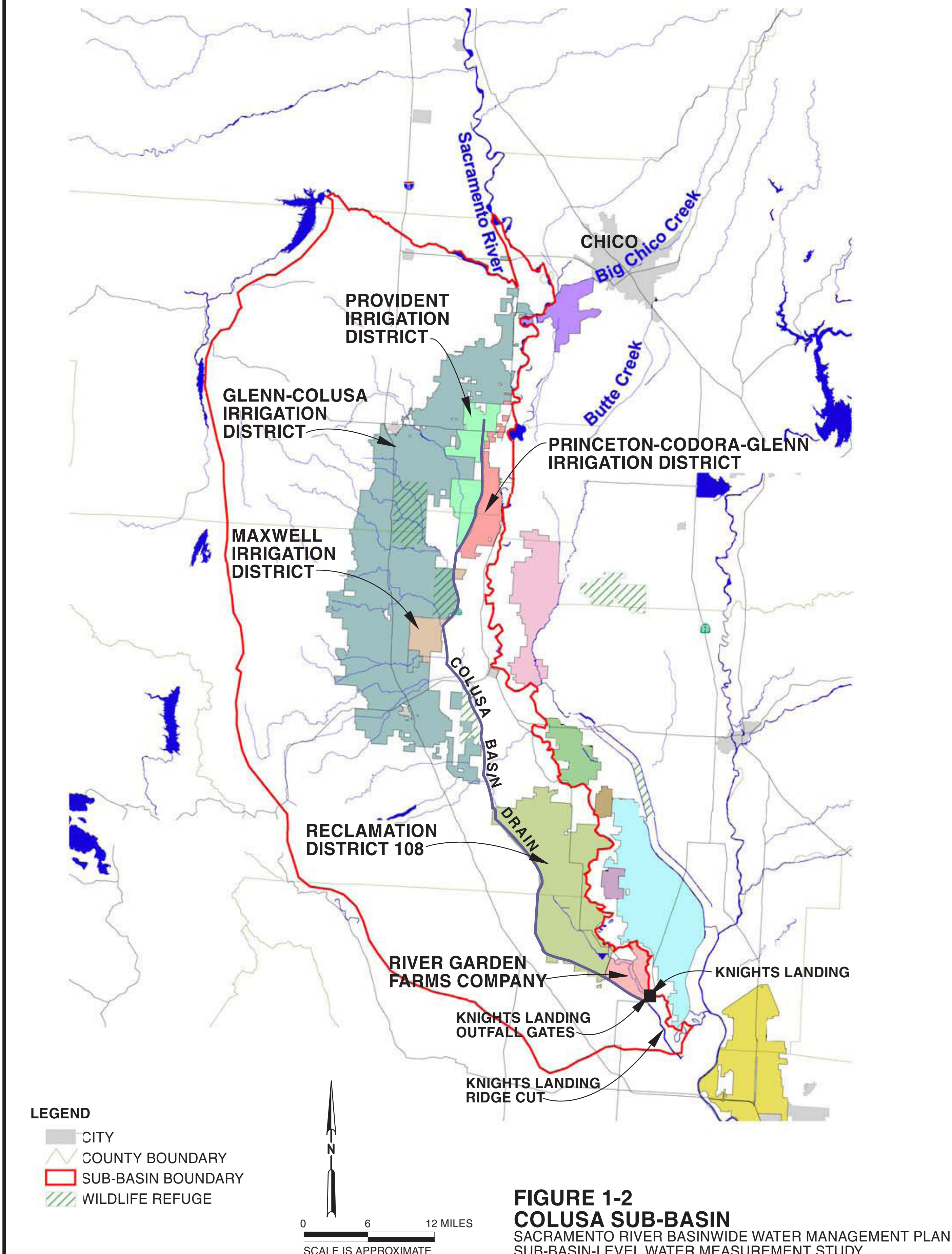


FIGURE 1-2
COLUSA SUB-BASIN
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN
SUB-BASIN-LEVEL WATER MEASUREMENT STUDY

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flow is split into two distinct channels at lower flows. Flow into or out of the Knights Landing Ridge Cut is not currently measured.

The SRSCs within the Colusa Sub-basin are Glenn-Colusa Irrigation District, Provident Irrigation District, Maxwell Irrigation District, Princeton-Codora-Glenn Irrigation District, River Garden Farms Company, and RD 108. The major non-SRSC users are within the Tehama-Colusa Canal Authority region, which also drains into the Colusa Basin Drain and the Colusa Basin Drain Mutual Water Company. Although it has a supplemental water supply contract with Reclamation, the Colusa Basin Drain Mutual Water Company relies entirely on drainage from upstream water users for its surface water supplies.

American Sub-basin

The American Sub-basin, as defined by the BWMP, is bounded on the west by the Sacramento and Feather Rivers, on the north by the Bear River, and on the south and southeast by the American River. The eastern boundary is the Valley floor. A large proportion of the area encompasses urban areas including parts of the City of Sacramento and Sacramento County. Figure 1-3 shows the extent of the American Sub-basin.

Groundwater accounts for a significant proportion of water supplied to the sub-basin at 40 percent with the majority of groundwater use attributable to municipal and industrial (M&I) users in the Sacramento metropolitan area. Surface water supplies make up 54 percent of the total supply. (SCRCs contribute 20 to 25 percent of total water supply, and water service contractors make up less than 10 percent of total water supply.) Although drainwater contributes to only a small fraction of supply, it amounts to nearly 60,000 ac-ft per year, or 6 percent of sub-basin water supply. In most sub-basins, water demand is primarily from agricultural users, but in the American Sub-basin, the demand is split nearly equally between agricultural and M&I water requirements (Reclamation, 2001). Agricultural water demands in the American Sub-basin are met mostly with surface water.

The Measurement Study narrowed down the geographic scope of the American Sub-basin to include only the Natomas Basin. The SRSCs in the Natomas Basin include the NCMWC and several smaller (short-form) contractors. The NCMWC provides water supplies mostly to agricultural users. Drainage out of the Natomas Basin is the responsibility of RD 1000.

Butte Sub-basin

The Butte Sub-basin is on the east side of the Valley and bounded by the Sacramento River on the west, by Big Chico Creek on the north, by Butte Creek and Butte Slough on the east, and by the Sacramento River and Butte Slough on the south. Figure 1-4 shows the extent of the Butte Sub-basin.

Agricultural water requirements make up 98 percent of the sub-basin water demand. Surface water supplies make up 48 percent of the total water supply, drainwater supplies 17 percent, and groundwater supplies 35 percent. No water service contractors are in the sub-basin, and SCRCs contribute to less than 15 percent of the total water supply (Reclamation, 2001). Drainwater return flows and diversions, particularly along the lower Butte Creek and Butte Slough, are significant to the hydrology of Butte Sub-basin and flow management. Improved management may benefit drainwater users by increasing supply reliability.

Due to the limited budget of this Measurement Study, the scope of the Butte Sub-basin investigations was restricted to the southern region, within the service area of RD 1004.

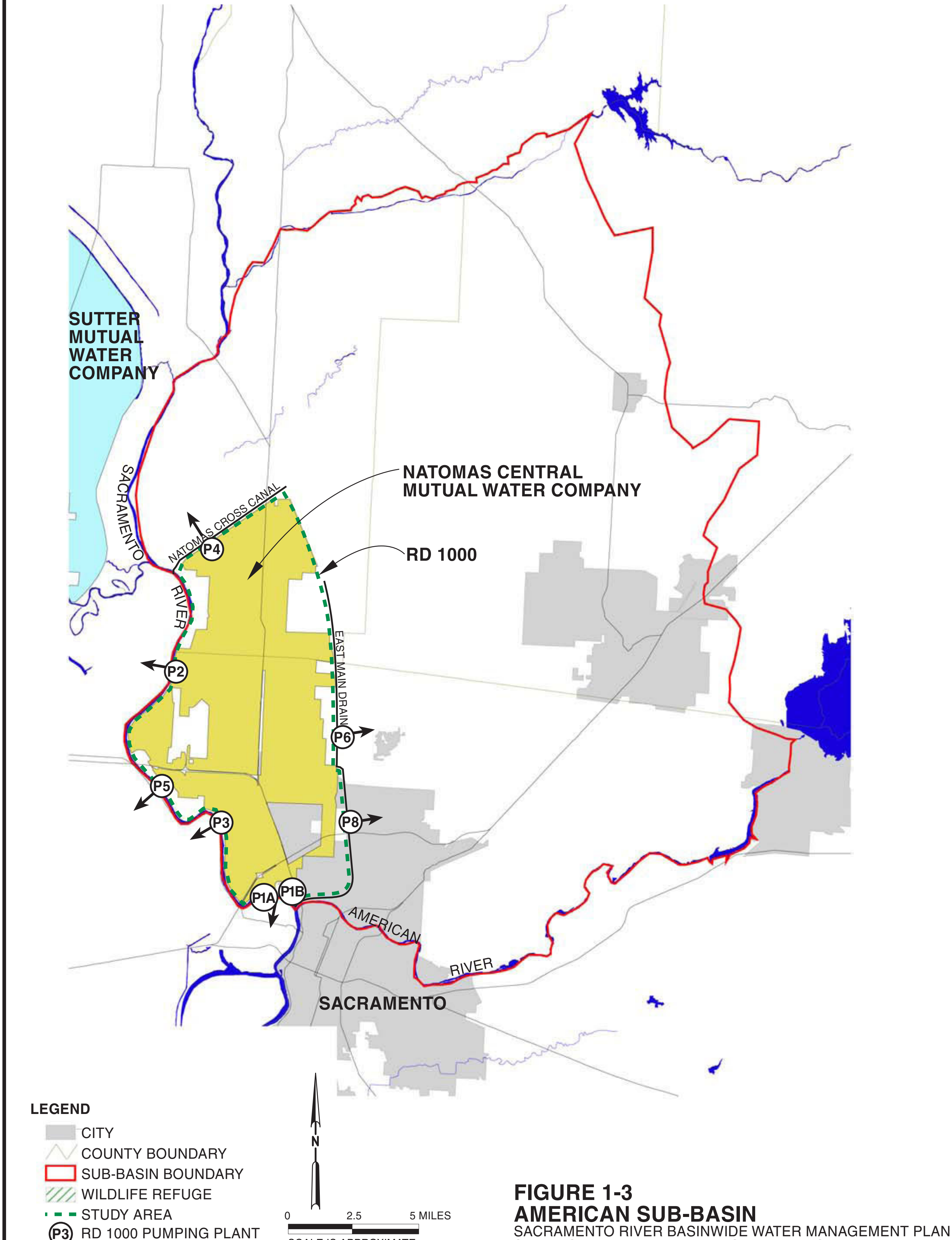

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FIGURE 1-3
AMERICAN SUB-BASIN
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN
SUB-BASIN-LEVEL WATER MEASUREMENT STUDY

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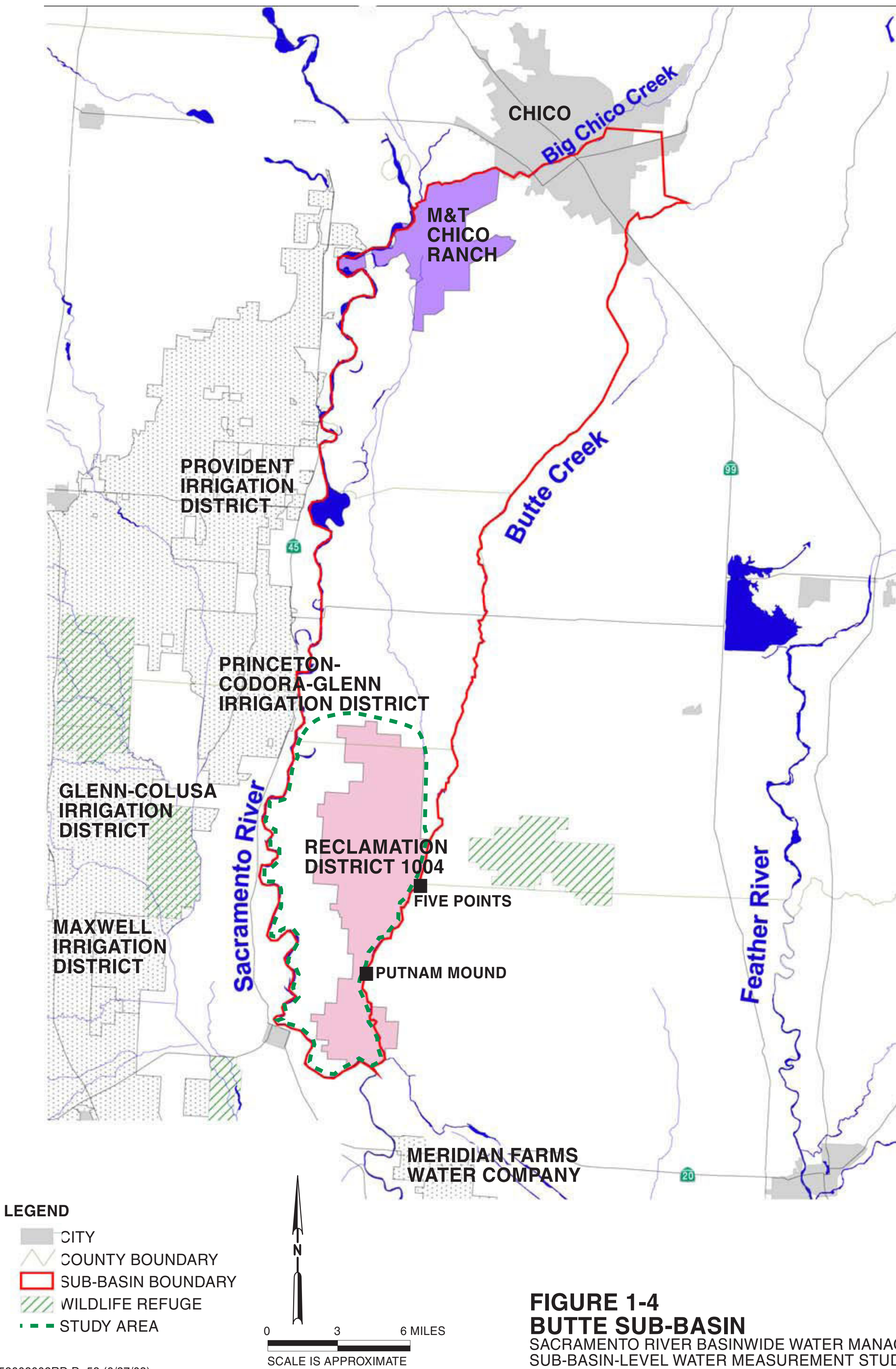

FIGURE 1-4
BUTTE SUB-BASIN
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN
SUB-BASIN-LEVEL WATER MEASUREMENT STUDY

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Sutter Sub-basin

The Sutter Sub-basin, as defined in the BWMP, includes the drainage area on the east side of the Valley floor and is bounded by the Sacramento River on the western and southern boundary. The eastern boundary is the west levee of the Sutter Bypass. The northern boundary is Butte Creek and Butte Slough, as shown on Figure 1-5.

Surface water accounts for 83 percent of the water supply for the southern Sutter Sub-basin, and drainwater accounts for the remaining 17 percent. Agricultural water requirements account for 99 percent of the demand in the sub-basin (Reclamation, 2001).

RD 1500 is responsible for providing drainage facilities and management in the southern portion of the Sutter Sub-basin and operation of the pumping plant at Karnak. The Main Drainage Canal in the Sutter Sub-basin flows generally from north to south. Water within the Sutter Mutual Water Company (SMWC) system is distributed from the Main Canal to a series of secondary canals, laterals, and fields, separated by flashboard checks. Drainage occurs from fields, several of which may drain into one lateral. Laterals flow into the secondary canal and finally into the Main Drainage Canal.

Water recycling is restricted within SMWC due to water quality concerns, but it remains a key component of the water supply. Nearly 15,000 ac-ft of water is recycled in a favorable crop year, depending on the crop pattern. The cost of "new" water generally drives the recycled water market. Recycling is also used to supplement the water supply at times of the year when water demand is unusually high, such as during the rice flood-up season.

Due to the limited budget for this Measurement Study and because the area north of the Tisdale Bypass is small compared to the area south of the bypass, this Measurement Study is restricted to the southern portion of the Sutter Sub-basin, which is the region south of the Tisdale Bypass. Although there are other small SRSCs in the southern Sutter Sub-basin, SMWC is the SRSC responsible for the delivery of water to most agricultural areas in this portion of the sub-basin.

Redding Sub-basin

The Redding Sub-basin covers the northern part of the Sacramento Valley floor. The area spans from Shasta Dam to just above Red Bluff on the western side of the Valley up to the coastal mountain range. See Figure 1-6 for the area encompassed by the Redding Sub-basin.

A substantial fraction of the water requirement in the Redding Sub-basin comes from M&I uses in the Redding metropolitan area. One-third of the water requirement is from M&I, and two-thirds of the water requirement is from agricultural needs. SRSCs account for 55 to 60 percent of the water supply, and water service contractors account for 15 percent. Drainwater supplies less than 2 percent. Finally, groundwater makes up 15 to 20 percent of water supply (Reclamation, 2001).

DWR has reported that the Redding Groundwater Basin is of quality and availability adequate for storage. Drainwater, conversely, is rarely available. Anderson-Cottonwood Irrigation District, the only significant irrigation district within the sub-basin, has crop and irrigation types not conducive to drainwater use.

Due to its complexity and the limited budget of this Measurement Study, the Redding Sub-basin has been excluded from this initial phase of investigation with respect to sub-basin water measurement.

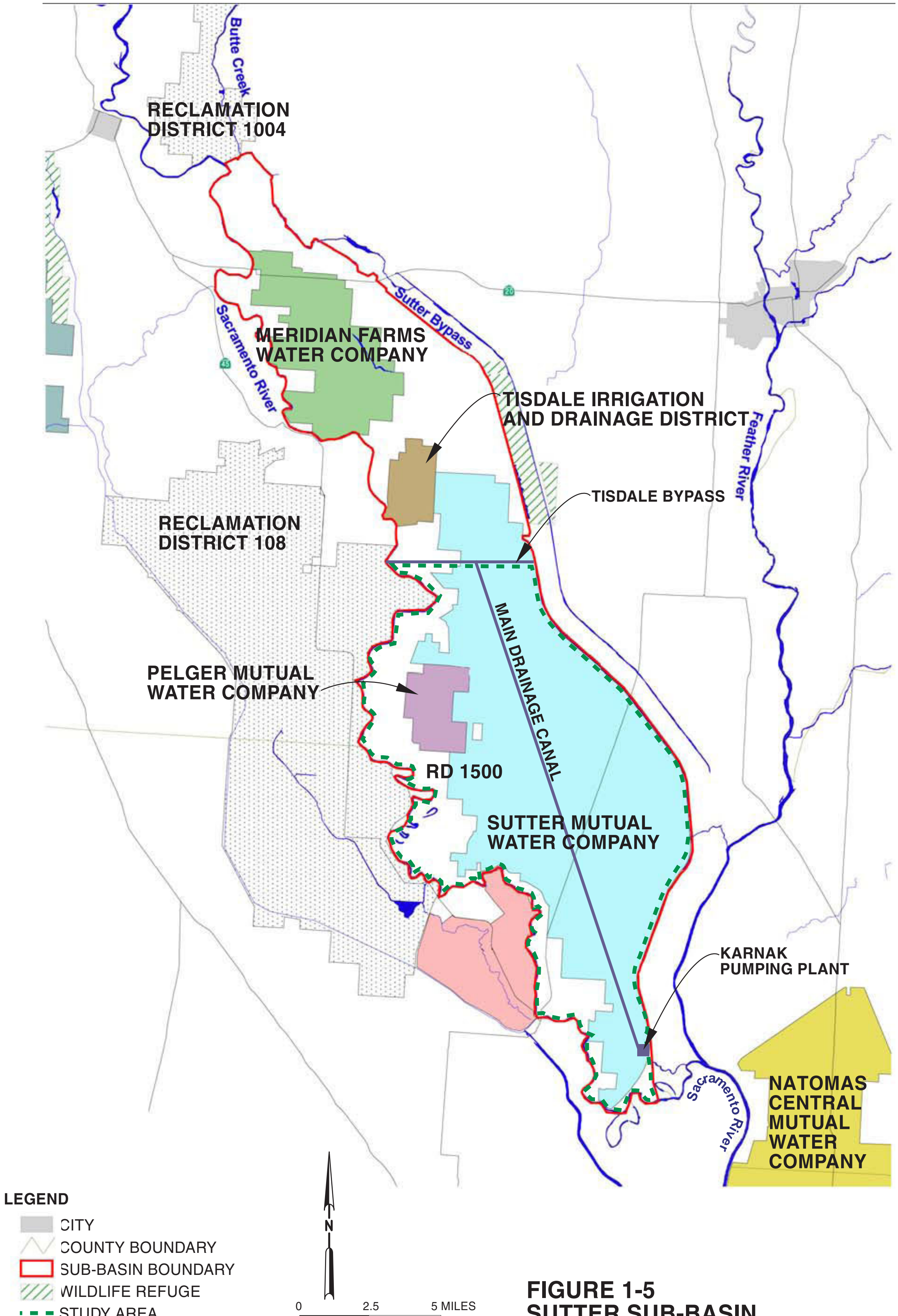

FIGURE 1-5
SUTTER SUB-BASIN
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN
SUB-BASIN-LEVEL WATER MEASUREMENT STUDY

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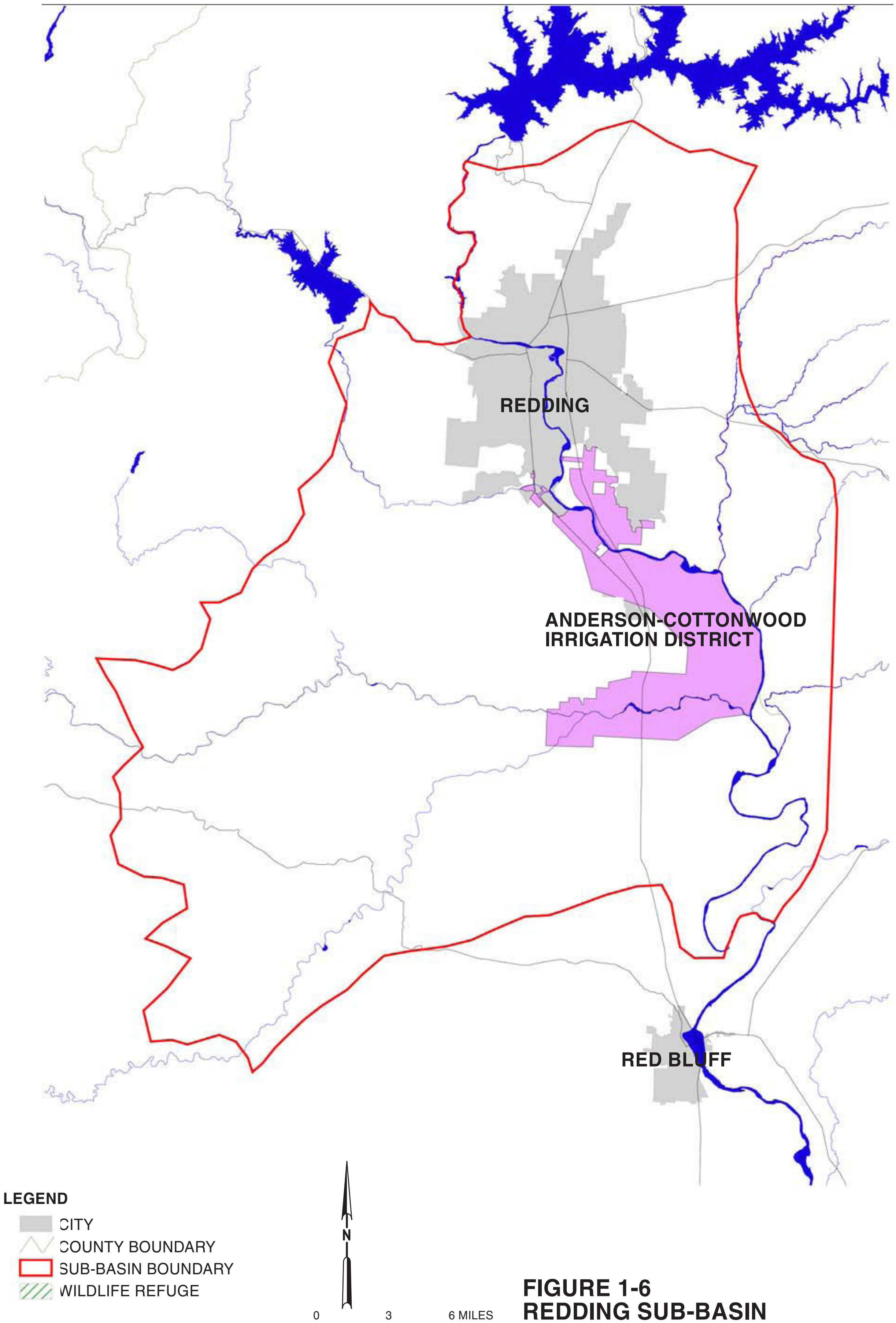

FIGURE 1-6
REDDING SUB-BASIN
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN
SUB-BASIN-LEVEL WATER MEASUREMENT STUDY

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section 2

Existing Outflow Water Measurement Facilities and Operations

For each of the sub-basins investigated in this Measurement Study, management of the measurement facilities, measurement procedures, and data collection efforts were documented. Water quality monitoring, if any, that occurs at the sub-basin outflow sites was also identified.

Colusa Sub-basin

Management

The Colusa Basin Drain and the Knights Landing Outfall Gates structure on the Sacramento River facilitate removal of drainwater from the Colusa Sub-basin. The Colusa Basin Drain begins about 9 miles northeast of the City of Willows and flows southerly to its outfall at the Sacramento River near the Town of Knights Landing. The Knights Landing Outfall Gates are located 0.3 mile northwest of the town at Sacramento River Mile 34.15. The outfall structure consists of eight 66-inch-diameter automated gates and two 42-inch-diameter hand-operated gates. Flap gates installed on the downstream or Sacramento River side of the structure permit flow only in the direction of the drain to the river.

Colusa Basin Drain Outfall Structure

All of the gates were rebuilt in 1985. The two hand-operated gates are only opened during flood conditions. The outfall gates are operated to maintain the water level upstream of the structure to certain target levels, depending on agricultural operations and flood conditions.

Typical Ridge Cut Channel Conditions

The Knights Landing Ridge Cut is an additional point of outflow from the Colusa Sub-basin and provides flood relief during high water events. The Ridge Cut functions as an extension of the Colusa Basin Drain from Knights Landing to the Yolo Bypass allowing drainage water to flow into the bypass when the Sacramento River level is high. Farmers use a small amount of water from the Ridge Cut for irrigation. During the irrigation season, the water level in the Colusa Basin Drain is maintained at the outfall gates to ensure that water can be diverted from the Colusa Basin Drain by upstream users. The flow into and through the Ridge Cut is not measured during the irrigation season or flooding season.

Measurement

Measurements were first recorded at the Knights Landing Outfall Gates in the 1940s. The O&M of the outfall structure is primarily the responsibility of the Sacramento Maintenance Yard of the DWR Central District, and the Northern District's Sutter Yard maintains the water measurement facilities.

Colusa Basin Drain Immediately Upstream of the Outfall

DWR has classified this gauge as an "Atypical Station," which means that the flow is determined by a rating curve based on gauge height and not actual flow measurements. Flow is calculated from theoretical equations that take into account flow regime, gate opening, and an estimate of the headloss through the gates.

The following four flow regimes may exist through the gates:

- Submerged orifice flow
- Freeflow orifice flow
- Submerged weir flow
- Freeflow weir flow

These flow regimes are used to determine the method used to calculate the discharge. Typical flow conditions through the outfall structure are usually characterized as "submerged." Potentiometers (Celesco, 0 to 5 volts) are calibrated to the gate opening. A linear relationship exists between voltage and the gate opening. The potentiometers are tied into the telemetry system at the Sacramento Maintenance Yard.

Both upstream and downstream water levels are needed to compute the discharge through the Outfall Gates. The upstream gauging station is located immediately upstream of the outfall structure, and the downstream station is located at the Sacramento River at Knights Landing Station, approximately 0.25 mile downstream of the Knights Landing bridge. The head difference between these stations is used to estimate the headloss between the drain and the river (DWR, 1998).

Discharge through the outfall gates is calculated using a computer program developed by DWR. The calculation is dependent on the flow regime at the time data were recorded and whether the water elevation in the Colusa Basin Drain is above or below the height of the gate opening. If submerged weir conditions exist, the coefficient of submergence is equal to one. If other conditions are present, the percentage of submergence is calculated based on a ratio between the Sacramento River stage and Colusa Basin Drain stage. Each gate has a discharge coefficient. Orifice flow is calculated for each gate by multiplying the coefficient of submergence, discharge coefficient, and the depth of flow. Stage and gate opening are used to calculate depth of flow when the Colusa Basin Drain is above the height of the gate opening. An adjustment is made to account for closed flap gates, if necessary (DWR, 1998). Historically, the discharge coefficient was calibrated with discharge measurements taken with flow meters, but no calibration has taken place for at least 8 years.

Measurement of discharge at the gates is difficult because highly turbulent conditions usually exist when measurements are most often needed. Turbulence is a problem for obtaining an accurate measurement on the downstream side. Upstream flow is deep and slow-moving, which presents other measurement challenges. Additionally, water can rise faster than the gates can adjust to keep the water level at target depth. Although water levels are measured and recorded each hour and the gates adjusted accordingly, water levels may rise significantly between measurements as a result of changes upstream.

Data Collection

A DOS-based computerized data logger tracks gate position and upstream gauge height measured by a shaft encoder. The data is logged at 15-minute intervals. This upstream data is not telemetered; DWR employees download the data by hand and return to the office to calculate flow through the outfall structure. DWR employees rely on handwritten notes taken by the Sacramento Maintenance Yard to fill in any missing or questionable data points. Data have been certified in this manner through 2001.

Certified data are available upon request from DWR; however, the data are not posted on the California Data Exchange Center website.

Water Quality Measurement

DWR Sutter Yard employees do not take water quality measurements at the outfall structure. DWR collects periodic grab samples for testing water quality in the Colusa Basin Drain at Highway 20. In addition, Glenn-Colusa Irrigation District takes periodic drainwater electrical conductivity readings of its outflow.

American Sub-basin

Management

The focus of the Measurement Study relating to the American Sub-basin is outflow from the Natomas Basin, which is within the American Sub-basin and includes the service area of NCMWC, an SRSC and a BWMP participant, and several smaller short-form contractors along the Sacramento River. RD 1000 is responsible for the drainwater outflow of NCMWC and the Natomas Basin.

RD 1000 Pumping Plant 4

Although several individuals with small pumps divert water from the Sacramento River into the Natomas Basin, NCMWC is responsible for the majority of the Natomas Basin surface water supply. The NCMWC's surface water supplies are supplemented by recycled water operations at Pumping Plants 2 and 4 and numerous internal lift pumps. Plant 4, located in the northern part of NCMWC's service area, pumps water out of the Natomas Cross Canal and into the supply canal. The Natomas Cross Canal generally flows into the Sacramento River during the winter. In some years, during the irrigation season, the flow in the Sacramento River drops to a level that restricts NCMWC's ability to divert water from the Natomas Cross Canal. When these conditions occur, NCMWC constructs a temporary dam in the canal just upstream of the

Sacramento River confluence, and water is pumped from the Sacramento River into the Cross Canal and flows easterly toward the companies Bennett and Northern Pumping Plants.

Due to rising water costs and holding time requirements for pesticides and herbicides, the Natomas Basin has been operated as a "closed system" since about 1986. This designation changed some of the pumping operations and limited the outflow of drainage water. A minimum of 28 days is now required between certain pesticide/herbicide application and discharge of water to the Sacramento River. The typical water holding time for drainage water is 30 to 45 days after the last application in RD 1000. During the irrigation season, water levels in the drainage canals may fluctuate between 12 and 18 inches due to recirculation in the system.

RD 1000 Pumping Plant 3

The NCMWC and RD 1000 have agreements regarding outflow operations. From April 1 to October 1, RD 1000 does not discharge unless NCMWC requests the discharge. RD 1000 operates the pumps, but does not release water unless the county agricultural commissioner agrees with NCMWC pumping requests.

RD 1000 operates eight pumping plants to manage basin outflow. All pumps are considered to be high-head pumps (20+ feet of head), and are not as efficient when pumping larger heads (when river is low). None of the RD 1000 pumps have variable-frequency motors. Some pumps have been reconditioned in recent years, which involved either building up, grinding, and refinishing the impellers to original specifications, or installing new impellers and replacing the bell and dome if necessary. Table 2-1 lists some general notes on the pumps.

RD 1000 Pumping Plant 4 Discharge to the Natomas Cross Canal

Measurement

The NCMWC has recorded measurements of all inflows into NCMWC, totaling about 92,000 ac-ft annually in recent years. These measurements do not include inflows from some private diverters and groundwater pumped for irrigation (approximately 5,000 acres).

None of the RD 1000 pump discharges are directly metered. All measurements of drainwater discharge are estimates based on original pump curves, unless more recent pump curves are available from pump testing. Although the last testing of the drain pumps was conducted in 1991 to 1992, not all pumps were tested at that time. Generally, RD 1000 focuses on removing the water from the Natomas Basin without focusing on the exact quantity of water removed.

TABLE 2-1
RD 1000 Pumping Plants – Summary Details

Plant	Description	Measurement	Other Notes
1A	4 x 600 hp centrifugal pumps. Strictly used for winter flows currently.	Flow estimates based on pump tests from 1992. The pumps were tested after being refurbished in 1990. Outflow discharges into box culverts and cannot be measured at that point. When pumps were tested in 1992, the exposed suction pipes were metered.	Constructed 1911 to 1914.
1B	RD 1000 is demolishing and rebuilding the original Plant 1B in summer of 2003. The existing two pumps will be replaced with six new pumps with 48-inch-diameter discharge pipes. Planned continued use for rice drainage operations in the fall and for winter drainage outflow.	Meters are not included in the new plant construction. The discharge pipes will be exposed in a meter vault, which could facilitate installation of meters.	
2	1 x 200 hp pump: Drain canal water can be pumped into an irrigation lateral (Highland Ditch) or into the river. Recirculation of drainwater into the irrigation lateral occurs all summer. 1 x 300 hp pump: Used almost exclusively for winter outflows.	1 x 200 hp pump: The flow into irrigation lateral is not currently metered. 1 x 300 hp pump: Not currently metered.	Pumps constructed in the 1960s. 300-hp pump used occasionally for rice drainage due to maintenance at other plants.
3	1 x 300 hp; 2 x 200 hp pumps; 1 x 250 hp pump: Used almost exclusively for winter outflow.	An access vault exists for testing discharge. Potentially, the vault could be outfitted with meters.	1 x 300 hp and 2 x 200 hp pumps constructed in late 1960s and reconditioned in 2001. 1 x 250 hp pump constructed in 2001.
4	2 x 400 hp and 1 x 300 hp pumps each with 48-inch-diameter discharge pipes. Operation occurs in winter and summer. Normally drains rice acreage in the northern part of RD 1000. The 2 x 400 hp pumps are typically used for winter drainage. All pumps are equipped with 36-inch-diameter discharge pipes.	There is no access to discharge pipes because a stability berm between the levee and pumping plant buried the area. Metering would require construction of an access vault. “Recycled” water is not metered. Flow estimates are made with RD 1000 pump rating table[a].	Original 300-hp pump constructed in late 1950s. All reconditioned in 2001. If siphoning action is present, the pumps noticeably discharge more flow.
5	3 x 100 hp pumps. Used all winter for normal airport drainage.	There is no access vault to the discharge pipes that could facilitate metering the pump outflow.	Plant was constructed as part of Sacramento Airport in 1970s.
6	1 x 125 hp; 1 x 200 hp; 1 x 250 hp; 1 x 300 hp. Under normal operations, strictly used for flood control.	Exposed section of pipe might not meet minimum required for testing. For metering, construction of a vault would be required.	Pumps constructed in 1970s.
8	4 x 700 hp: Exclusively used for winter drainage. 2 x 300 hp: Used for fall rice drainage. 1 x 200 hp: Used for fall rice drainage. 2 x 500 hp: Added in 2001 as a city project for new development.	No pump testing since construction.	Constructed in early 1980s.

[a] Recycle operations: If water is flowing from the river into the Natomas Cross Canal (and not the reverse), NCMWC gets “credit” from Reclamation for pumping water from the single 300-hp pump into the Natomas Cross Canal. Because water is not flowing to the river, NCMWC remains a closed system.

Note:

hp = horsepower

To estimate the monthly discharge of water from all plants, the operators estimate pumping volumes strictly based on the pump rating table. This table has a discharge rating (ac-ft per hour) that was derived from the most recent pump test or, in some cases, the original pump curve. These ratings are based on typical operating condition hydraulic head differentials. No adjustments are made to the ratings to account for actual pumping head, siphoning action, or impeller age, even if there is a noticeable increase or decrease in flow.

Data Collection

One time per month, RD 1000 operators record the hour meter reading for every pump in the Natomas Basin. From the hour totals, the operator uses ac-ft per hour ratings on the pump rating table to calculate volume pumped (ac-ft per month).

RD 1000 does not have a database for pumping records, and therefore, all pumping volume data are recorded on paper records. RD 1000 staff are responsible for entering monthly pumping volumes in the monthly Superintendent's Report, which has been reported to the RD 1000 Board of Directors since 1911. The outflow data are not made readily available for use outside of RD 1000 without authorization from the District Engineer.

Water Quality Measurement

The only water quality testing performed by RD 1000 occurs during herbicide operations each fall. RD 1000 applies Glyphocate (for water primrose, Johnson grass, and nut grass) and copper (for coontail). A National Pollutant Discharge Elimination System permit requires RD 1000 to test prior to, during, and after every herbicide application.

The City of Sacramento completed a baseline water quality study in the Natomas Basin prior to the 2001 irrigation season. The City of Sacramento regularly tests drainwater throughout the summer.

Butte Sub-basin

Management

RD 1004 encompasses approximately 15,000 acres of irrigated land. Rice is the predominant crop. Both groundwater and surface water are used for irrigation. RD 1004 has one 7-cfs groundwater well that runs most of the irrigation season. Two additional groundwater wells are being considered in the northern part of RD 1004. Numerous private groundwater wells are located throughout the system, but generally they are only used during droughts or when curtailments are imposed on Sacramento Valley water users. RD 1004 also has three pumps on Butte Creek, known as the "Behring Pumps," that provide a critical secondary source of surface water.

RD 1004 generally takes water into the system year-round, except when maintenance is performed on the conveyance system and during weed spraying. This occurs for approximately 2 weeks before and 2 weeks after the rice growing season. In the fall and winter, RD 1004 floods fields for rice decomposition and for wildlife habitat. Although drainwater can exit the sub-basin from RD 1004 via gravity flow into Butte Creek, RD 1004 operates a closed system with an extensive recirculation system.

Several factors have led to the development of a recirculating system, including inadequate drainwater retention capacity and the increasing cost of Central Valley Project water. Water is reused approximately three times, and there is minimal outflow through most of the irrigation season. Recirculated water is blended with surface water sources and a small amount of groundwater sources. Water from the farthest low point in RD 1004 can be recirculated by a series of pumps throughout two-thirds of RD 1004. After harvest, RD 1004 slowly releases drainwater into Butte Creek.

Because RD 1004 operates as a closed system, outflow during the irrigation season is minimal. During this time, the only outflow is from seepage and weir-board leaks. All weirs at outflow points are intentionally blocked during this season.

Drainage can exit RD 1004 by gravity into Butte Creek at the following three locations:

- **Five Points** – Drainwater in most of RD 1004 generally flows into Drumheller Slough, which ends at Putnam Road. The "cut-off channel" conveys drainwater to Five Points. Water can be routed into the borrow pit to be used for recirculation or discharged to Butte Creek. The gate at Five Points is closed throughout the irrigation season. The discharge pipe is 48 inches in diameter. In 2002, no water drained from Five Points until flood runoff resulted from heavy rains. During these situations, water flows over the weir boards.
- **Putnam Mound** – This outflow point is located at the lowest end of the system, south of the California Levee, at the end of the Flyway Ditch, Boat Canal, and East Canal. Most of the RD 1004 outflow is discharged at Putnam Mound through a 48-inch-diameter pipe.
- **Baber Land along Butte Creek** – There are several points along Butte Creek where small amounts of drainage can exit to Butte Creek via check structures, but they are rarely used for that purpose.

Measurement

Inflow to RD 1004 is metered at the main pumping plant near Princeton. Estimates of water diverted from Butte Creek can be made based on power records and pump tests. RD 1004 meters deliveries to all fields within its boundaries. RD 1004 does not measure discharge from the district at Five Points, Putnam Mound, or from the Baber Lands along Butte Creek.

Data Collection

RD 1004 does not collect any outflow data.

Water Quality Measurement

Currently, a regular water quality monitoring program is not in place within RD 1004.

Sutter Sub-basin

Management

The SMWC is responsible for initial conveyance into SMWC and delivery of the water. RD 1500 manages the outflow of water from the southern portion of Sutter Sub-basin. The SMWC delivers irrigation water to approximately 50,000 acres. An additional 20,000 acres are provided drainage service by RD 1500, but are outside SMWC's boundaries. Those within this acreage, "Rim Landers," have their own riparian rights to the water or short-form contracts, but still require drainage of the water by RD 1500.

The most significant outflow facility in SMWC is the main pumping station for RD 1500, located at Karnak at the end of the Main Drainage Canal. The RD 1500 pumping station at Karnak consists of three pumping plants. The plants discharge into the lower end of the Sutter Bypass where the channel becomes Sacramento Slough. Pumping Plant No. 1, constructed in 1914, consists of six 800-hp units, each rated at 78,500 gallons per minute. Each has been recently renovated with new impellers. The renovated pumps have not been re-rated, but, according to RD 1500, are likely close to the original specifications. These pumps are only operated during times of high water (never during irrigation season) because they are inefficient at low flows.

Constructed in 1952, Pumping Plant No. 3 consists of four 700-hp vertical turbine pumps. The outlet to Plant No. 3 consists of three box culverts, each approximately 7 feet wide by 6 feet tall. The pumps may run every day during irrigation season. They may also be used in the winter to manage drainwater if flood flows are present. When in use, the pumps run for 12 hours each night, or they may alternate turning off at off-peak hours to ensure power costs are minimal. Plant No. 3 is much more efficient than Plant No. 1 when water in the river is low.

Pumping Plant No. 2 is currently inoperative. Between the two operational plants, Plant Nos. 1 and 3, capacity is reached at 1,900 cfs. However, these plants do not run concurrently. If possible, pumps are only run at off-peak hours to minimize cost. Outflow at Plant No. 3 can occur by gravity flow when the water level in the Sutter Bypass is lower than that in the Main Drainage Canal. If the water level in Sutter Bypass is higher, excess water must be pumped from the forebay.

Measurement

The critical outflow measurement site for the Sutter Sub-basin is at the Karnak pumping station. DWR classified this measurement site as "Atypical" and has created a computer program to perform the flow calculations for both gravity flow and pumping flow. For gravity flow, velocity coefficients (C-values) have been calibrated using a series of curves generated for velocity coefficient versus head. The velocity coefficients are multiplied by the flow area to calculate discharge.

For pumping flow at both Pumping Plant Nos. 1 and 3, a series of curves for rate of discharge versus head have been generated to best fit the rating curve for the rate of discharge. In both plants, the rate of discharge is multiplied by the number of pumps in operation to calculate the total discharge rate. Outflow from Pumping Plant No. 3 can occur by gravity if the water level in the drain is greater than the water level in the bypass. If the water surface in

Karnak Pumping Plant Forebay

the bypass is high and gates at Pumping Plant No. 3 are open, water may flow from the bypass into the Main Drainage Canal. Backflow from the bypass into the plant forebay is not measured.

Sutter Bypass at Karnak Pumping Plant Discharge and Beginning of the Sacramento Slough

Data Collection

Power use (recorded in hours), Sutter Bypass water-level elevations, and the pumping plant forebay elevations are recorded at the pumping facility. Sutter Bypass water levels are measured at a stilling well located on the levee near the discharge from Pumping Plant No. 1. Changes in water level are recorded from a readout on the side of Plant No. 2 in the forebay. Data are recorded at 15-minute intervals for both the water levels in the forebay and the Sutter Bypass. The data recorder consists of a tape with encoder and data logger, which records water levels and gate elevations. The data are manually downloaded and sent to DWR for calculation of mean daily flows for the facility. Calculated flow data are available from DWR; however, the data are not posted on the California Data Exchange Center website.

Water Quality Measurement

Electrical conductivity, a salinity indicator, is measured weekly by RD 1500 staff, and water samples are sent to University of California at Davis for analysis. Electrical conductivity monitoring is fairly inexpensive, and adding total dissolved solids or temperature testing to the existing electrical conductivity monitoring program has been considered for a future expansion of the water quality monitoring program.

Discharge of Pumping Plant No. 3 into the Sutter Bypass

Section 3 Recommended Facilities and Operational Improvements

Recommendations for potential outflow measurement improvements in each sub-basin are discussed below.

Colusa Sub-basin

As noted in Section 2, the flow conditions downstream of the Knights Landing Outfall Gates are turbulent during a large portion of the year and not ideal for water measurement. Upstream of the structure, the water in the Colusa Basin Drain is extremely slow and deep with silt buildup and surface debris, presenting other challenges to developing a permanent station. The recommendations below are to refine, if possible, the existing measurement methods used by DWR. Also presented is an alternative option that would develop a new measurement station on the Colusa Basin Drain.

Measurement Facility Improvements

The following measurement improvements are suggested for the Knights Landing Outfall Gates station.

Option 1: Calibration Effort

- Verify and/or refine the hydraulic coefficients for theoretical flow calculations for all flow regimes. Develop loss coefficients as a function of gate opening, if warranted.
- Recalibrate the potentiometers that measure outfall gate openings for the 10 gates. Accurate gate opening measurements are critical to the hydraulic calculations used to determine flow.

Option 2: New Measurement Site

An alternative to Option 1 would be to line a section of the Colusa Basin Drain upstream of the outfall and upstream of the overflow into the Ridge Cut channel. In the lined section of the canal, a Doppler flow meter to measure flow would be installed. This alternative measurement option would allow for the measurement of both the Outfall and the Ridge Cut, which could provide a more complete data set of sub-basin outflow.

Environmental Study and Permitting Requirements

Environmental study and permitting requirements have been identified for the implementation of Option 2. Because of the minor extent of modifications to the Colusa Basin Drain, it is anticipated that the project would be exempt from the California Environmental Quality Act (CEQA) as a minor alteration to an existing facility (Class 1, as described in Section 15301 of the CEQA Guidelines). This determination would need to be made by the Lead Agency, which for this project is assumed to be DWR. In general, nothing other than minor administrative action is required for a Categorical Exemption.

The Lead Agency could choose to prepare an Initial Study/Negative Declaration to satisfy CEQA requirements. If an Initial Study is prepared, effort would be required to characterize the affected environment and potential impacts for key resources of concern (e.g., vegetation and associated wildlife, and groundwater). It is assumed that the limited extent of the proposed improvements, and associated limited potential impacts to the environment, would not warrant the inclusion of mitigation measures or result in impacts that are potentially significant (i.e., that warrant preparation of an Environmental Impact Statement).

Table 3-1 provides a list of permits, including a brief description, and agency approvals that likely would be required to implement Option 2.

Operational and Maintenance Improvements

The following O&M improvements are suggested for the Knights Landing Outfall Gates station:

- Provide funding mechanism to keep this measurement site operable.
- Modernize the data collection equipment.

Estimated Costs

Additional funding would be required to improve measurement at the Colusa Basin Drain Outfall. The poor channel conditions for measurement currently present in the Colusa Basin Drain upstream of the Knights Landing Outfall Gates do not facilitate the use of Doppler or other type of velocity-measuring equipment. Due to the expense required to improve these channel conditions, two options are suggested for measurement improvement. First, it is suggested that the rating for the existing facilities be checked and refined to improve the existing level of outflow measurement for the Colusa Sub-basin. An alternative recommended improvement option requiring further investigation would be to develop a new measurement site on a lined section of the Colusa Basin Drain upstream from the Knights Landing Ridge Cut. The estimated costs for these efforts are identified below.

Option 1: Calibration Effort

The calibration effort would involve making a series of flow measurements under various conditions to validate and/or refine the existing equations used by DWR to estimate outflow. Because the flow reaching the Knights Landing Outfall Gates is unregulated, this effort would need to be conducted at various times during an irrigation season to assure testing is conducted under all possible flow conditions. It is recommended that one set of measurements be conducted

TABLE 3-1
Permit Summary for Option 2 – Colusa Sub-basin

Permit/Approval	Responsible Agency	Intent/Description
Streambed Alteration Agreement/ California Endangered Species Act	California Department of Fish and Game	Required for changes to a “streambed” pursuant to Section 1601 of the Fish and Game Code. Triggers Responsible Agency requirements under CEQA.
Encroachment Permit	Reclamation Board	The Reclamation Board, a division of DWR, maintains jurisdiction over nonfederal levees, and requires a permit for work along levees under their jurisdiction.
National Pollution Discharge Elimination System – Stormwater Management during Construction	State Water Resources Control Board/Central Valley Regional Water Quality Control Board	The State Water Resources Control Board’s General Permit requires that projects that disturb greater than 1 acre develop a plan to minimize potential erosion and sedimentation associated with stormwater releases.

at each of the four flow regimes identified in Section 2 under Colusa Sub-basin Measurement. Each set of measurements would consist of two to three discharge measurements made with different gate configurations. The cost for each set of measurements, including the associated office work required to check the existing ratings or develop new ratings, is estimated to be approximately $5,000. The total cost for four sets of measurements would be approximately $20,000. This cost estimate assumes existing equipment is used to log and record gate openings and water levels. The estimate does not include O&M costs. As with the current measurement practice at the Knights Landing Outfall Gates, this alternative would not capture the flow out of the Colusa Sub-basin to the Knights Landing Ridge Cut.

Option 2: New Measurement Site

Table 3-2 shows the estimated cost to shape and concrete line a 100-foot section of the Colusa Basin Drain. A Doppler or other ultrasonic-type flow meter would be installed in the control section to monitor velocity, flow direction, and water depth. Flow rates and volume would be calculated based on the data collected.

Annual Operations and Maintenance

If the only measurement improvement at Knights Landing Outfall Gates is a calibration effort, no new equipment would be installed; thus, no additional annual O&M costs would be incurred. If DWR drops the Knights Landing Outfall Gates station from its measurement program, funding would need to be obtained to collect, tabulate, review, and report outflow data.

If Option 2 is developed, costs for O&M would be incurred in addition to the cost of the measurement equipment and its installation. These estimated costs include the periodic inspection of the equipment to ensure it is operating correctly, periodic calibration of the measurement device(s), replacing or charging batteries, and downloading and processing the recorded data. These additional annual O&M costs for the Colusa Sub-basin are estimated to be approximately $10,000 to $15,000. This estimate is based on the following assumptions:

- Site is inspected once prior to the irrigation season and once per month after the irrigation season begins (six visits).
- Site is inspected, and only minor maintenance is required such as replacing batteries, clearing minor obstructions, and cleaning sensors.
- Calibration is checked once per year.
- Collected data are reviewed and processed, and a table of mean daily and monthly discharge is prepared for each site.

TABLE 3-2
Colusa Basin Drain Equipment Cost Estimate for Alternative Measurement Site

Location	Equipment	Description	Estimated Cost
Colusa Basin Drain	Side-looking Doppler flow meter	Sontek Argonaut or similar	$16,000
		Installation, calibration, and testing	$10,000
	Canal lining	Concrete line up to 100 feet of canal	$190,000
		Engineering	$38,000
		Environmental and permitting (assume Initial Study/Negative Declaration)	$16,000
Total			**$270,000**

American Sub-basin

Measurement Facility Improvements

Measurement investigations of the American Sub-basin were focused on outflow at RD 1000, since that is the outflow directly related to NCMWC, an SRSC and participant of the BWMP. Pumping data from 1990 to 2002 were used to determine the average contribution of each plant to the total volume of water pumped from NCMWC during the irrigation season (April to September) and during rice drainage (September to October). As shown on Figure 3-1, Pumping Plants 1B, 8, and 4 have historically accounted for the highest total volume of water pumped from NCMWC by RD 1000 during each season.

Within Plants 1B, 8, and 4, individual pumps have contributed to plant outflow to various degrees. In Plant 1B, Pumps 1 and 2 have been responsible for 80 to 90 percent of the flow during both the irrigation season and rice drainage period. Although Plant 8 is important during both the irrigation and rice drainage period, only Pumps 3, 4, and 5 (of seven total pumps) are used during September through October. These pumps would be critical to NCMWC's outflow measurement during the rice drainage season. Finally, Pump 3 is most significant to the performance of Plant 4, accounting for over 50 percent of the flow through the plant during both seasons. However, Pumps 1 and 2 in combination are also equally important during these seasons.

Installing ultrasonic flow meters on discharge pipes is recommended to improve flow measurement accuracy and water management. Plants 1B, 8, and 4 typically account for the majority of NCMWC's outflow during the irrigation and rice drainage seasons and are therefore considered a priority for any outflow measurement program.

The following pumps within each plant are recommended for metering priority:

- Plant 1B: All six pumps in the new plant (48-inch-diameter discharge pipe)
- Plant 4: Pumps 1, 2, and 3 (48-inch-diameter discharge pipe)
- Plant 8: Pumps 3, 4, and 5 (36-inch-diameter discharge pipe)

Plant 4 would also require the construction of an access vault to add meters. The other plants have exposed discharge pipes.

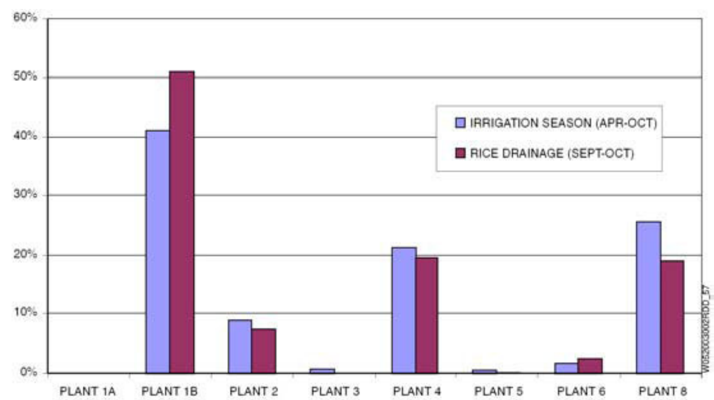


Figure 3-1
RD 1000 Pumping Plants Percentage of Total Outflow by Plant

Operational and Maintenance Improvements

Currently, operations staff at RD 1000 record data reliably on a monthly basis using pump curve estimates. The proposed measurement devices would collect data continuously and more accurately for most of the irrigation season outflow. The proposed data collection would also allow data storage in a database rather than the current practice of paper records.

Estimated Costs

As identified above, Pumping Plant 1B Pumps 1 through 6, Pumping Plant 4 Pumps 1 through 3, and Pumping Plant 8 Pumps 3 through 5 are considered critical for measurement of irrigation-season outflow from the American Sub-basin. The accuracy of the outflow measurements at these facilities would be greatly increased through the installation and use of ultrasonic flow meters. The cost estimates identified in Table 3-3 are based on a recent project conducted by RD 108 at its Rough and Ready Pumping Plant and information obtained from various manufactures of water measurement equipment. Additional costs would be incurred if all pumps at each of the three pumping plants were outfitted with flow meters or if nonirrigation-season outflow measurement is required at the other pumping plants.

The Panametrics ultrasonic flow transmitters identified above provide totalized flow readings. This information can be sent via a 4-20 mA signal to a data logger to monitor the timing and the quantity of flow or directly to a supervisory control and data acquisition system for remote monitoring.

The cost to purchase and install data loggers capable of recording outflow data at the three pumping plants identified above is estimated to be $2,000 per site, or a total of $6,000 for the three pumping plants.

Based on Table 3-3, the total cost to purchase, install, and calibrate equipment capable of accurately measuring the majority of the outflow from the Natomas Basin is estimated to be approximately $70,000. These costs do not include annual O&M costs or data processing costs.

Annual Operations and Maintenance

In addition to the cost of the measurement equipment and its installation, costs for O&M would be incurred. These costs include the periodic inspection of the equipment to ensure it is operating correctly, periodic calibration of the measurement device(s), replacing or charging batteries, and downloading and processing the recorded data.

TABLE 3-3
Equipment Cost Estimates for RD 1000 Pumping Plants

Pumping Plant	Equipment	Description	Estimated Cost
1B	2-Channel Panametrics Model AT 868 ultrasonic flow transmitter	3-AT 868 dual-channel transmitters, with transducers, couplings, and wiring	$22,000
	(2-channel model allows one transmitter to monitor and record flow in two pipes)	Installation and calibration	$6,000
	Data logger	Purchase and install	$2,000
4	2-Channel Panametrics Model AT 868 ultrasonic flow transmitter	2-AT 868 dual-channel transmitters, with transducers, couplings, and wiring	$15,000
	(2-channel model allows one transmitter to monitor and record flow in two pipes)	Installation and calibration	$3,000
	Data logger	Purchase and install	$2,000
8	2-Channel Panametrics Model AT 868 ultrasonic flow transmitter	2-AT 868 dual-channel transmitters, with transducers, couplings, and wiring	$15,000
	(2-channel model allows one transmitter to monitor and record flow in two pipes)	Installation and calibration	$3,000
	Data logger	Purchase and install	$2,000
Total			**$70,000**

Notes:

Cost for a single-channel AT 868 is approximately $5,000. Installation costs are the same as the dual-channel units. The dual-channel AT 868 transmitters at Pumping Plants 4 and 8 would allow for one additional pump to be equipped with an accurate measuring device and could serve as a backup if one of the primary pumps was not able to be used.

The cost of installing an access vault for Plant 4 is not included at this time.

Annual O&M costs for the Natomas Basin are estimated to be approximately $20,000. This estimate is based on the following assumptions:

- Site is inspected once prior to the irrigation season and once per month after the irrigation season begins (six visits).
- Site is inspected, and only minor maintenance is required such as replacing batteries, clearing minor obstructions, and cleaning sensors.
- Calibration is checked once per year.
- Collected data are reviewed and processed, and a table of mean daily and monthly discharge is prepared for each site.

Butte Sub-basin

Measurement Facility Improvements

As noted in Section 2, RD 1004 currently operates a closed system and makes extensive use of tailwater occurring within is boundaries. As a result, in most years, there is very little outflow from RD 1004 during the irrigation season. In addition, where possible, preharvest drainwater from rice fields is recirculated and reused for rice straw decomposition and wetlands habitat. As also noted in Section 2, although RD 1004 measures its diversions from the Sacramento River and all deliveries within RD 1004 are metered, RD 1004 currently does not measure its outflow. Therefore, to better understand the actual quantity and timing of outflow from RD 1004, the following facility improvements are suggested for Butte Sub-basin:

- Retrofit Five Points and Putnam Mound with measurement devices in discharge pipes. Outflow points along Butte Creek are rarely used and, thus, not recommended at this time for measurement improvement.
- Install data collection devices.

Operational and Maintenance Improvements

Under current operations, there is very little outflow from RD 1004. However, because RD 1004 does not monitor the outflow that is discharged, it is recommended that the equipment be installed at the two existing points where the majority of the outflow does occur, Five Points and Putnam Mound.

Estimated Costs

Table 3-4 shows the estimated cost for the purchase and installation of equipment capable of measuring outflow at RD 1004's two main discharge locations, Five Points and Putnam Mound. Because the pipes may

TABLE 3-4
RD 1004 Equipment Cost Estimates

Pumping Plant	Equipment	Description	Estimated Cost
Five Points	Ultrasonic flow meter with water-level sensor installed in 48-inch-diameter pipe	Unidata Starflow or similar	$6,000
Putnam Mound	Ultrasonic flow meter with water level sensor installed in 48-inch-diameter pipe	Unidata Starflow or similar	$6,000
Total			**$12,000**

Note:

Estimated cost includes approximately $3,500 for equipment and approximately $2,500 for installation.

not always run full and because debris can be an issue in the drains, it is proposed that ultrasonic flow meters with water-level sensors be installed in the 48-inch-diameter discharge pipes at both locations. Collecting water-level data in the pipes together with velocity data would allow the flow volumes to be calculated. These installations may require that the existing discharge pipes be extended with sections of smooth-wall pipe to accurately measure velocities

Annual Operations and Maintenance

In addition to the cost of the measurement equipment and its installation, costs for O&M would be incurred. These costs include the periodic inspection of the equipment to ensure it is operating correctly, replacing or charging batteries, and downloading and processing the recorded data. Annual O&M costs for the Butte Sub-basin are estimated to be approximately $7,500 to $10,000. This estimate is based on the following assumptions:

- Each site is inspected once prior to the irrigation season and once per month after the irrigation season begins (six visits).
- Both sites are visited on the same day.
- The site is inspected, and only minor maintenance is required such as replacing batteries, clearing minor obstructions, and cleaning sensors.
- Collected data are reviewed and processed, and a table of mean daily and monthly discharge is prepared for each site.

Sutter Sub-basin

Measurement Facility Improvements

Measurement of outflow from the Sutter Sub-basin is based on ratings developed by DWR. The rating for Pumping Plant No. 1 is based on the number of hours the pumps are in operation. Each pump is assumed to pump at the same rate, and there is no adjustment for pumping head. As stated previously, Pumping Plant No. 1 is not used for irrigation-season outflow.

Irrigation-season outflow occurs by both gravity and pumping at Pumping Plant No. 3. Outflow is calculated based on head differential between the RD 1500 Drain and Sacramento Slough, gate openings, and, for pumped flow, the hours and number of pumps in operation.

Pumping Plant No. 2 is not currently used for either irrigation-season or winter outflow.

DWR field staff have indicated that the data currently being collected at the Karnak Pumping Plant, regarding water levels and time of operation, may be within 10 percent of actual. The accuracy of the ratings being used to calculate the flow through the pumping plant is uncertain. To improve the accuracy of the measurement of the outflow from SMWC, two possible options have been identified.

Option 1: Flow-meter Installation

Option 1 would install ultrasonic flow meters in each of the four concrete box culverts leading from the pumps to the Sacramento Slough. This option would allow for continuous measurement of the irrigation-season outflow but would not capture outflow pumped through Pumping Plant No. 1. To capture the nonirrigation-season outflow, smaller flow meters also would need to be installed on the Pumping Plant No. 1 discharge pipes.

Option 2: New Measurement Site

Option 2 would line a section of the Main Drainage Canal upstream from the pumping plant forebay and install a Doppler-type flow meter to measure flow in the canal. Option 2 would allow for the measurement of both irrigation-season and nonirrigation-season outflow without the need to install equipment on the Pumping Plant No. 1 discharge pipes.

Environmental Study and Permitting Requirements

Environmental study and permitting requirements have been identified for the implementation of Option 2. Because of the minor extent of modifications to the RD 1500 Main Drainage Canal, it is anticipated that the project would be exempt from CEQA as a minor alteration to an existing facility (Class 1, as described in Section 15301 of the CEQA Guidelines). This determination would need to be made by the Lead Agency, which for this project is assumed to be RD 1500. In general, nothing other than minor administrative action is required for a Categorical Exemption.

The Lead Agency could choose to prepare an Initial Study/Negative Declaration to satisfy CEQA requirements. If an Initial Study is prepared, effort would be required to characterize the affected environment and potential impacts for key resources of concern (e.g., vegetation and associated wildlife, and groundwater). It is assumed that the limited extent of the proposed improvements, and associated limited potential impacts to the environment, would not warrant the inclusion of mitigation measures or result in impacts that are potentially significant (i.e., that warrant preparation of an Environmental Impact Statement).

Table 3-5 provides a list of permits, including a brief description, and agency approvals that likely would be required to implement Option 2.

Operational and Maintenance Improvements

Cooperative efforts between RD 1500 and DWR have been successful in maintaining the current methods of measurement at the Karnak Pumping Plant. This Measurement Study is recommending improvements to the measurement methods by adding meters that would allow for continuous recording of flow data. It is assumed that the current level

TABLE 3-5
Permit Summary for Option 2 – Sutter Sub-basin

Permit/Approval	Responsible Agency	Intent/Description
Streambed Alteration Agreement/ California Endangered Species Act	California Department of Fish and Game	Required for changes to a “streambed” pursuant to Section 1601 of the Fish and Game Code. Triggers Responsible Agency requirements under CEQA.
Encroachment Permit	Reclamation Board	The Reclamation Board, a division of DWR, maintains jurisdiction over nonfederal levees, and requires a permit for work along levees under their jurisdiction.
National Pollution Discharge Elimination System – Stormwater Management during Construction	State Water Resources Control Board/Central Valley Regional Water Quality Control Board	The State Water Resources Control Board’s General Permit requires that projects that disturb greater than 1 acre develop a plan to minimize potential erosion and sedimentation associated with stormwater releases.

of cooperation between these entities would continue.

Estimated Costs

The amount of funding required to improve outflow measurement from the Sutter Sub-basin is dependent upon the option chosen and the level of environmental review required. Because the focus of the Measurement Study is on irrigation-season outflow and because of the uncertainly at this time regarding the permitting and environmental review requirements, Option 1 is recommended as the preferred course of action. The Option 1 improvements recommended are limited to installing continuously recording flow meters at Pumping Plant No. 3.

For comparison purposes, costs for improvements to Pumping Plant No. 1 under Option 1 and the estimated cost to implement Option 2 are also provided below.

Option 1: Flow-meter Installation

Table 3-6 shows the estimated cost for the purchase and installation of equipment for Option 1. To compare the costs to collect the same level of information under the two options, Table 3-6 includes costs associated with installing measuring equipment on both Pumping Plant Nos. 1 and 3.

Option 2: New Measurement Site

Table 3-7 shows the estimated cost to shape and concrete line a 100-foot section of the RD 1500 Main Drainage Canal. A Doppler or other ultrasonic-type flow meter would be installed in the control section to monitor velocity, flow direction, and water depth. Flow rates and volume would be calculated based on the data collected.

TABLE 3-6
SMWC Equipment Cost Estimates – *Option 1*

Pumping Plant	Equipment	Description	Estimated Cost
Pumping Plant No. 3	Sontek Argonaut – SW or similar	Upward-looking Doppler-type flow meter (includes one unit for each of the four box culverts at approximately $10,000 each)	$40,000
		Installation and calibration for all four units	$13,000
Total for Pumping Plant No. 3			**$53,000**
Pumping Plant No. 1	2-Channel Panametrics Model AT 868 ultrasonic flow transmitter (2-channel model allows one transmitter to monitor and record flow in two pipes)	3-AT 868 dual-channel transmitters, with transducers, couplings, and wiring	$22,000
		Installation and calibration	6,000
	Data logger[a]	4-20mA data logger to record flow data at 15-minute intervals	1,600
Total for Pumping Plant No. 1			**$29,600**

[a]The Panametrics ultrasonic flow transmitters identified above provide totalized flow readings. This information can be sent via a 4-20 mA signal to a data logger to monitor the timing and the quantity of flow or directly to a supervisory control and data acquisition system for remote monitoring. The cost to purchase and install data loggers capable of recording outflow data is estimated to be $1,600 per site.

TABLE 3-7
SMWC Equipment Cost Estimates – *Option 2*

Location	Equipment	Description	Estimated Cost
RD 1500 Drain Canal	Side-looking Doppler flow meter	Sontek Argonaut or similar	$16,000
		Installation, calibration, and testing	$10,000
	Canal lining if necessary	Concrete line up to 100 feet of canal (concrete lining may not be required)	$175,000
		Engineering	$35,000
		Environmental and permitting (assume Initial Study/Negative Declaration)	$16,000
Total for Option 2			**$252,000**

Annual Operations and Maintenance

In addition to the cost of the measurement equipment and its installation, costs for O&M would be incurred. These costs include the periodic inspection of the equipment to ensure it is operating correctly, periodic calibration of the measurement device(s), replacing or charging batteries, and downloading and processing the recorded data.

Annual O&M costs for the Sutter Sub-basin are estimated to be approximately $10,000 to $15,000, depending upon the option selected and the number of measuring devices installed. This estimate is based on the following assumptions:

- Site is inspected once prior to the irrigation season and once per month after the irrigation season begins (six visits).
- Site is inspected, and only minor maintenance is required such as replacing batteries, clearing minor obstructions, and cleaning sensors.
- Calibration is checked once per year.
- Collected data are reviewed and processed, and a table of mean daily and monthly discharge is prepared for each site.

section 4

Implementation Benefits and Challenges

The BWMP identified implementation of a Sub-basin-level Water Measurement Program as a necessary step to support the concept of water management at a sub-basin level. Although many have suggested a sub-basin or regional level of management would be beneficial in meeting agricultural, M&I, and environmental water needs, it must be recognized that such an approach would require a substantial degree of coordination with respect to system operations, improvements, data use and management, and funding acquisition. This section identifies the benefits that may be realized with successful implementation, as well as the anticipated challenges associated with such a program.

Sub-basin-level Measurement and Management

Implementation of the proposed Measurement Program would be one of many tools to support the vision for expanded regional cooperation within the Sacramento Valley recommended in the BWMP. As discussed in the BWMP, the relatively high degree of both inter- and intra-district reuse and use of drainwater within the Sacramento Valley suggests the proposed Measurement Program could be particularly beneficial in understanding potential impacts that sub-basin management may have on river flows and timing. Successful implementation would require the establishment of new roles and responsibilities in the areas of program coordination, capital financing, installation, O&M, and data management and reporting.

Benefits of Sub-basin-level Measurement

Water measurement at the sub-basin level would have multiple benefits, including benefits that extend beyond the mere collection and organization of data. Implementation of the proposed Measurement Program may lead to increased coordination among BWMP participants as well as other water management entities within a given sub-basin. Improved measurement would lead to a better understanding of the local water balance, and may provide data that could be used for the real-time management of local, state, and federal water resources. Facilitating information exchange between sub-basins and irrigation districts would be beneficial in that it would enable the exchange of new measurement techniques and provide potential opportunities for measurement improvements through collaboration.

Water measurement at a sub-basin level is recommended in the BWMP as a tool that can assist in improving water supply reliability and water quality, and in providing the information necessary to achieve maximum environmental benefits and is consistent with CALFED Quantifiable Objectives. Coordinated and improved measurement at the sub-basin level would provide for better understanding of the water balance and may lead to improved water use efficiencies through both short- and long-term management at the sub-basin level. The sites investigated in this Measurement Study were chosen because they are considered initial critical points for sub-basin outflow measurement. Additional sites (as noted in Section 5) are suggested for investigation as an extension of this proposed Measurement Program if funding can be obtained to further evaluate and implement the sub-basin-level approach discussed in this technical memorandum.

The following are among the key benefits of the proposed Measurement Program:

- **Improved Understanding of Sub-basin Outflow/Inflow** – Data collected through the Measurement Program would provide information regarding flow rate, quantity, and timing needed to make basic management decisions and to track implementation of management actions. The data would also help refine estimates of sub-basin-level water use efficiency.
- **Coordinated Management of Sub-basin Outflow/Inflow** – Improved measurement may provide information leading to improved control and coordination of inflows/outflows from sub-basins to ensure adequate supply to in-sub-basin users (as well as down-sub-basin users) and help meet management targets related to timing of return flows into the Sacramento River.
- **Coordinated Management of Drainwater Flow Rates** – Improved measurement may provide information leading to improved control and coordination of inter- and intra-district flows in major regional drains to ensure adequate supply to in-sub-basin users (as well as down-sub-basin users) and help meet management targets related to timing of return flows into the Sacramento River.
- **Maximized Benefits from Other Regional Actions** – Effectively integrating regional drainwater management with other regional actions such as conjunctive use programs and water transfers may maximize regional efficiency in drought periods.
- **In the Future, Facilitation of a Sub-basin-level Water Quality Monitoring Program** – Depending on the implementation of the proposed Measurement Program and emerging water quality regulations, the Measurement Program could potentially facilitate monitoring for water quality purposes.

Improving local water management has a recognized statewide benefit, including benefits consistent with the goals of CALFED's Water Use Efficiency and Watershed Management Programs, which are listed in Tables 4-1 and 4-2.

TABLE 4-1
Relationship with CALFED Water Use Efficiency Program Goals

CALFED Water Use Efficiency Program Goals[a]	Sub-basin-level Water Measurement Program Benefit
Reduce water demand through "real water" conservation	The success of real water conservation is partially determined by an evaluation of actual water diversions and return flows. Improved measurement at the sub-basin level may facilitate evaluation of conservation projects.
Improve water quality by altering volume, concentration, timing, and location of return flows	Improved measurement and the resulting improved understanding of the water balance would provide necessary information on the volume and timing of return flows on the sub-basin level.
Improve ecosystem health by increasing in-stream flows where necessary to achieve targeted benefits	Sub-basin outflow data could assist with water operations decisionmaking that potentially could improve in-stream flows on the Sacramento River.

[a]Source: http://calwater.ca.gov/Programs/WaterUseEfficiency/WaterUseEfficiency.shtml

TABLE 4-2
Relationship with CALFED Watershed Management Program Goals

CALFED Watershed Management Program Goals[a]	Sub-basin-level Water Measurement Program Benefit
Maximize use of available water supplies through conservation, water recycling, and water quality improvements	An improved understanding of the water balance from improved measurement at the sub-basin level may help water districts prioritize conservation and reclamation actions. Improved measurement facilities may facilitate the addition of water quality monitoring equipment.
Increase the flexibility of water systems at the state, federal, and local level through improvements in conveyance, storage, and water project operations	Use of improved data could increase the flexibility of water systems at the sub-basin-level, which could have statewide benefits.
Develop groundwater and surface water storage projects to boost flexibility and provide additional supplies for agriculture, urban, and environmental use	The development of new groundwater and surface water storage projects includes an evaluation of project diversion and release capability. Additional data describing water availability and drainage system capacity would provide increased information for the analysis of new projects.

[a]Source: http://calwater.ca.gov/Programs/WaterManagement/WaterManagement.shtml

Alternative Institutional Frameworks

Successful implementation of the proposed Measurement Program would require some agreed-upon management structure to support coordination in the Sacramento Valley and to define the maintenance and cost-sharing responsibilities among cooperating agencies and SRSCs. It is anticipated that the cooperating entities at a minimum would include the BWMP participants (SRSCs, Reclamation, and DWR). Additional entities would include other agricultural (including reclamation districts), M&I, and environmental users (primarily refuges) within a given sub-basin. It is recommended that initial efforts focus on irrigation districts and companies because of their proportional water needs and to develop momentum and gain acceptance of the concept.

Development of the structure for coordination is being undertaken in the larger context of ongoing BWMP efforts. In support of the BWMP effort, alternative regional partnerships and institutional frameworks are being considered that could support successful implementation of multi-agency or sub-basinwide management options. The SRSCs and Reclamation are currently continuing to explore the development and implementation of regional water management criteria through the BWMP to further support the sub-basin management level. The recently signed SVWMA is an example of another forum that is based on cooperation across districts throughout the Sacramento Valley.

Oversight and cooperative arrangements could take on several forms with varied levels of management authority. For example, institutional frameworks could fall into one of the following categories:

- **Memorandum of Understanding or Agreement:** Existing water districts, water companies, cities, and counties, or some combination of these entities joined through a Memorandum of Understanding or Agreement. Ideally, existing powers granted to current entities under the California Water Code could provide adequate management authority to enable a partnership arrangement to function effectively.
- **Virtual District:** Formation of a new, overarching umbrella-type water district (or "virtual district") that interfaces with existing entities and provides the authority to maintain facilities and coordinate activity involving multiple agencies.
- **Joint Powers Authority:** Formation of a Joint Powers Authority between entities.

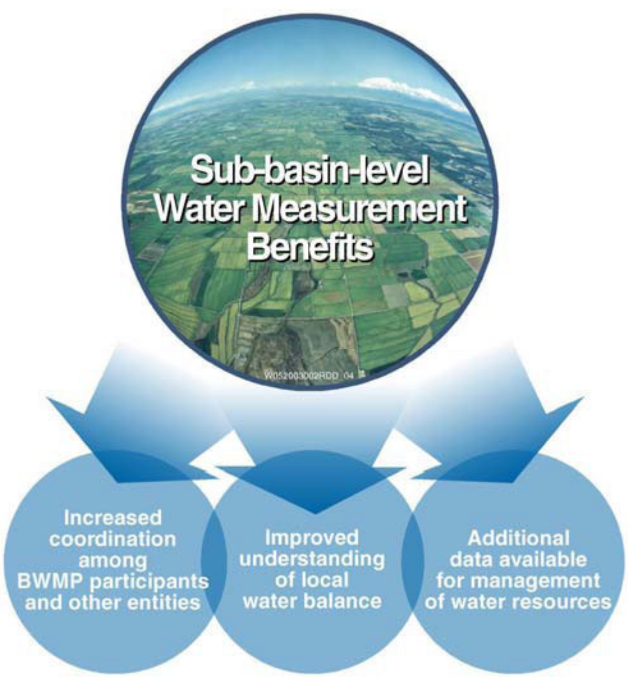
Upfront identification of the proposed Measurement Program coordination responsibilities would be necessary to ensure effective implementation and would provide the momentum to move forward and sustain program operation. Under any of the alternative institutional frameworks, agreements regarding the following issues would be required:

- Membership
- Structure (staff level versus Board level)
- Program scope and goals
- Program administration responsibilities
- Cost-sharing commitments
- Ownership of measurement facilities
- O&M responsibilities
- Data management and reporting
- Interface with other governing bodies such as counties and special districts

Gaining Acceptance

As described above, the potential benefits of regional management at the sub-basin level are large; however, the implementation of such a program (Measurement Program) would require a significant level of coordination and "re-thinking" of how water is managed. Accordingly, it is suggested that implementation of such a program be taken in manageable steps to ensure buy-in and an understanding of the potential mutual benefits. The focus on a few key outflow points in this technical memorandum (as well as the identification of necessary future actions, including the all-important coordination issue) represents just such an initial, incremental step toward implementing a larger scale program.

At this time and as discussed above, new partnerships are forming in the Sacramento Valley as a result of the BWMP, the SVWMA, and in response to new water quality implementation requirements associated with the agricultural discharge waiver. Each of these ongoing efforts requires an increased level of coordination across district and water user boundaries and suggests a sub-basin-level management approach has merit and could garner support.



Other successful regional programs such as the Redding Area Water Council, coordination among water users in the Colusa Basin, the Sacramento Area Water Forum (in the American Sub-basin), and the American River Basin Cooperating Agencies provide templates and/or existing forums to advance the sub-basin-level concept.

Facility Installation, Operation, and Maintenance

Facility Installation

At this time, the primary implementation issues related to facility installation are funding and agreement among all participating entities as to which facilities should be installed first. This technical memorandum recommends that the initial focus of the proposed Measurement Program be on sub-basin outflow measurement. The actual installation is a relatively simple matter that, if funded, could be implemented by DWR or local participant agencies. For larger-scale construction projects, as identified in Section 3, the use of an independent contractor may be required. Installation and construction would be coordinated with other operational downtime such as pumping plant or outfall gate maintenance to avoid substantial delays.

Operation and Maintenance

O&M responsibilities would need to be specified in a formal agreement. Under a Memorandum of Understanding, an individual water purveyor or drainage district could commit to the O&M of facilities installed on their water conveyance and drainage infrastructure. Alternatively, a Joint Powers Authority or Virtual District could employ staff to carry out the necessary O&M functions. It is recommended that initial efforts, described in Section 5, be focused on facilities that can be operated by either a participating SRSC, a reclamation district, or DWR because a formal institutional arrangement would not likely be in place immediately.

Cost sharing should take into consideration the value of the data to the individual participants, and an effort should be made to engage other beneficiaries who are not currently party to BWMP efforts. These entities could include CALFED, DWR, the State Water Project contractors, Reclamation, the Central Valley Regional Water Quality Control Board, U.S. Fish and Wildlife Service, and California Department of Fish and Game, all of whom would benefit from the availability of improved flow measurement.

Data Management

The initial Measurement Program, as described in Section 5, would include installation and data collection over a 2-year period. Data management would be performed by cooperating entities such as DWR and SRSCs. Initial data sharing would be among cooperating SRSCs and agencies. Data reports could be made available to other interested entities. Initial data management efforts would involve downloading of data at the sites and making the raw data available to cooperators. After the initial data collection period, the cooperating entities would need to weigh the benefits and costs associated with a centralized database and data management.

In the future, cooperating entities of the fully implemented Measurement Program could consider making the data available on a more widespread basis. Data collected under the Measurement Program could be incorporated into the DWR California Data Exchange Center. The California Data Exchange Center provides a centralized location to store and process real-time and historical hydrologic information gathered by various cooperators throughout the state. The California Data Exchange Center then makes the information accessible to the cooperators, public and private agencies, and any potential stakeholder through the Internet.

Use of Data

This Measurement Study focuses on key sub-basin outflow points, but ultimately, a comprehensive Sub-basin-level Water Measurement Program would include all significant sources of inflow and outflow, which would be of use for all cooperating SRSCs and agencies, as well as numerous other interested entities. Use of real-time and historical data could be used for short-term water operations decisions and longer-term planning purposes to achieve the Measurement Program benefits described previously.

Section 5 outlines a plan to carry out an initial 2-year Measurement Program. After initial outflow measurement locations are improved and data are collected and analyzed, the potential uses of data can be better defined, as well as the extent of data sharing.

Section 5 Recommended Next Steps

Immediate action is required to implement the recommendations contained in this technical memorandum as an initial step toward a Sub-basin-level Water Measurement Program. This initial step includes obtaining funding to improve water measurement at key sub-basin outflow locations over a 2-year period to collect data and evaluate the improved water measurement.

During this initial phase, improvements to measurement at existing facilities would be made, data would be collected and analyzed, and refinements to the Measurement Program would be identified. After this initial 2-year period, additional funding would be required for annual O&M at each measurement site. After 2 years, the need for construction at the Colusa Basin Drain for a new measurement site should be evaluated.

It is recommended that SRSCs continue to work toward the development of an inter-district cooperating structure to facilitate the Measurement Program and other operational and planning activities.

Measurement Facility Improvements

The recommendations to improve measurement at key outflow points in the Sacramento Valley were presented in Section 3. These recommendations represent an incremental step toward a comprehensive Sub-basin-level Water Measurement Program that would encompass the major points of inflow and outflow for Sacramento Valley sub-basins. To achieve improved measurement, funding is required to take the reconnaissance-level recommendations contained herein and refine them into detailed final designs. Upon agreement on a final plan, construction or installation of measurement and collection equipment would be required, followed by a calibration process. It is proposed that the initial components of this Measurement Program be implemented over 2 years, with each year followed up with progress reports.

After the initial 2-year phase, structural modification to the Colusa Basin Drain, as described in Section 3, could be constructed, if warranted. The next phase of the Measurement Program would also include continued data collection and study of additional inflow and outflow locations.

The key steps of the initial 2-year phase are described below:

Funding – To implement the recommendations for key outflow sites, funding is required immediately for the program components listed below, including final design, installation, and operation of this initial set of outflow locations. In Section 3, the costs of improving the measurement at outflows locations were estimated. The total cost of the recommended improvements is estimated to be $155,000 for initial capital costs, including design and installation/ construction. Annual O&M costs are estimated to be on the order of $60,000. The total estimated cost to implement the proposed initial 2-year phase is $275,000.

These cost estimates do not include larger-scale improvements for a new measurement location on the Colusa Basin Drain. The necessity of this project would be evaluated after the initial improvements were made at

Knights Landing Outfall Gates. Capital costs for engineering, construction, and environmental permitting are estimated to be $270,000.

If additional funding is available beyond the scope of these initial outflow measurement improvements, it is recommended that this Measurement Study be extended to include additional sub-basin outflow and inflow locations to move toward a comprehensive measurement program.

Final Design of Measurement Improvements – The reconnaissance-level recommendations described in Section 3 may require further refinement, including detailed design specifications. Where applicable, a detailed calibration process must be further refined through coordination with DWR and/or other operating agency field staff.

Installation of Measurement and Collection Facilities – Measurement devices and data collection equipment would be installed at all recommended locations. Installation would be coordinated with operations staff of the facility owner. Depending on the sub-basin operations, some sites may be best suited for installation during the irrigation season (during times of minimal outflow) with calibration during the rice drainage period. Other sites that experience sustained drainage outflow during the irrigation season may necessitate installation in the fall season, with calibration during winter rain events.

Measurement Calibration – After installation, the measurement devices would be calibrated to ensure flow measurement accuracy. Where possible, field measurements would be taken to verify data from measurement devices.

Initial Data Collection – Depending on the timing of project funding, data may be collected in the first year as soon as devices are installed and calibrated or other recommended improvements are made. This initial data collection would be useful in determining refinements necessary for ongoing measurement.

Cooperating SRSCs and agencies already operating measurement locations would measure with the recommended improvements under the proposed coordinated program. For this initial 2-year period, a structured agreement may not be in place, and data collection may need to be implemented by a combination of participating district staff and consulting engineers. These costs should be included in any funding requests involving this Measurement Study.

Year 1 Progress Report – The purpose of the progress report after the first year is to document the devices that have been installed or the improvements that have been made, as well as the overall effectiveness of the improvements. This report would document any refinements required for future measurement. Any data that have been collected during Year 1 would be presented in this progress report.

Year 2 Data Collection – It is anticipated that outflow data would be collected for the entire irrigation season in Year 2. The emphasis of this Measurement Program is on water use during the irrigation season. The sites identified and addressed in the Measurement Study do not capture higher outflows from these basins, and therefore, any data collected during high flow events (i.e., in the winter) would have limited, if any, usefulness. Year-round measurement would require additional equipment and/or modifications at every location.

Evaluate Measurement Equipment – The measurement and data collection technologies applied to this initial 2-year phase of the Measurement Program would be evaluated. The evaluation would investigate measurement accuracy, ease of operation, and reliability of data collection.

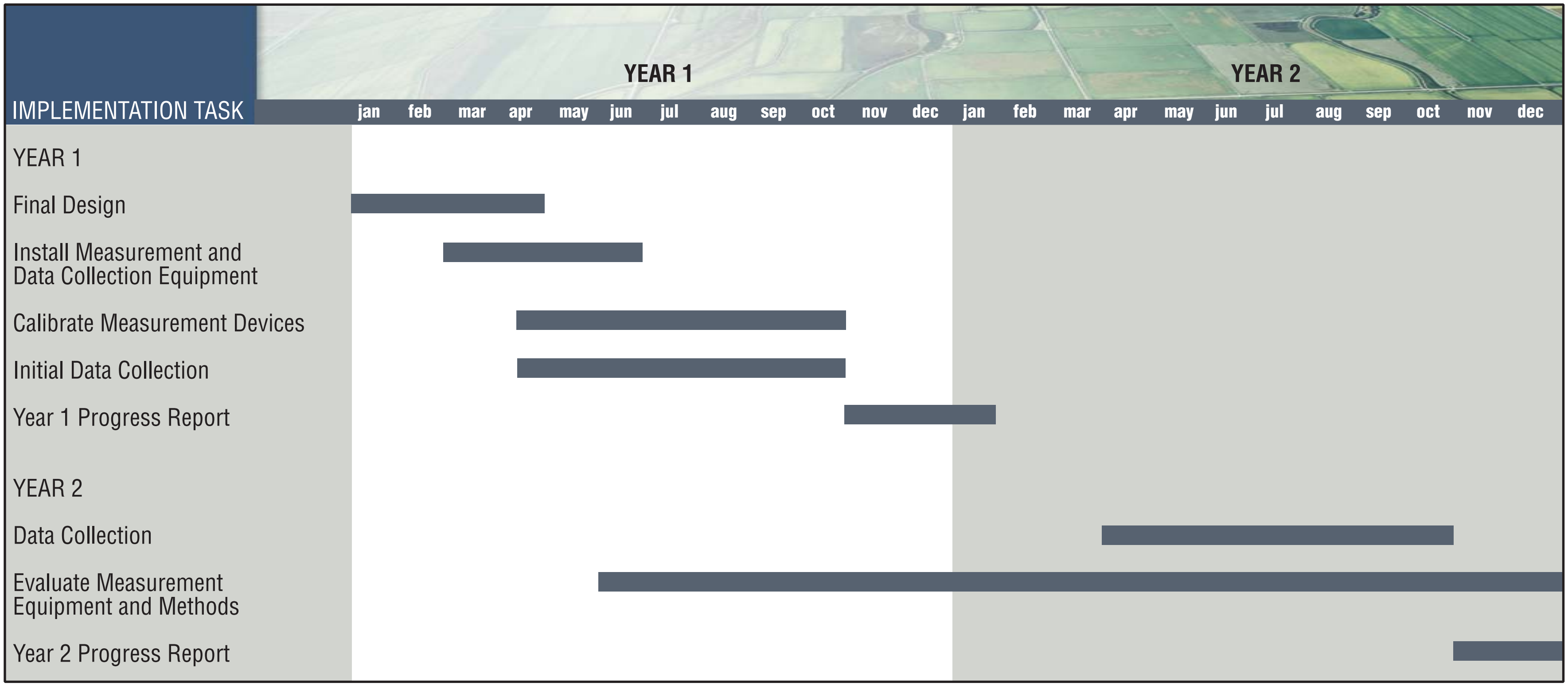
Sub-basin-level Data Analysis – The data collected would be used for sub-basin-level water balance calculations. Other initial uses for the data may include sub-basin outflow discharge timing and quantity analysis. These types of analyses are a potential benefit of the proposed Measurement Program, but not necessarily a component of the program.

Year 2 Progress Report – In the second progress report, all collected data would be summarized. The results of the equipment evaluation and of the measurement improvements would also be presented. The operations costs associated with the improved water measurement could also be documented. A key component of this progress report is an evaluation of how the data could be used in the future for operations and water management purposes.

Figure 5-1 presents a conceptual schedule showing the implementation of the initial 2-year phase of the proposed Measurement Program.

Continued Sub-basin-level Coordination

Improving the water measurement at key sub-basin locations to facilitate improved water operations at the sub-basin level and throughout the Sacramento Valley is one component of the overall BWMP. By improving the confidence in data and making the data available, coordination within sub-basins among districts and among sub-basins should continue to improve. It is recommended that the SRSCs continue to work toward developing the organizational framework required to implement a comprehensive Sub-basin-level Water Measurement Program that would facilitate further coordinated operations throughout the Sacramento Valley.



Note:
Implementation schedule assumes that funding has been secured for a two year initial program including capital costs and O&M.

FIGURE 5-1
INITIAL IMPLEMENTATION SCHEDULE
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN
SUB-BASIN-LEVEL WATER MEASUREMENT STUDY

CH2MHILL

section 6 References

California Bay-Delta Authority website:
http: //calwater.ca.gov/Programs/WaterUseEfficiency/WaterUseEfficiency.shtml

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Appendix B
Cooperative Water Measurement Study Work Plan

December 2003

Bureau of Reclamation/

Sacramento River Basinwide Water Management Plan

Cooperative Water Measurement Study Work Plan

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Section 1 Purpose and Background

The determination of appropriate water measurement both across and within water districts or mutual water companies (districts/companies are used interchangeably in this document) to support improved water management has been an important issue in the development of the Sacramento River Basinwide Water Management Plan (BWMP), which is being prepared by the Sacramento River Settlement Contractors (SRSC) in cooperation with the Bureau of Reclamation (Reclamation). To assist in evaluating how best to address and define the appropriate level of measurement, the SRSCs submitted, and Reclamation approved, a proposal for a cooperative study to evaluate options for improved water measurement within and potentially across the SRSC service areas.

Current internal measurement approaches vary for each SRSC, ranging from instrument-based to visual observation measurement techniques. This Cooperative Water Measurement Study Work Plan (Work Plan) provides the background information for the Cooperative Water Measurement Study (Cooperative Study) and recommends a course of action for study implementation. The Cooperative Study between the SRSCs and Reclamation would be the initial phase in investigating current and potential measurement approaches to provide a scientific and practical basis for appropriate changes.

The Work Plan purpose and background information are presented in this section. Section 2.0 describes the study approach and major components of the Cooperative Study. The details of the proposed Cooperative Study are presented in Section 3.0 with a proposed implementation schedule. A discussion of recommended immediate next steps is presented in Section 4.0.

1.1 Work Plan Purpose

The Cooperative Study will address the issue of the appropriate level of agricultural water measurement in a cooperative manner between SRSCs and Reclamation. The Cooperative Study will provide insights into the measurement issue while supporting the ongoing regional criteria and contract renewal process as part of SRSC long-term contract renewals.

This Work Plan will guide implementation of the Cooperative Study and provide the documentation and foundation for necessary future actions, including funding. The purpose is further categorized as follows:

Summarize relevant background information – The issues and related efforts that help define the need for science-based information regarding appropriate levels of agricultural water measurement in the Sacramento Valley are presented.

Recommend a course of action for implementation – This Work Plan details the approach, implementation schedule, and the components of the Cooperative Study. The potential use of study results is also presented in this Work Plan.

Characterize measurement study sites – The Work Plan details the baseline information for the proposed measurement study sites within Natomas Central Mutual Water Company (NCMWC). This Work Plan also provides the technical information and estimated cost required to measure water at the lateral level and the turnout level at NCMWC.

Provide the basis for additional funding – This Work Plan will provide the approach, study details, and cost estimates necessary to justify the need for funding to implement the Cooperative Study.

1.2 Sacramento River Basinwide Water Management Plan

The primary objective of the BWMP is to provide the SRSCs with a comprehensive basis upon which to manage water resources to meet existing and future agricultural water needs in a manner that can also serve other environmental and municipal and industrial water needs in the Sacramento Valley. Figure 1-1 shows the geographic scope of the BWMP.

1.2.1 BWMP Goals and Objectives

The following four primary goals and objectives were defined for the BWMP:

- Meet valleywide water supply demands in a sustainable manner
- Achieve mutual benefits with Reclamation
- Evaluate opportunities to improve water management through coordinated actions
- Develop mutual data sets for contract renewal

A unique relationship exists between the SRSCs and Reclamation based on decades of cooperation and working relationships in the Sacramento Valley. Because of these relationships, the SRSCs and Reclamation recognized that there were some significant opportunities to realize mutual benefits as part of the BWMP process. The commitment toward collaboratively addressing issues and developing solutions was an outcome of this goal.

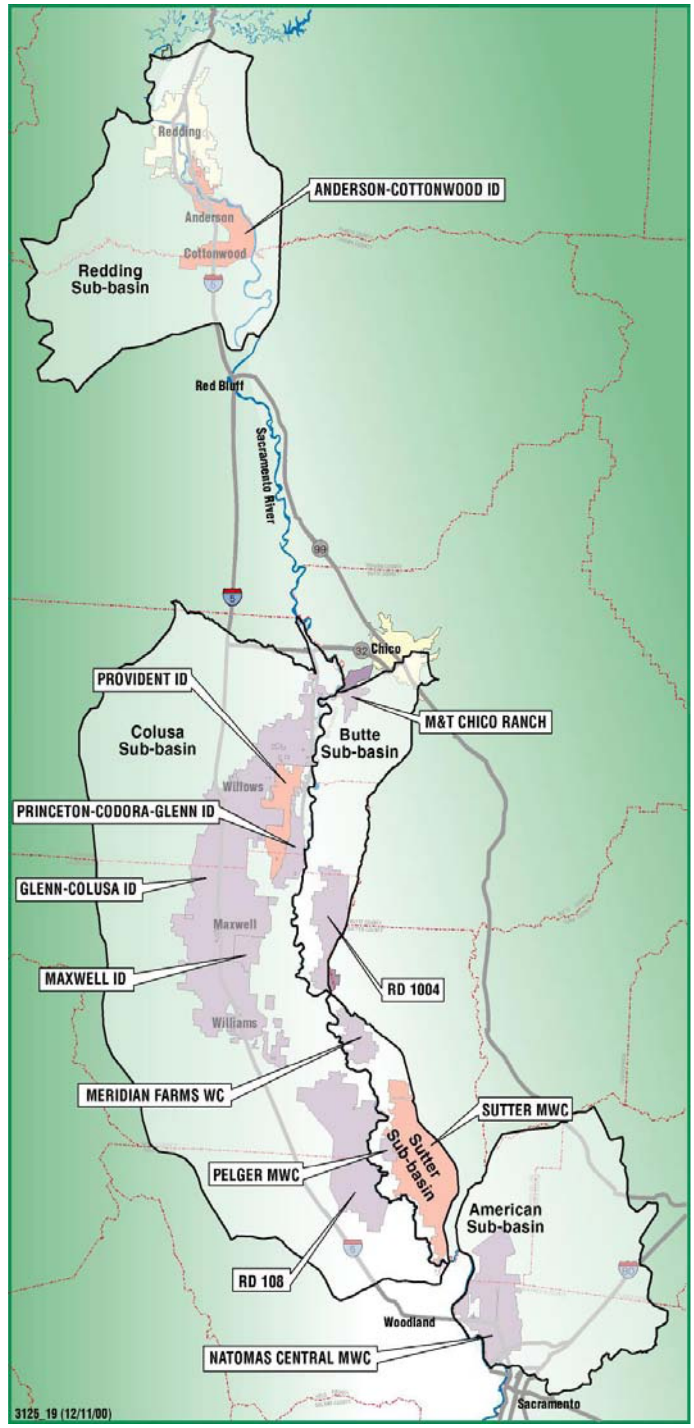
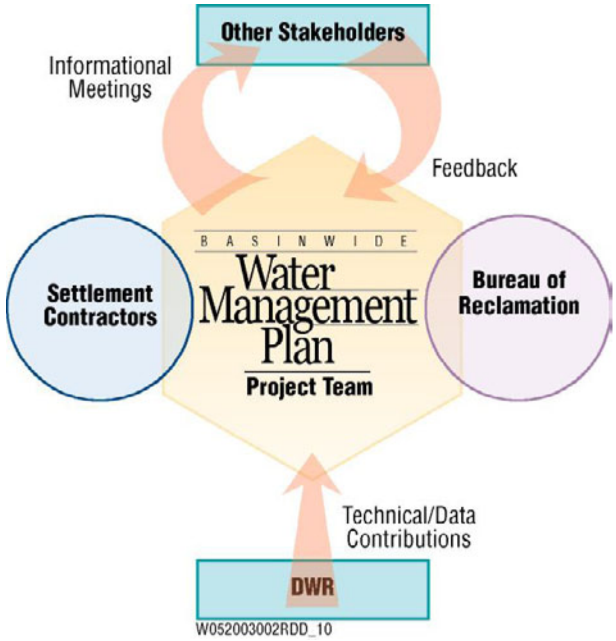


FIGURE 1-1
BWMP Geographic Scope

1.2.2 Sub-basin and Field-level Measurement

Among the numerous water management improvement options evaluated in the BWMP, appropriate water measurement was identified as an area requiring additional investigation. Given the relatively high degree of water reuse both within and among districts or mutual water companies, the BWMP recommended that water management and associated measurement at a sub-basin level be further evaluated to promote continued reuse and optimal management of interdistrict water use. A separate study sponsored by the CALFED Water Use Efficiency (WUE) Program was completed by SRSCs in July 2003, to investigate sub-basin-level water measurement and management.

The Cooperative Study would begin to evaluate the appropriate level of intradistrict measurement. As described below, continued demands on the state's finite water resources require that water be used in as efficient a manner as possible. The joint state-federal CALFED program, specifically with respect to the WUE subprogram, is working to fund and sponsor research to address the question of appropriate measurement in terms of location, method, cost, and necessity. The Cooperative Study would support this subprogram and would add to the body of knowledge currently being developed across the state. In addition to intradistrict approaches, this Cooperative Study would also identify where interdistrict and/or sub-basin-level measurement might be prudent and/or potentially preferable.



1.3 Reclamation Involvement and Contract Renewal

In addition to evaluating methods of improving water management, the BWMP was used to form a basis for the renewal of the SRSC's Central Valley Project contracts with Reclamation. This Cooperative Study will support the SRSCs and Reclamation in developing a mutually agreeable surface water delivery water measurement program that will be consistent with the proposed regional criteria as part of each of the contracts. To be consistent with regional criteria and to be mutually agreeable to Reclamation, the following questions were identified by Reclamation as part of the Work Plan development:

1. What are the most cost-effective measurement methods that will work satisfactorily under the conditions of the SRSCs' service area?
2. What are the benefits that are derived from measurement at turnout, lateral, and district levels? Are there potential issues/benefits of pricing water by

volume measured at the turnout or customer level?

3. Based on information gained from questions 1 and 2, what are the benefits and costs associated with measurement at the sub-basin, district, lateral, and turnout levels?

The Cooperative Study will address these questions while also supporting the requirements of the proposed regional criteria. The regional criteria make reference to measurement at the customer-level within the contractor service area. This Work Plan will investigate several levels of measurement, including field-level (turnout-level), which is used interchangeably with customer-level for this Work Plan.

1.4 Third-party Reviewer Involvement

The SRSCs and Reclamation agreed that the development of this Work Plan and subsequent study implementation should include a third-party reviewer to ensure objectivity and promote stakeholder acceptance. Accordingly, a nationally recognized expert in irrigation and water measurement methods has reviewed previous drafts of this Work Plan and provided recommendations to help ensure that Reclamation's three basic questions are properly addressed. The third-party review will help establish broad-based support of the measurement study, once implemented.

1.5 CALFED Involvement with Water Measurement

The CALFED mission is to restore ecological health and improve water management for beneficial uses of the Bay-Delta, which includes the entire Sacramento River watershed. One goal of the CALFED WUE Program is to define appropriate water measurement as it relates to agricultural water use efficiency. CALFED committed to convening an Independent Review Panel on Appropriate Measurement and working with the California State Legislature to develop legislation requiring the appropriate measurement of all water uses in California.

With an open process, including stakeholder involvement, the panel has focused on the following aspects of water measurement:

- Benefits and costs of measurement to water users, suppliers, and the general public
- Barriers to measurement: technical, economic, institutional, or political

Through summer 2003, the panel provided extensive advice on the technical information needed to support such a definition. Using the panel's recommendations, CALFED staff and consultants have nearly completed an analysis intended to demonstrate current practices and the costs and benefits associated with different measurement intensities. In September, the panel prepared a final report that detailed the panel's recommendation on appropriate agricultural water measurement. CALFED is currently developing an implementation approach on the basis of the panel's recommendation.

Implementation of this Work Plan would be consistent with the CALFED objectives.

1.6 Sacramento Valley Water Measurement and Pricing

Many local and site-specific factors influence the choice of measurement method, both between and within districts. However, the methods used to measure water within a given water district or company boundary are driven largely by the following key factors common to the SRSC service areas:

- Arranged water delivery scheduling (as opposed to purely on-demand or rotation)
- Primarily unlined earthen canals and laterals on open-channel distribution systems
- Extensive use of drainwater
- Predominance of particular crops and related irrigation methods within a given district
- Operations and maintenance (O&M) costs related to different measurement methods

The extent of water measurement, the methods used, and the level of recording and documentation varies greatly between individual irrigation districts, from extensive measurement and reporting at all operations levels to less intensive measurement at key supply and distribution points only. Water measurement for a typical Sacramento Valley irrigation district can be considered in terms of the following basic levels:

1. Supply
2. Conveyance and distribution
3. Turnout to individual fields or customers
4. Drainage
5. Sub-basin outflow

Descriptions of the existing measurement systems at the range of operations levels follow.

1.6.1 Supply

Diversions from the Sacramento River are the primary water source for the SRSC service areas. All major diversions are measured and recorded using meters, pump tables, or other equipment installed and maintained by Reclamation staff.

Surface water is the predominant source of water supply for SRSCs, and the majority of groundwater pumping facilities that exist are privately owned. Those districts that own and operate wells typically have flow meters and totalizers. Power use records may also be used to estimate volume of groundwater pumped.

1.6.2 Conveyance and Distribution

Flows in the supply distribution canals and laterals that distribute water primarily diverted from the Sacramento River are typically measured at major flow control structures such as inline gates (checks), and at lateral turnouts (headgates). Measurement may be estimated using a rating curve and measuring head.

1.6.3 Field Turnouts

Delivery of water to individual fields is measured in some districts and at least estimated within all districts. However, recording these deliveries is not a common practice. Where flow rates are not measured at the field, deliveries and use can only be estimated by duty used by the district or company to charge the landowner for water.

1.6.4 Drains

Most districts do not measure flows into individual field drains, although in some cases, district inflows resulting from another district's drainage outflow are estimated at key drain diversion point check structures. Outflows from drains are generally measured by a combination of drain pump meters or power use records, reclamation district drain pump meters or power use records, and recording of drainwater stage at key outflow points from the district service area.

1.6.5 Sub-basin Outflow

Drainage conveyance facilities in districts are typically networked to a common low-point within the district, which in many cases, is a point at the lower end of a sub-basin. Drainage is returned to the Sacramento River either by gravity flow or pumping plants. There are varied levels of sub-basin outflow measurement throughout the basin. Generally, the sub-basin outflow is either unmeasured or it is estimated using theoretical flow calculations on the basis of head and gate openings.

1.6.6 Pricing Practices

Water pricing and associated measurement practices vary throughout the Sacramento Valley. Existing pricing structures are influenced by many factors including cost of water supplies, district or company bylaws and regulations, operating costs, common crop types, and irrigation methods. Districts typically set a pricing structure to cover O&M costs and long-term capital improvements. Some of the current price structures include a direct or indirect quantity component. Pricing structures generally include a basic maintenance charge, regardless of water use (e.g., $10 per acre per year). Beyond this flat rate per acre, pricing structures generally follow one of these types:

- Per acre charge: $ per acre irrigated. May vary by crop type, or be the same for all crops.
- Per irrigation: $ per acre per irrigation. May vary by crop type, or be the same for all crops.
- Per acre-foot: $ per acre-foot delivered.

Overview of Study Approach and Components

2.1 Approach

This Cooperative Study draws from the three components described below to provide guidance that will be used in continued cooperation between Reclamation and the SRSCs in determining an appropriate level of water measurement. These components were developed using Reclamation objectives, input from a third-party reviewer, and an agreement from SRSCs on proceeding. These components will assist in determining the appropriate level of measurement throughout the Sacramento Valley; therefore, active participation from several SRSCs is proposed.

The results of any one component will not be used independently in determining the appropriate level of water measurement for SRSCs. Rather, the results from all three components will be used to support mutually acceptable long-term water measurement program for SRSCs.

2.2 Field Study Site Selection and Characterization at NCMWC

Evaluation of field-level measurement approaches (including installation of in-the-field measurement devices) was determined to be mutually acceptable within one district within the SRSC study area. The Natomas Central Mutual Water Company (NCMWC) volunteered to participate and identified specific study sites. The data and observations made at these sites are intended to support recommendations and provide insights beneficial throughout the Sacramento Valley. The operations and management staff of NCMWC were actively involved with the site selection process. The sites were chosen so that a reasonable number of measurement points would be required to measure the inflows and outflows for an evaluation of the various flow paths.

The field study portion of the Cooperative Study will be coordinated with Cal Poly Irrigation Technology Resource Center (ITRC). Reclamation has an ongoing work agreement with the ITRC to investigate irrigation and measurement methods and devices. The ITRC has a funding mechanism from Reclamation, and this study will benefit from applying ITRC technical expertise. The required measurement equipment descriptions below will be updated after a more detailed investigation of alternative equipment is undertaken in cooperation with the ITRC. Devices will be chosen that are cost-effective in terms of purchase cost and operation. The alternative device selection process will be summarized in study reports.

2.2.1 NCMWC Study Site Characteristics

The NCMWC sites were chosen to minimize the number of variables that could affect the study. Sites were chosen to provide a continuous block of irrigated lands with mostly isolated water supply and drainage systems, where inflow and outflow points were well defined. None of the sites are served by private or district-owned wells, nor is there any significant inflow of groundwater by natural means. The sites chosen are each several hundred acres in area and include mostly rice given the prevalence of rice land within NCMWC's boundary and the Sacramento Valley in general, but have also included other crops. Irrigation practices and soils of the study sites are typical for other districts. The study sites are historically irrigated in most years, but some factors, such as temporary water transfers or market conditions, could affect future application of water on the sites. Other factors considered were accessibility and landowner cooperation. Alternative NCMWC sites could be identified for implementation if unanticipated circumstances, such as landowner cooperation, cause the sites described below to be less favorable.

The details of the two study sites within NCMWC are presented below. A vicinity map showing the site locations, with respect to NCMWC boundaries, is shown on Figure 2-1. A more detailed map of the study sites, with measurement device locations, is shown on Figure 2-2. The required equipment for the 2-year study is also listed.

2.2.2 NCMWC Background

The NCMWC was formed in 1921 to divert water from the Sacramento River primarily for agricultural use, and also for limited M&I use. M&I diversions are for use at the Sacramento International Airport and the Sacramento Airport Special Planning Area (Metro Air Park) only. Reclamation District (RD) 1000, which was formed by an act of legislature in 1911, has boundaries that are, for practical purposes, coincident with the boundaries of NCMWC.

NCMWC and RD 1000 are located on the east side of the Sacramento River between the Town of Knights Landing and the City of Sacramento, in the Counties of Sutter and Sacramento, within the southern portion of the American Basin. NCMWC and RD 1000 encompass agricultural and urban land within the area surrounded by the Sacramento River on the west, the Natomas Cross Canal on the north, the Pleasant Grove Canal and the Natomas East Main Drain on the east, and the American River on the south. The RD 1000 service area encompasses approximately 55,000 acres, including approximately 36,000 acres that are served by NCMWC's distribution system. The landholders within the shared boundaries are both shareholders of NCMWC, a private company, and rate payers for RD 1000, a public entity. NCMWC's distribution system includes approximately 130 miles of canals and laterals and 60 pumps in over 40 internal locations. In addition, NCMWC makes use of a portion of RD 1000's approximately 180 miles of drainage canals. The NCMWC completed the installation of a recirculation system in 1986 to reduce river diversions, improve water quality in the Sacramento River, and to increase overall water use efficiency. The recirculation system includes 26 pumping station locations that recapture water for reuse within its boundaries. The majority of the soils within NCMWC are identified by Reclamation, as Class 1. According to Reclamation, Class 1 soils are "suitable for high production of any climatically adapted crop."

Rice is the predominant crop grown within NCMWC, typically accounting for approximately 75 percent of the irrigated acreage annually. Water pricing within NCMWC is based on crop type and acreage.

The NCMWC study sites are located within the eastern portion of NCMWC's service area (see Figure 2-1). The two sites are adjacent to each other and separated by a large delivery canal, which runs from west

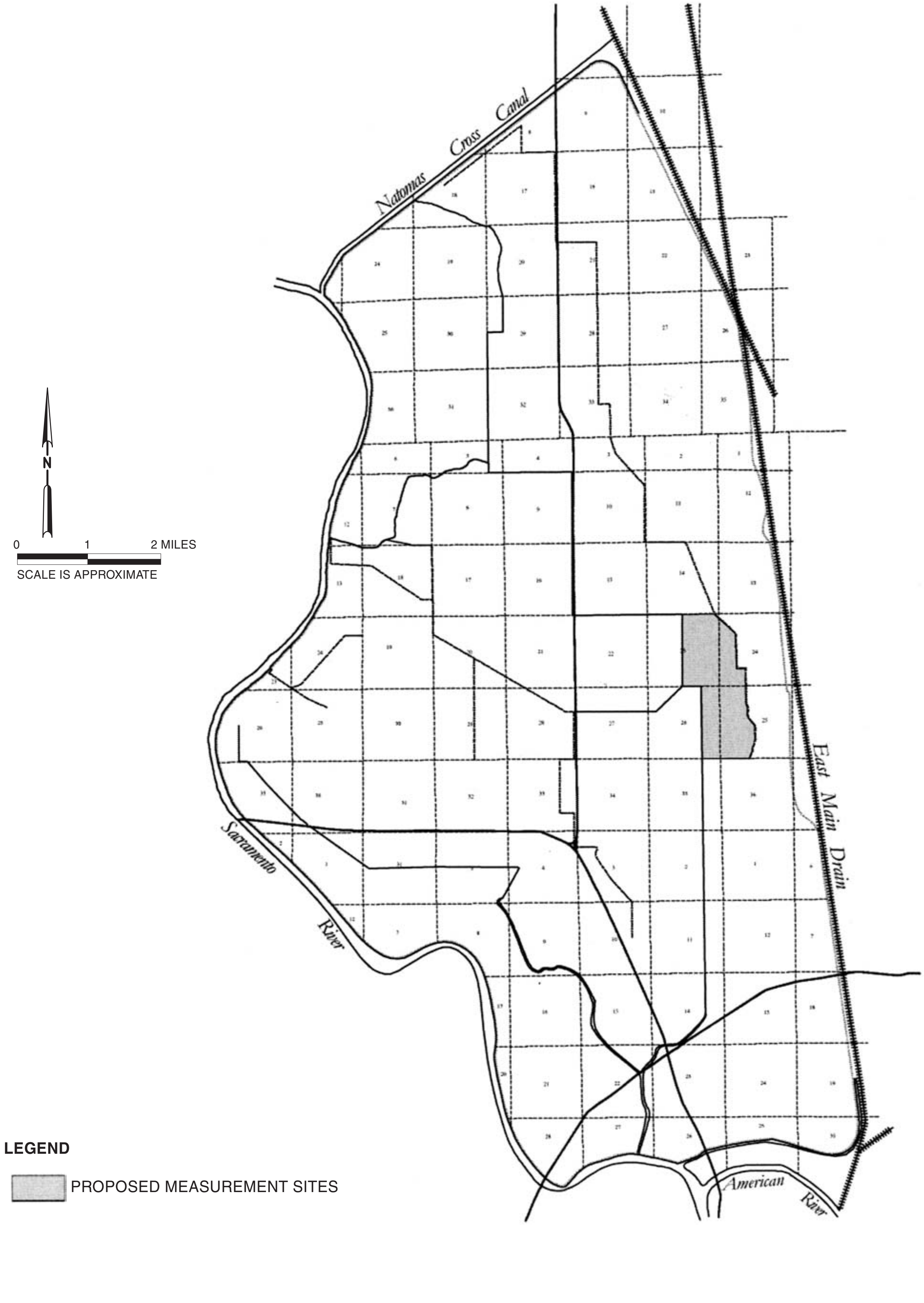


FIGURE 2-1
NCMWC SITE LOCATION MAP
RECLAMATION/BWMP COOPERATIVE WATER MEASUREMENT STUDY WORK PLAN

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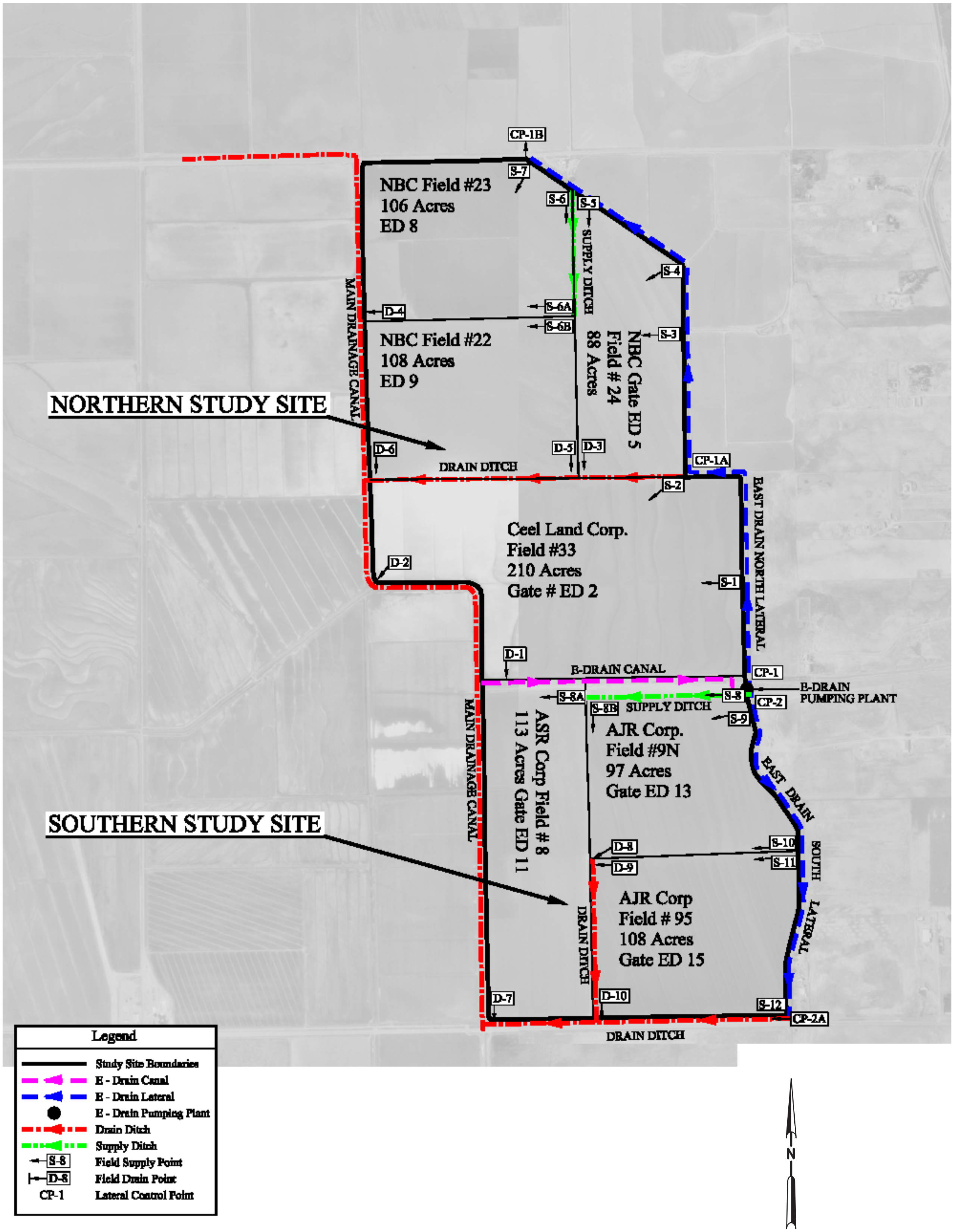

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FIGURE 2-2
NCMWC PROPOSED MEASUREMENT SITES
RECLAMATION/BWMP COOPERATIVE WATER MEASUREMENT STUDY WORK PLAN

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to east, terminating at NCMWC's E-Drain Pumping Plant. The northern parcel consists of approximately 512 acres, and the southern parcel is approximately 318 acres. Both parcels are generally planted to rice. These sites were chosen because of their proximity to each other, which should result in very similar conditions relative to soils types and climatic conditions. Both parcels are irrigated solely with surface water supplies, which originate from the same source.

Water is delivered to the study sites through the E-Drain Pumping Plant. The E-Drain Pumping Plant consists of two, 50-horsepower pumps with 24-inch-diameter discharge pipes. According to pump tests conducted in 2002, the capacity of these pumps is approximately 9,500 gallons per minute (gpm) for the northern pump and approximately 7,600 gpm for the southern pump. The pump tests found the efficiencies of both pumps to be very low and NCMWC has repaired both pumps in 2003, which has improved the pumps' efficiency.

Water is lifted from the E-Drain to a lateral canal, which flows north and south. This lateral supplies water to the two study sites; the Northern Study Site and the Southern Study Site. It is proposed to use the Northern Study Site for the Turnout-level Study in Year 2 and the Southern Study Site for the Lateral-level Study control. The delivery and outflow facilities for each site are described below.

NCMWC Turnout-level Site (Northern Study Site)

Water Delivery. As identified above, the Northern Study Site encompasses approximately 512 acres within four separate fields: 22, 23, 24, and 33. Water is lifted from the E-Drain into a lateral canal where it can be directed either north or south. Flow direction is determined by the configuration of flashboard structures located on the lateral a short distance north and south of the pumping plant. The lateral is approximately 30 feet wide at its top, 8 feet wide at its bottom, and 8 feet deep. The flashboard structure, which controls or regulates water flowing north, consists of a 45-inch flashboard riser, which is connected to a 36-inch-diameter corrugated metal pipe (CMP). This structure is identified as CP-1. After the canal is brought to its normal operating levels, the CMP is submerged and remains full until the canal is drained. Deliveries from the lateral to the fields located in the Northern Study Site consist of seven, 18-inch screw gates connected to short sections of CMP. Figure 2-2 shows the locations of the delivery points and are identified as S-1 (Delivery Point Number 1) through S-7. For information purposes, other structures are also shown on

Figure 2-2, including both screw gates and risers, which are used to distribute water to specific fields.

Outflow. In addition to the field deliveries, water can be discharged from the northern lateral at two locations. These outflow points are used to help control water levels in the canal and to drain the canal for maintenance. These drain points are shown as CP-1A and CP-1B on Figure 2-2. CP-1A is an 18-inch flashboard riser structure with an 18-inch-diameter discharge pipe. This discharge pipe does not flow full except when the lateral is being drained. CP-1B is an 18-inch screw gate that at one time was used to deliver water to fields north of the study area. Under current operations, this structure is rarely used for this purpose. In addition to lateral drains, CP-1A and CP-1B, each field contains one or two drains or outflow structures. There are five of these drain structures in the Northern Study Site. These outflow structures are shown on Figure 2-2 and are identified as D-1 (Outflow Point Number 1) through D-5.

Fields. Field 33 is approximately 210 acres, which are typically planted to rice. Water flows generally from east to west. This field is served by two, 18-inch screw gate delivery points (S-1 and S-2) and two drains identified as D-1 and D-2. D-1 consists of an 18-inch flashboard riser attached to a short section of 18-inch-diameter CMP. D-2 is a 17-inch flashboard riser with an 18-inch-diameter CMP discharge pipe.

Field 24 is approximately 88 acres, which are typically planted to rice. Water flows generally from northeast to southwest. This field is served by three, 18-inch screw gate delivery points (S-3, S-4, and S-5) and one drain identified as D-3. D-3 consists of a 29-inch flashboard riser attached to a short section of 18-inch-diameter CMP discharge pipe.

Field 23 is approximately 106 acres, which are typically planted to rice. Water flows generally from east-northeast to west-southwest. This field is served by an 18-inch screw gate delivery point S-7. Water can also be delivered to Field 23 through S-6, which supplies water to a ditch flowing north to south between Fields 23 and 24. This ditch terminates at a 23-inch flashboard riser structure (S-6B) located at the southeast corner of Field 23, which controls delivery to Field 22. Water from the ditch can be delivered to Field 23 by way of a 34-inch-wide flashboard check structure located just upstream of the terminus of the ditch. This checkboard delivery structure is designated as S-6A. A single drain services Field 23 (designated as D-4), and consists of a 23-inch flashboard riser attached to a short section of 18-inch-diameter CMP discharge pipe.

Field 22 is approximately 108 acres, which are typically planted to rice. Water flows generally from northeast to south-southwest. This field is served by a single delivery point (S-6B) and two drains (D-5 and D-6). D-5 consists of a 23-inch flashboard riser attached to a short section of 18-inch-diameter CMP. D-6 consists of an 18-inch flashboard riser attached to a short section of 18-inch-diameter CMP. Table 2-1 summarizes the turnout-level site.

TABLE 2-1
NCMWC Turnout-level Site Summary

Field	Irrigated Acres	2003 Crop
33	210	Rice
24	88	Rice
23	106	Rice
22	108	Rice
Total	**512**	

Required Measurement Equipment. The Northern Study Site is proposed for turn-out level measurement. In Year 1, deliveries to the Northern Study Site would be measured at the lateral level. As envisioned, this would entail installation of equipment capable of measuring and recording water levels at the control structure located at the head to the Northern Lateral (CP-1), and at the overflow drain CP-1A. According to the information provided by NCMWC staff, there is typically no outflow at the end of the lateral location CP-1B; therefore, no measurement equipment is proposed for this location. In addition to the water-level sensors, measurements will be made to develop ratings for the existing drop structures located at CP-1 and CP-1A.

In Year 2 of the study, additional equipment will be installed to measure deliveries and outflow for each field. Information from these measurements will be compared with the Year 2 lateral-level measurements to help evaluate the measurement program. NCMWC staff have indicated that there is little problem with debris in the lateral; therefore, propeller flow meters, equipped with totalizers and data loggers, should be used to measure and record field-level deliveries.

Cultural practices for rice typically require outflow throughout the irrigation season. After the fields are flooded, a certain amount of flow through the fields is required to produce a healthy crop. Because small changes in water levels may occur throughout each day, from climatic and operational conditions, water-level sensors using floats contained in a temporary stilling well are proposed. These types of devices are typically more accurate in measuring small changes in water levels at a lower cost than pressure transducers.

The equipment proposed for use in Years 1 and 2 of the study are identified in Table 2-2.

NCMWC Lateral-level Site (Southern Study Site)

Water Delivery. The Southern Study Site encompasses approximately 318 acres within three separate fields: 8, 9N, and 9S. Water is lifted from the E-Drain into a lateral canal where it can be directed either north or south. Flow to the Southern Study Site is controlled by a 30-inch flashboard riser structure with a 30-inch-diameter CMP discharge pipe (CP-2) located on the lateral a short distance south of the pumping plant.

TABLE 2-2
Equipment for the NCMWC Turnout-level Site – Year 1 and Year 2 Installations

Location(s)	Description	Measurement Device[a]	Estimated Cost	Year(s) Installed
CP-1	Head of Northern Lateral	Unidata Precision Water Level Sensor #6541	$2,000[b]	Years 1 and 2
CP-1A	Emergency spill and drain	Unidata Precision Water Level Sensor #6541	$2,000[b]	Years 1 and 2
S-1 through S-6 and S-7	Field supply – 18-inch screw gates	McCrometer Flow Meter #M1718	$2,500 each[c]	Year 2 only
S-6A and S-6B	Field supply for Fields 22 and 23	Unidata Precision Water Level Sensor #6541	$2,000[b]	Year 2 only
D-1 through D-6	Field drains	Unidata Precision Water Level Sensor #6541	$2,000 each[b]	Years 1 and 2

[a]The manufacturer name and model number are provided for reference and the basis for the cost estimate. Other suitable equipment may be substituted during study implementation.

[b]Cost estimate includes cost for equipment estimated to be approximately $1,500 per meter plus estimated installation cost of $500 per meter. Additional costs will be required to develop ratings for each of the structures.

[c]Cost estimate includes an estimated $500 for installation.

The lateral is approximately 30 feet wide at its top, 8 feet wide at its bottom, and 8 feet deep. After the lateral is brought to its normal operating levels, the CMP discharge pipe is submerged and remains full until the canal is drained. Deliveries from the lateral to the fields located within the Southern Study Site consist of five, 18-inch screw gates connected to short sections of CMP (S-8 through S-12). Figure 2-2 shows the locations of these delivery points. Two other structures (S-8A and S-8B) are used to distribute the water delivered to Fields 8 and 9N through delivery point S-8. Each of these structures is shown on Figure 2-2.

Outflow. A 24-inch flashboard riser, with an 18-inch-diameter CMP discharge pipe, is located at the southern end of the south lateral. This structure, identified as CP-2A, controls water levels in the lateral by allowing excess water to spill into a drain that runs east to west along the southern border of the study site. This structure can also be used to help drain the lateral for maintenance purposes. Outflow from the fields in the Southern Study Site are controlled by flashboard riser structures. Each field contains one or two of these outflow structures. There are four of these drain structures in the study site. These outflow structures are shown on Figure 2-2 and are identified as D-7 through D-10.

Fields. Field 8 is approximately 113 acres located in the western portion of the study site. This field is typically planted to rice. Water flows generally from northeast to southwest. This field is served by a single delivery point (S-8B) located at the end of a ditch that runs from east to west from the lateral at S-8 to the northeast corner of Field 8. The structure at S-8A consists of a 39-inch flashboard riser with a 24-inch-diameter CMP discharge pipe. The single drain for this field (D-7) is located at its southwest corner and consists of a 29-inch flashboard riser with an 18-inch-diameter CMP discharge pipe.

Field 9N is approximately 97 acres and is typically planted to rice. Water flows from the north and east to the southwest. Water can be delivered to field 9N at delivery point S-8A, S-9, and S-10. S-8A consists of a 24-inch flashboard riser structure located near the northwest corner of Field 9N.

Delivery points S-9 and S-10 consist of 18-inch screw gates with short sections of 18-CMP-diameter discharge pipe. Field 9N has a single 21-inch flashboard riser drain with an 18-inch-diameter discharge pipe located at the field's southwest corner (D-8). This drain discharges into a drain ditch that flows north to south, which empties into a larger drain that flows east to west along the southern boundary of the study site.

Field 9S is approximately 108 acres and, as with the other fields in the study sites, is typically planted to rice. Water is delivered to this field through two, 18-inch screw gates (S-10 and S-11). These two delivery points were included in a previous measurement study conducted by NCMWC and are equipped with McCrometer flow meters. The flow meters have not been read or serviced by NCMWC for several years. Water flows generally from east-northeast to west-southwest. There are two drains, one located at the northwest corner of the field (D-9) and another located at the southwest corner of the field (D-10). D-9 is a 24-inch flashboard riser structure with an 18-inch-diameter CMP discharge pipe. D-10 consists of a 20-inch flashboard riser and an 18-inch-diameter discharge pipe. Table 2-3 summarizes the lateral-level site.

TABLE 2-3
NCMWC Lateral-level Site Summary

Field	Irrigated Acres	2003 Crop
8	113	Rice
9N	97	Rice
9S	108	Rice
Total	**318**	

Required Measurement Equipment. The Southern Study Site is proposed for lateral-level measurement only. Deliveries to the Southern Study Site would be measured at the lateral level only in both years. Equipment capable of measuring and recording water levels at the control structure located

at the head to the Southern Lateral (CP-2) and at the overflow drain CP-2A would be installed. In addition to the water-level sensors, measurements would be made to develop ratings for the existing drop structures located at CP-2 and CP-2A.

The equipment proposed for use in Years 1 and 2 of the study are identified in Table 2-4.

TABLE 2-4
Equipment for the NCMWC Lateral-level Site – Year 1 and Year 2 Installations

Location(s)	Description	Measurement Device[a]	Estimated Cost	Year(s) Installed
CP-2	Head of Southern Lateral	Unidata Precision Water Level Sensor #6541	$2,000[b]	Years 1 and 2
CP-2A	Emergency spill and drain	Unidata Precision Water Level Sensor #6541	$2,000[b]	Years 1 and 2

[a]The manufacturer name and model number are provided for reference and the basis for the cost estimate. Other suitable equipment may be substituted during study implementation.

[b]Cost estimate includes cost for equipment estimated to be approximately $1,500 per meter plus estimated installation cost of $500 per meter. Additional costs will be required to make measurements to develop rating for each of the structures.

2.3 Conduct Interviews

A key aspect of the proposed Cooperative Study is to document the current state of water measurement in a greater level of detail than has been documented in the past. Interviews are proposed to document the numerous factors involved in water delivery decisions and management of the water supply.

Two districts were chosen and agreed to participate in this component of the Cooperative Study: NCMWC and RD 108. Detailed interviews will also be a necessary portion of the data analysis component, detailed in Section 2.4, which involves RD 1004 and Sutter Mutual Water Company (SMWC). The NCMWC is an ideal participant simply because measurement equipment will be installed on two plots of land, as described in Section 2.2. Also, to fully understand the field study portion of the Cooperative Study, the interviews are necessary. RD 108 is the second candidate that volunteered to actively participate. Although all SRSCs have unique physical and policy characteristics, interviewing these four is expected to provide a better understanding of current practices that could be observed through most of the Sacramento Valley. Other SRSCs may be identified during the Cooperative Study to participate as well.

A questionnaire would be developed for participants to fill out. Follow-up interviews would be conducted to gain further insight into the measurement issue. The questionnaire would be developed and reviewed in conjunction with a social scientist. The social scientist will help formulate the questionnaire in a manner that will avoid bias and will assist in the evaluation of the interviews. A neutral third party may be used to facilitate the interviews and evaluations. Some examples of questions for operations superintendents, ditch riders, and individual landowners include the following:

- How is water measured currently at the sub-basin level, district level, lateral level, and field level (inflows and outflows) ?
- How is water ordered?
- How is water apportioned for simultaneous orders along a lateral below the last point of measurement?
- In the absence of volumetric water pricing, what are the incentives (to operators and farmers) for being “wise water managers”?

The results of the interviews would be documented in the Cooperative Study reports.

2.4 Delivery Data Analysis at SMWC and RD 1004

2.4.1 Background

Prior to 1992, RD 1004 charged for water on a "flat rate" per acre basis. The rate was based on the crop planted for that year. Beginning in 1992, RD 1004 began charging for water on a per-acre-foot delivered basis. The new billing method required that the volume of water delivered to each field be known. To measure the quantities delivered to RD 1004's customers, meters were installed and records kept for each turnout.

In the case of SMWC, until the 2003 irrigation season, water deliveries were measured and water was charged for based on the actual quantity delivered. Deliveries were measured using rating tables for the various sizes of gates used as turnouts by SMWC. The rating tables provide flow rate for various gate opening and head differentials. The SMWC staff typically check the gate opening and the water levels upstream and downstream of the gate once each day. This data is recorded manually by the ditch rider. For the 2003 irrigation season, the SMWC Board of Directors directed that water would be charged on a flat rate basis according to the crop and acreage. Although water pricing is currently based on a flat rate, SMWC personnel continue to measure quantities delivered to each field for operational purposes.

Because of these recent changes in water pricing policies, an opportunity to examine the effects of pricing and measurement without installing measurement equipment was recognized.

2.4.2 Collect Data and Develop Database

Monthly data regarding river diversions are available in electronic format from Reclamation for both RD 1004 and SMWC from 1964 through the 2003 irrigation season.

Records of deliveries and crop acreages for SMWC are available in electronic format for the years 2000 through 2002. Records for the years 1992 through 1999 and 2003 are also available; however, these records will have to be input to be included in the electronic database for analysis. The 1992 through 2002 records would provide an 11-year period of volumetric pricing by SMWC.

Records of deliveries and crop acreages for RD 1004 are available in electronic format for the years 1999 through 2002. Records for the years 1992 through 1998 are available; however, these records will have to be input to be included in the electronic database for analysis.

After the database is set up for each district, a time series of river diversions, available lateral flow measurements, turnout-level measurements, and groundwater pumping estimates will be plotted. Crop acreages will be identified and used to understand the quantity of water consumed by crops. Where appropriate, records from neighboring districts with similar soils, land use, and water delivery practices may be included if access to these records can be obtained.

2.4.3 Collect Hydrologic, Operational, and Policy Information

Additional information regarding other factors that might affect the timing and quantity of water deliveries will be obtained through detailed interviews with managers and operations staff, and from hydrologic and weather records. These interviews will be undertaken to get a full understanding of the whole picture on water supply and any observed changes in water operations indicated by the delivery data.

Operations staff from both RD 1004 and SMWC will provide information on the real costs of installing, calibrating, maintaining and purchasing measurement devices. An estimate of the labor involved in collecting and managing data retrieved from devices will also be undertaken.

The interview process will include documenting the reasons that the board of directors for these SRSCs made changes in pricing and measurement policy. Pricing and measurement policy at the field level is a contractor decision, and understanding the decisionmaking process for these two organizations may provide insights when comparing delivery records and drawing any conclusions.

2.4.4 Analyze the Delivery Data

Data will be analyzed for trends in district diversions, internal water deliveries, and flow path under each billing practice. Differences in deliveries with and without volumetric water pricing will be identified. In addition, other factors, such as changes in crop varieties and patterns, irrigation methods, weather, and hydrologic conditions, that may have affected water deliveries will be identified.

In the event that the number of years of data available for before and after the policy change is not enough to draw useful conclusions or provide guidance, delivery data from neighboring districts may be obtained, if possible, to make general comparisons between pricing by volume delivered versus pricing by acreages and crop type.

Section 3 Study Details

The details of the proposed 2-year Cooperative Study are presented in this section, followed by a study budget and implementation schedule.

3.1 Study Coordination

The implementation of this Cooperative Study requires either a participating district or a consulting engineer to take the lead role in providing project coordination for all study components, technical support, and a centralized repository for collected flow data. It is anticipated that participating districts may not have staff or resources available to lead such an effort; and thus, this Work Plan assumes that funding would be necessary to provide technical support for the study. Technical support would be required for the purchase, installation, and calibration of equipment; data collection, management, and analysis; and the production of study reports.

Study coordination activities would include planning and scheduling the device installation and calibration tasks with the participating NCMWC staff. This process would be followed by a training session for system operators and farmers on common indicators of improperly functioning measurement devices. All interviews and data collection would coordinated by the implementation lead. Coordination of the field study, the interviews, and the delivery data analysis among Reclamation, the participating districts, and other BWMP participants would be facilitated by the technical staff. After project funding, a study kick-off meeting would be held with subsequent meetings at the conclusion of each study year. Study progress would be shared in the form of periodic reports with Reclamation, BWMP participants, and the funding source(s).

Analysis and study conclusions would be made by Reclamation and the third-party reviewer. Production and distribution of annual progress reports would be the responsibility of the technical staff.

3.2 Field Measurement Study at NCMWC

3.2.1 Purchase Measurement and Data Collection Equipment

After study funding is obtained, measurement devices and data collection equipment would be purchased and installed prior to the irrigation season. Table 3-1 shows the equipment cost breakdown by year for the NCMWC measurement sites.

TABLE 3-1
NCMWC Equipment – Cost Estimate[a]

Description	Estimated Cost ($)
Both Sites, Year 1 and Year 2	
Lateral-level Supply Measurement (includes spill measurements)	8,000
Drainage Measurement	12,000
Total Cost	**$20,000**
Turnout-level Site, Year 2	
Turnout-level Supply Measurement	21,500
Drainage Measurement	0
Total Cost	**$21,500**

[a] Includes installation, data loggers, and power supply. Does not include calibration and O&M.

3.2.2 Equipment Installation and Calibration

Installation would occur prior to the irrigation season (prior to April) and would be coordinated with district O&M staff at NCMWC. Equipment would be installed according to the manufacturers' specifications and, if possible, using the expertise of technical representatives of device manufacturers. Manufacturer representatives may also provide installation training.

Participating company O&M staff may be required to assist with some aspects of device installation. For example, a backhoe or shovel assistance may be required to clean sediment and heavy brush from turnout outlets prior to device installation and calibration. If device installations require a new section of pipe at turnouts or supply laterals, O&M staff may be required to weld pipe extensions and to backfill exposed pipe.

Depending on the measurement device used, calibration would involve either verifying flow or developing a rating curve (head-discharge relationship) using a portable meter. Calibration would also ensure that the data collection equipment is recording the correct measured values. The calibration process would follow manufacturers' recommended procedures.

3.3 Conduct Water Management/ Measurement Interviews

Interviews would occur at NCMWC and RD 108 with managers, operations staff, and landowners. Managers would help identify landowners to interview. It is expected that this process would take place in Year 1 of the Cooperative Study, but follow-up interviews may be beneficial in the second year of the study as well.

3.4 Collect and Organize Delivery Data at SMWC and RD 1004

Records and databases from RD 1004 and SMWC would be obtained. All data will be organized into databases. In addition to data organization, interviews will be conducted to collect other information to assist in understanding the whole water supply picture. To assure data quality control, calibration and maintenance records will be examined.

3.5 Delivery Data Analysis from SMWC and RD 1004

A separate database will be developed for both RD 1004 and SMWC. Each database will include data regarding the district's diversions, deliveries, crop acreages, and irrigation methods. The data included in the database will include at least a 5-year period before and after the change in pricing method, or, in the case of the volumetric pricing for SMWC, as much data as are available at the time the study is conducted. After the database is developed, data will be analyzed for trends in district diversions, internal water deliveries, and flow path under each billing practice. Differences in deliveries with and without volumetric water pricing will be identified. In addition, other factors, such as changes in crop varieties and patterns, irrigation methods, weather, and hydrologic conditions, that may have affected water deliveries will be identified. If appropriate, and if authorization can be obtained, data from neighboring districts may be incorporated into the study.

3.6 Field Measurement Data Analysis

One critical outcome of the field component of the Cooperative Study is determining the value of two levels of improved water measurement in terms of information gained. This study would present an analysis on how more detailed flow data collection could be beneficial.

3.6.1 Flow Path Analysis

The current flow path, using estimates of on-field water use, would be documented at NCMWC; and a comparison would be made to the flow paths using lateral-level measurements and turnout-level measurements. The flow paths using Year 1 data (lateral-level data) would be compared against current estimates. In Year 2, the flow paths using lateral-level data would be compared against the flow paths that used the turnout-level data and current estimates.

3.6.2 Measurement Data Comparison

Using the data collected at NCMWC, a comparison would be made using continuously recorded lateral-level measurement data and turnout-level measurement data. A volumetric comparison of the inflow and outflow would be made between continuously recorded data and a daily flow estimate or periodic checks (as an operator may estimate or check). This study would investigate the potential benefits of having continuous data and making that data available to system operators. Access to continuous flow data may have implications on how operators run the system and how districts manage their supplies and drainwater.

3.7 Benefits and Costs Documentation

The potential benefits and costs of current measurement practices, lateral-level measurement, and turnout-level measurement will be documented using as a basis the analysis of SMWC and RD 1004 data, field data from NCMWC, and interviews at NCMWC and RD 108. Any observations related to potential interdistrict measurement, cooperation, or coordination (including at a sub-basin level) will also be identified and noted.

3.8 Engineering and Data Management

The technical support staff would have the following basic engineering and data management responsibilities:

Installation/Calibration oversight – Technical staff would coordinate equipment purchase and installation with NCMWC staff and manufacturer staff. The technical staff would also be responsible for the calibration process to ensure accurate measurement and data collection.

Data download – The technical staff would be responsible for downloading data monthly from field units at NCMWC and transferring data to a centralized database. A process for downloading is suggested to help ensure measurement data accuracy. The basic components include the following:

- Visually inspect measurement and data logging equipment.
- Check reported values against the staff gage if possible. Check totalizer readings on flow meter against recorded data.

- Conduct necessary repairs or maintenance.

While the NCMWC staff would not be responsible for data downloads, they would be relied upon to inspect and report problems to the technical staff that could affect data collection or accuracy in the interim between monthly data downloads. System operators would be educated on the effects of excess debris or silt build-up. Water operations staff would be responsible for reporting vandalism or broken equipment. Immediate reporting of observed problems would minimize the loss of flow data.

Data management – After downloading raw data from the field, the data would be organized into a database. The technical staff would also be responsible for checking and verifying data accuracy and reasonableness. The source of data errors would be investigated and corrected. If possible, data gaps caused by equipment malfunction or other factors would be estimated.

3.9 Third-party Review

Third-party review and involvement from a recognized expert in agricultural water measurement and irrigation would continue from the development of this Work Plan into implementation of the Cooperative Study. Involvement of a third-party expert would help build broad-based support of the study among many stakeholders. The outside expert would be involved in approaches to data analysis and study conclusions, but would not be directly involved with field aspects, data analysis, or interviews of the study.

The outside expert would review study data and results of the interviews. The reviewer would provide input on the study results after Year 1 and after Year 2. Upon completion of Year 1, the outside expert would provide suggestions for refining the study in the second year. After the 2-year period of data collection, the outside expert would review and provide input to study conclusions in the final report.

3.10 Study Results Sharing

Cooperative Study data and analysis results would be distributed to Reclamation, participating districts, other BWMP participants, and the Study funding agency in the form of progress reports at the end of both years of the study and a final report. The study results would provide science-based information for the issue of water measurement in the Sacramento Valley.

3.10.1 Year 1 Progress Report

A progress report after Year 1 will have initial study data, preliminary analyses, and study accomplishments. This report will also document any study refinements that may be necessary to carry out the second year of the proposed initial field study. Potential refinements to the study approach, equipment, or sites would be identified. Suggested refinements from the third-party reviewer would be included in the report. All potential refinements would be presented to the Cooperative Study Working Group, which includes the participating districts, Reclamation, and the funding source(s), for their consideration and approval.

3.10.2 Year 2 Progress Report

The second study progress report would contain summaries of data and other information collected during Year 2 of the study.

3.10.3 Final Report

Following Year 2, a final report would be prepared that would summarize the purpose and accomplishments of the study and address the three basic questions described in Section 1.3. The final report would include study data and analysis of the field data, existing delivery data, interviews, and other information collected. This analysis would include comparisons of water use based on current measurement practices, lateral-level measurement, field-level measurement, and the potential for interdistrict and/or sub-basin-level measurement. An evaluation of the equipment used, including the field performance, ease of operation, and durability, would also be included in the final report. This report would also summarize the real costs of measuring agricultural water supply at various operational levels and the associated labor costs of downloading and managing flow data.

An important component of the final report would be an overall evaluation of the study, including whether or not a longer-term study would be a valuable undertaking. Refinements to the study approach or equipment, if necessary, would be noted in the report.

3.11 Study Budget

The Cooperative Study budget is presented in Tables 3-2 and 3-3. The cost budget breakdown is presented by year and major tasks that comprise the Work Plan. The 2-year Cooperative Study is estimated to cost $419,500. Costs associated with cooperation with the Cal Poly ITRC are assumed to be covered under work agreements between Reclamation and the ITRC. If funding opportunities are limited, the field study component could be separated out, and funding could be phased accordingly.

3.11.1 Year 1 Budget

The Cooperative Study budget for Year 1 is presented in Table 3-2.

TABLE 3-2
Cooperative Study Budget Year 1 – Equipment and Labor

Description	Estimated Cost ($)
Study Coordination and Misc. Engineering	25,000
Field Study at NCMWC	
Purchase and Install Equipment for Lateral-level Measurement	20,000
Facility Modifications (pipe extensions, vegetation, or sediment removal)	5,000
Calibrate/Un-install Equipment	5,000
Data Collection	35,000
Data Management and Engineering Analysis	25,000
Conduct Interviews at NCMWC and RD 108	15,000
Collect and Organize Delivery Data at SMWC and RD 1004	25,000
Delivery Data Analysis and Interviews at SMWC and RD 1004	25,000
Third-party Review	5,000
Prepare Year 1 Progress Report	20,000
Total	**$205,000**

3.11.2 Year 2 Budget

The Cooperative Study budget for Year 2 is presented in Table 3-3.

TABLE 3-3
Cooperative Study Budget Year 2 – Equipment and Labor

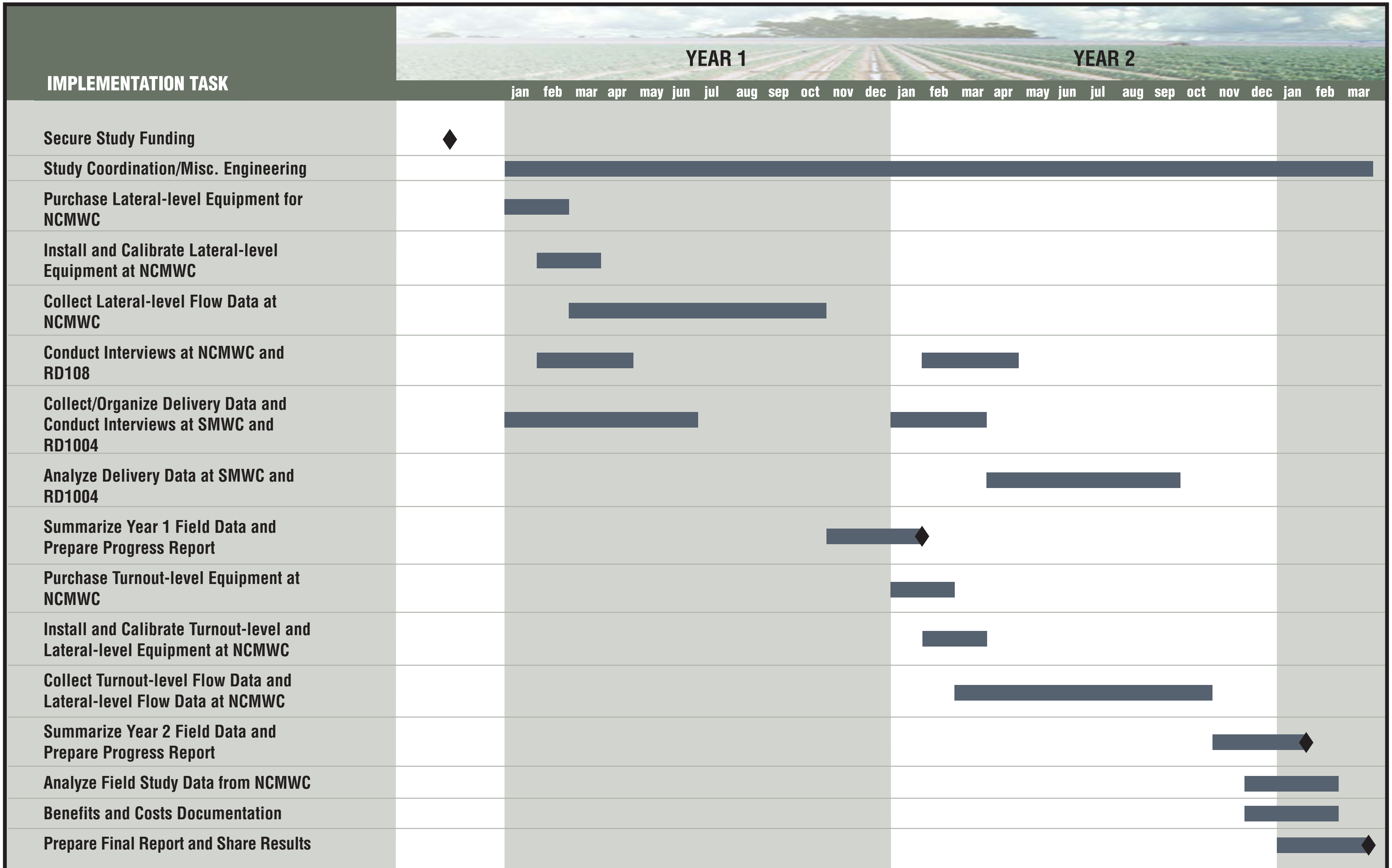
Description	Estimated Cost ($)
Study Coordination and Misc. Engineering	25,000
Field Study at NCMWC	
Purchase and Install Equipment for Turnout-level Measurement	21,500
Facility Modifications (pipe extensions, vegetation, or sediment removal)	5,000
Calibrate/Re-install/Un-install Equipment	10,000
Data Collection	60,000
Data Management and Engineering Analysis	25,000
Conduct Follow-up Interviews at NCMWC, RD 108, SMWC, and RD 1004	10,000
Third-party Review	8,000
Prepare Year 2 Progress Report	15,000
Prepare Final Report	35,000
Total	**$214,500**

3.12 Implementation Schedule

Completion of the Work Plan and distribution to potential funding agencies and funding partners are critical to the implementation of the Cooperative Study. After funding arrangements are in place, the purchase of measurement devices and data collection equipment would be coordinated with NCMWC prior to the irrigation season. After installation and testing of equipment, data would be collected for the entire irrigation season. Interviews and existing delivery data collection would also begin shortly after study funding. A progress report would summarize all data and study activities in Year 1.

A similar operation at NCMWC would commence in Year 2 for installation of equipment and data collection for the turnout-level devices. Follow-up interviews, data analysis, and benefits and costs documentation would occur in Year 2. The Year 2 study data and other information would be presented in the Year 2 progress report. A final report summarizing the entire Cooperation Study would be prepared for sharing among interested entities.

Figure 3-1 shows in more detail the proposed schedule of individual tasks for the 2-year Cooperative Study.



LEGEND

◆ KEY STUDY MILESTONES

FIGURE 3-1
PROPOSED IMPLEMENTATION SCHEDULE
RECLAMATION/BWMP COOPERATIVE WATER MEASUREMENT STUDY
CH2MHILL

W052003002RDD_100 (1/14/04)

Section 4 Recommended Immediate Next Steps

Immediate action is required to implement the Reclamation/BWMP Cooperative Study. In particular, funding opportunities identified during the development of this Work Plan should be aggressively pursued by the BWMP participants and Reclamation.

The following actions should be taken to initiate implementation of the Cooperative Study.

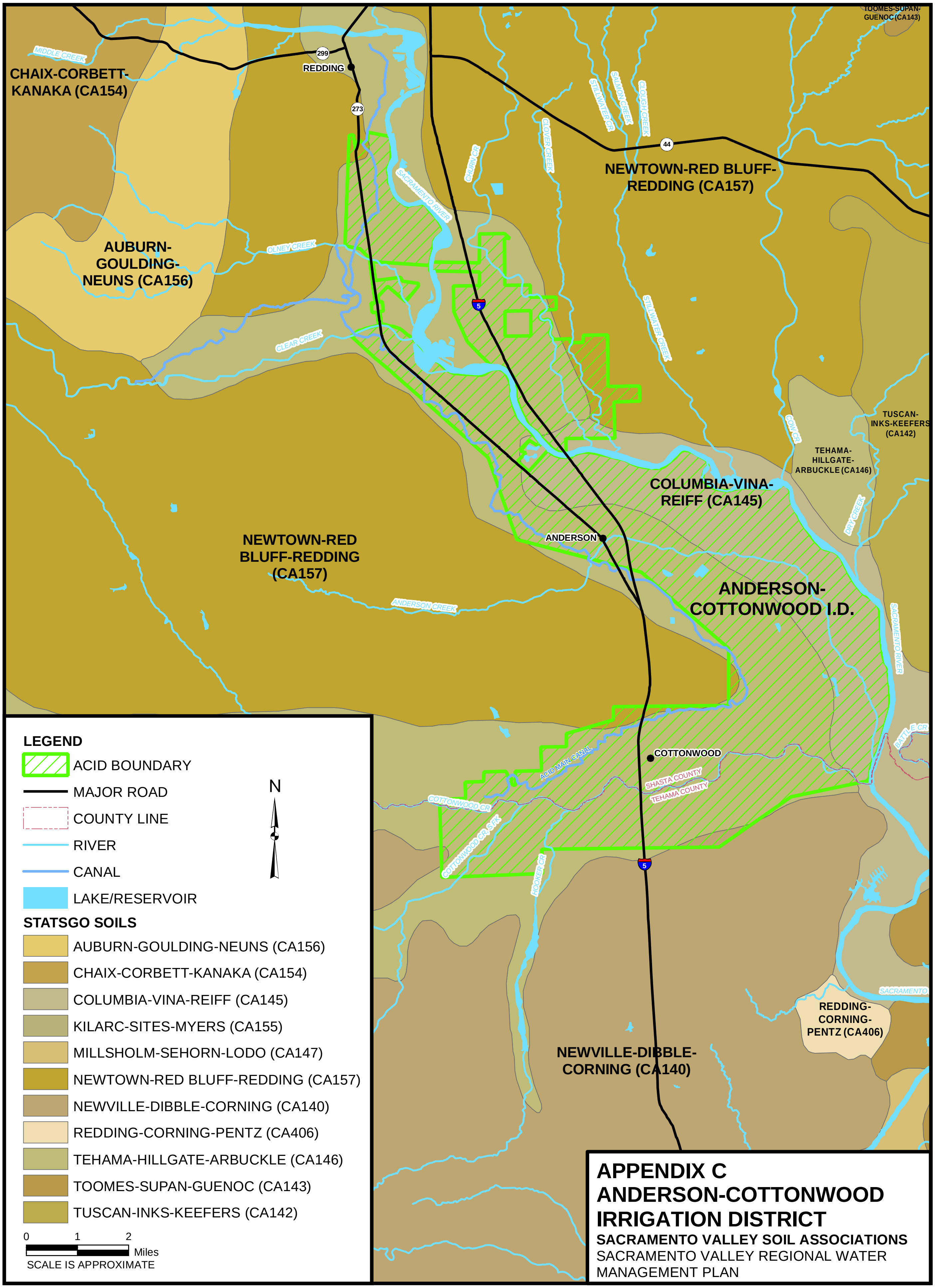
4.1 Continued Coordination

This Work Plan will be distributed among the BWMP participants (SRSCs), to Reclamation, to the CALFED Water Use Efficiency office, and to other relevant agencies that may have funding available for this type of study. Coordination between the SRSCs and Reclamation is expected to continue as part of BWMP activity and the contract renewal process. Coordination and dialogue should continue on the measurement issue as it relates to contract renewals.

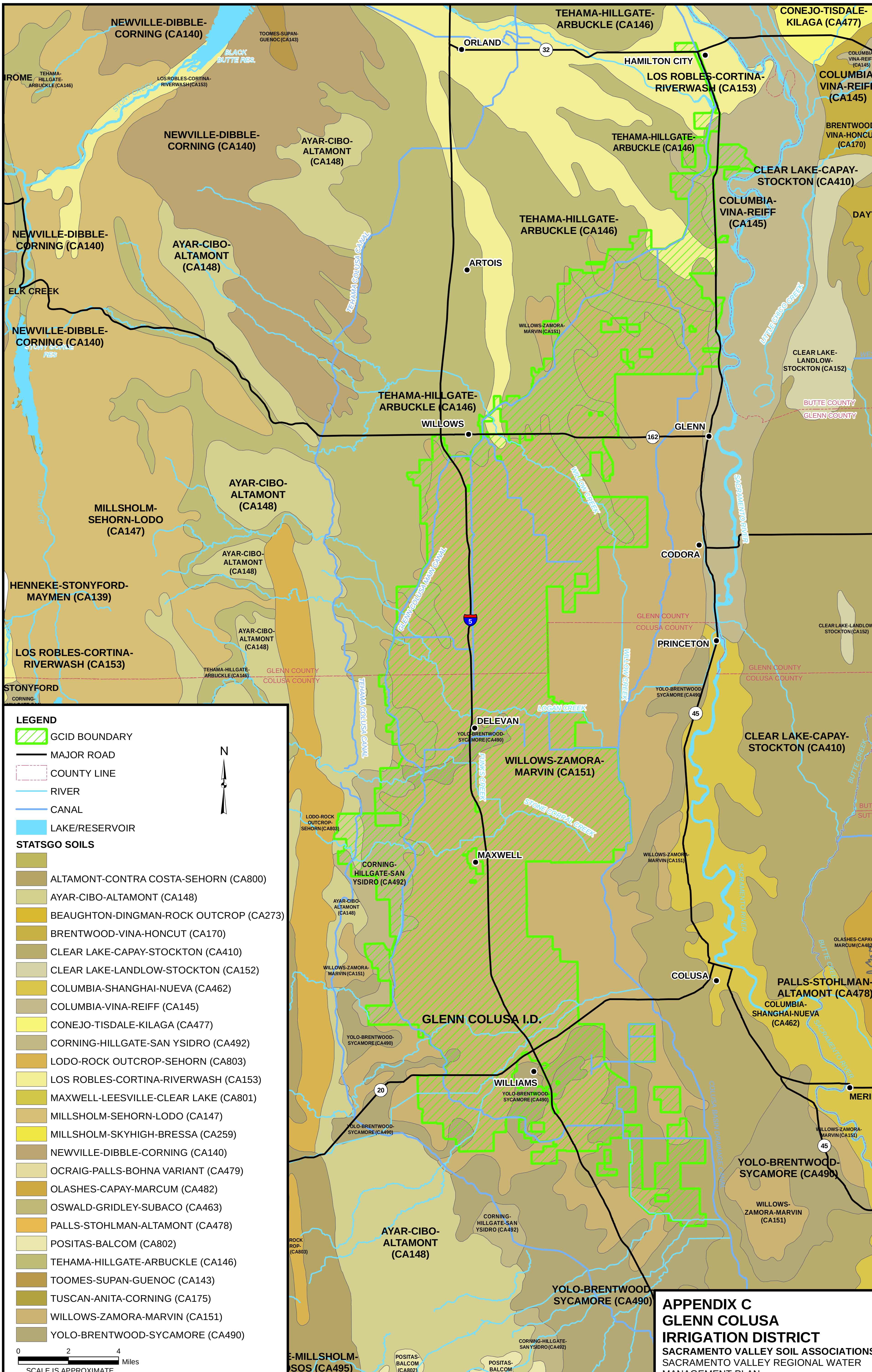
4.2 Obtain Funding

Reclamation may have grant funding available for the Cooperative Study. CALFED has indicated that there may be opportunities in the future to fund the study under the science program that is not a competitive grant proposal process. There may be other funding opportunities under the CALFED Water Use Efficiency grant application process to obtain funding. Under any case, this Work Plan is expected to provide the basis for the funding request.

Appendix C
Sacramento Valley Soil Associations



APPENDIX C
ANDERSON-COTTONWOOD IRRIGATION DISTRICT
SACRAMENTO VALLEY SOIL ASSOCIATIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN



APPENDIX C
GLENN COLUSA IRRIGATION DISTRICT
SACRAMENTO VALLEY SOIL ASSOCIATIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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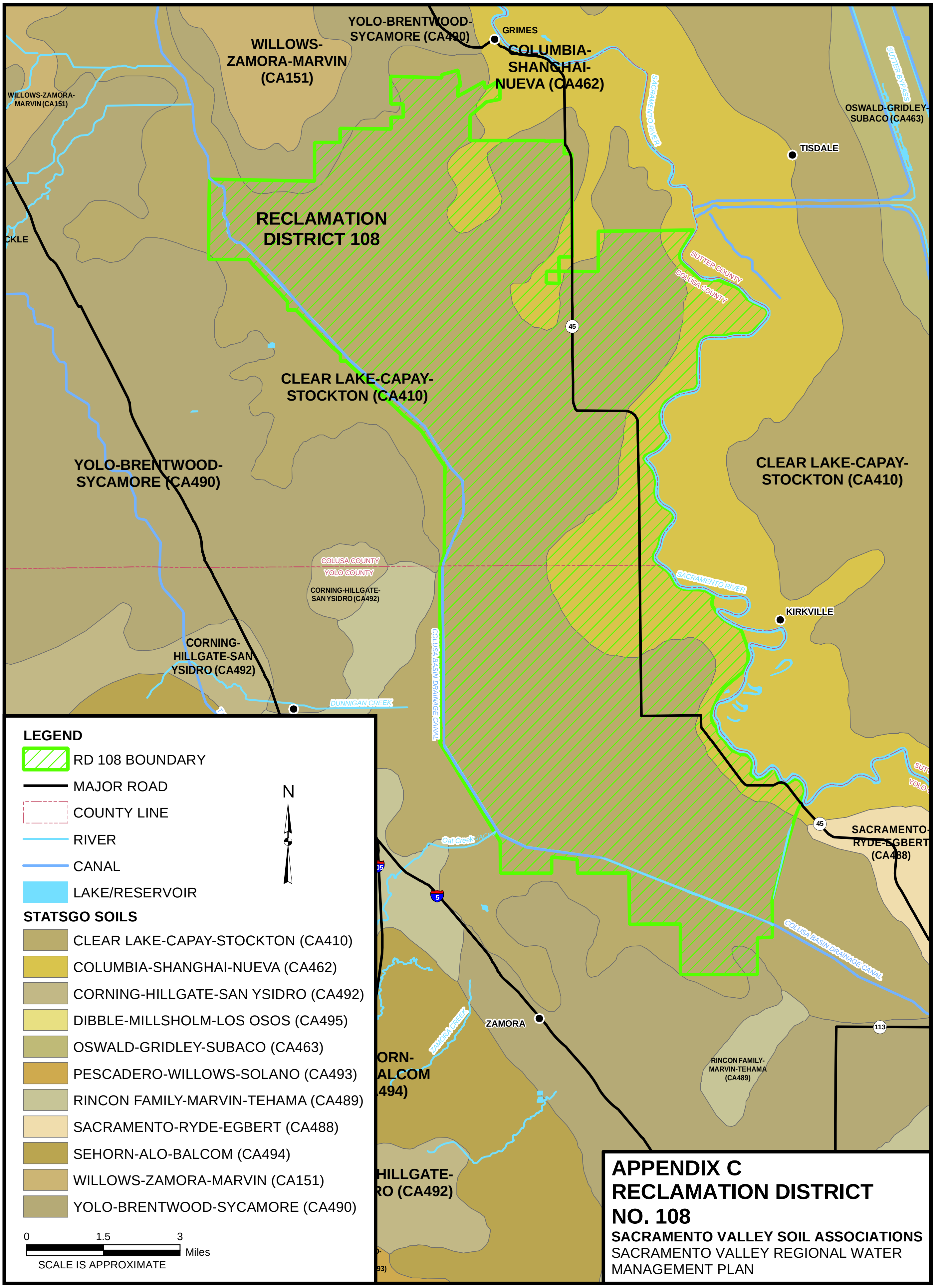
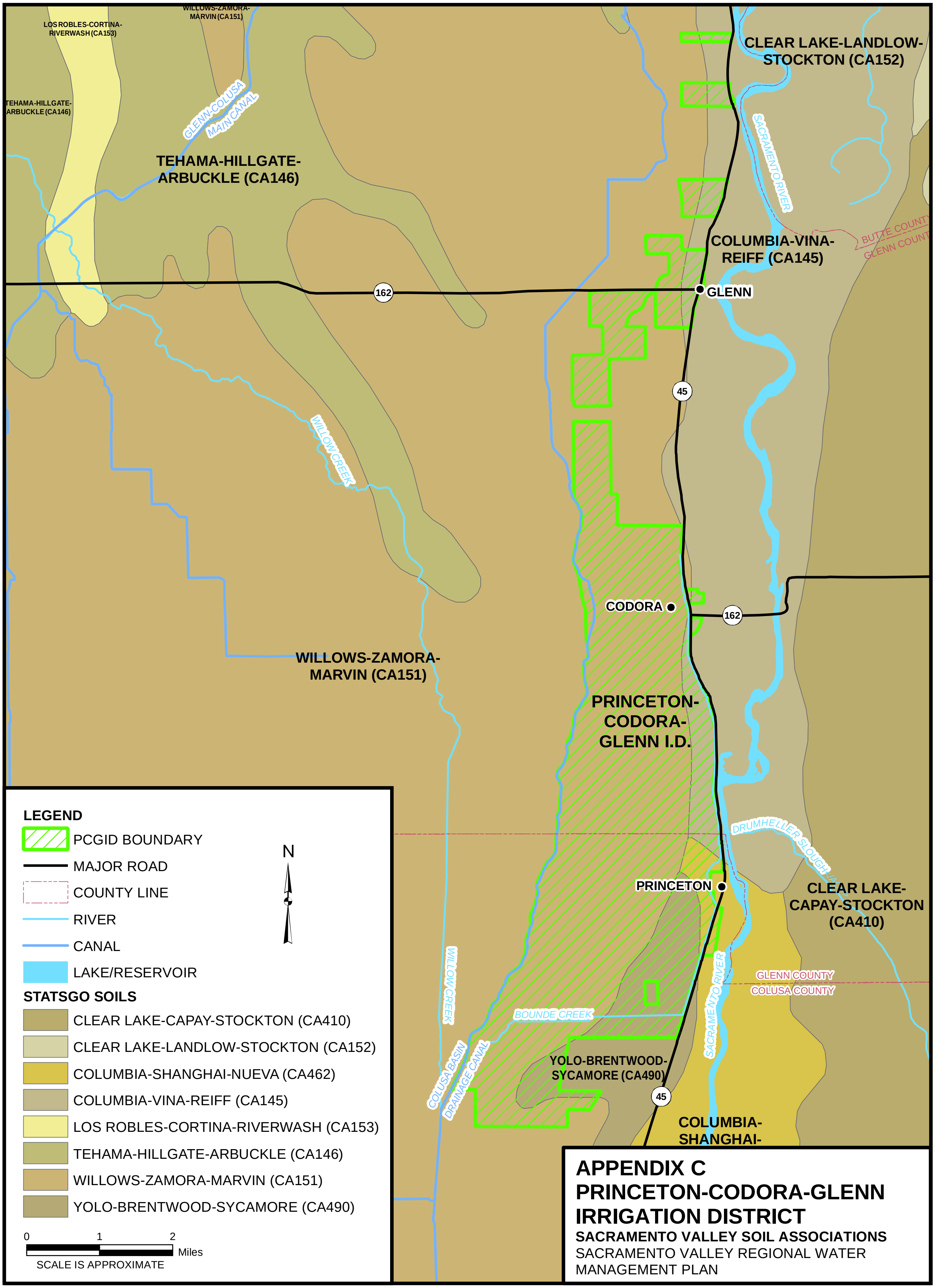


APPENDIX C
RECLAMATION DISTRICT NO. 108

SACRAMENTO VALLEY SOIL ASSOCIATIONS

SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN



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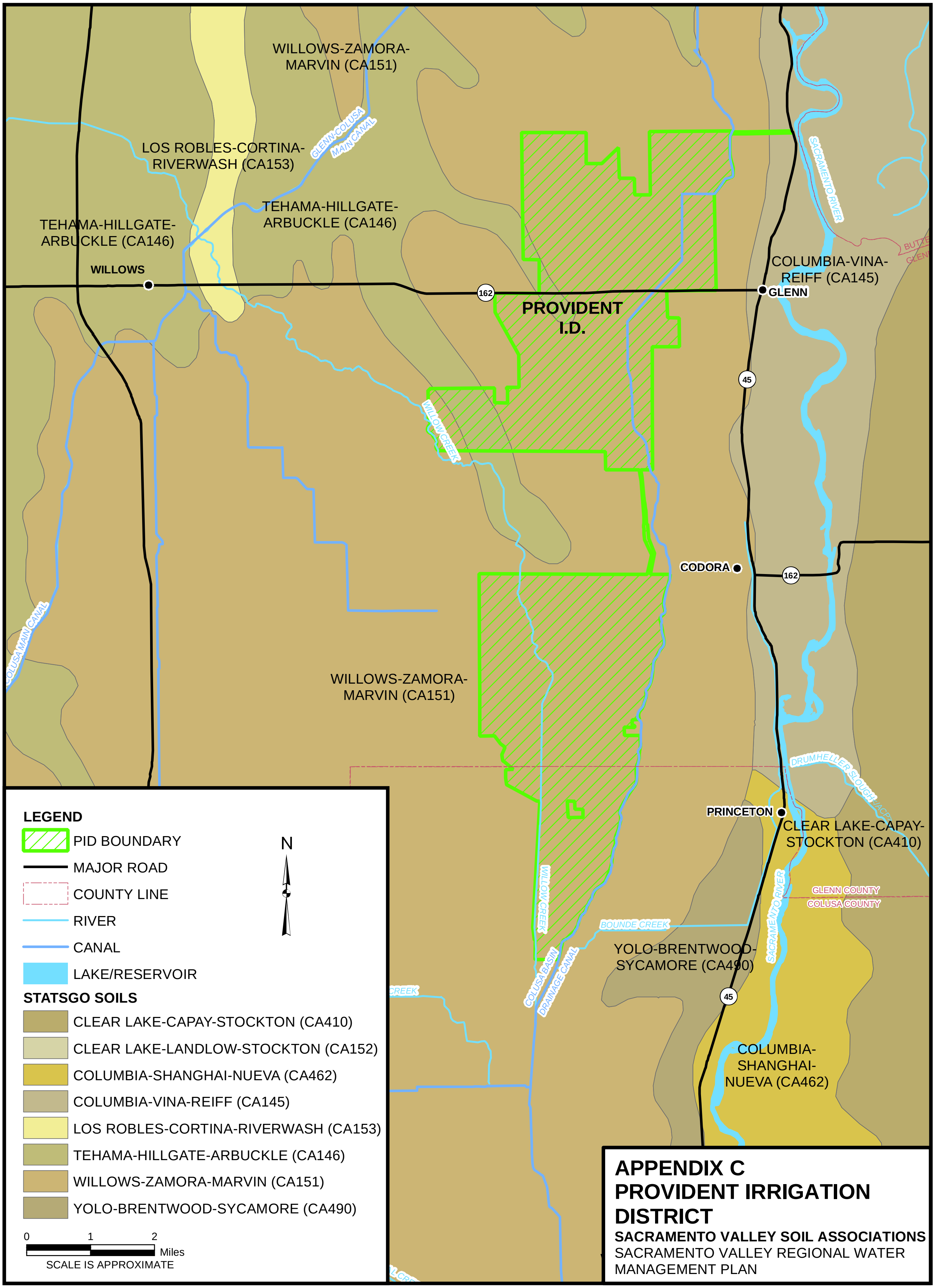

APPENDIX C
PROVIDENT IRRIGATION DISTRICT

SACRAMENTO VALLEY SOIL ASSOCIATIONS

SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

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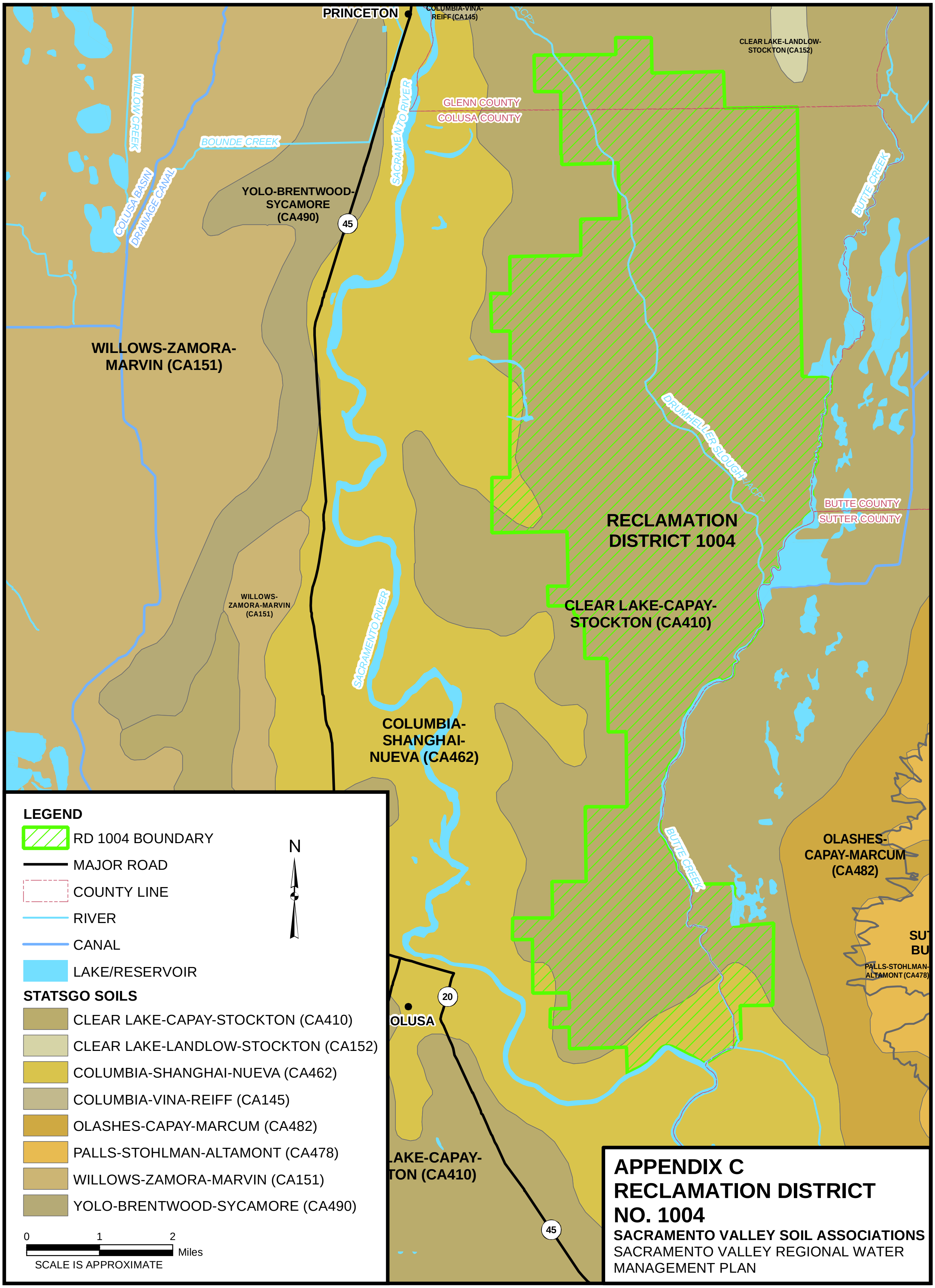
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CLEAR LAKE-LANDLOW-STOCKTON (CA152)
GLENN COUNTY
COLUSA COUNTY
WILLOW CREEK
BOUNDE CREEK
SACRAMENTO RIVER
COLUSA BASIN DRAINAGE CANAL
YOLO-BRENTWOOD-SYCAMORE (CA490)
45
BUTTE CREEK
WILLOWS-ZAMORA-MARVIN (CA151)
DRUMHELLER SLOUGH
BUTTE COUNTY
SUTTER COUNTY
RECLAMATION DISTRICT 1004
WILLOWS-ZAMORA-MARVIN (CA151)
CLEAR LAKE-CAPAY-STOCKTON (CA410)
SACRAMENTO RIVER
COLUMBIA-SHANGHAI-NUEVA (CA462)
OLASHES-CAPAY-MARCUM (CA482)
BUTTE CREEK
PALLS-STOHLMAN-ALTAMONT (CA478)
20
OLUSA
LAKE-CAPAY-TON (CA410)
45
LEGEND
RD 1004 BOUNDARY
MAJOR ROAD
COUNTY LINE
RIVER
CANAL
LAKE/RESERVOIR
STATSGO SOILS
CLEAR LAKE-CAPAY-STOCKTON (CA410)
CLEAR LAKE-LANDLOW-STOCKTON (CA152)
COLUMBIA-SHANGHAI-NUEVA (CA462)
COLUMBIA-VINA-REIFF (CA145)
OLASHES-CAPAY-MARCUM (CA482)
PALLS-STOHLMAN-ALTAMONT (CA478)
WILLOWS-ZAMORA-MARVIN (CA151)
YOLO-BRENTWOOD-SYCAMORE (CA490)
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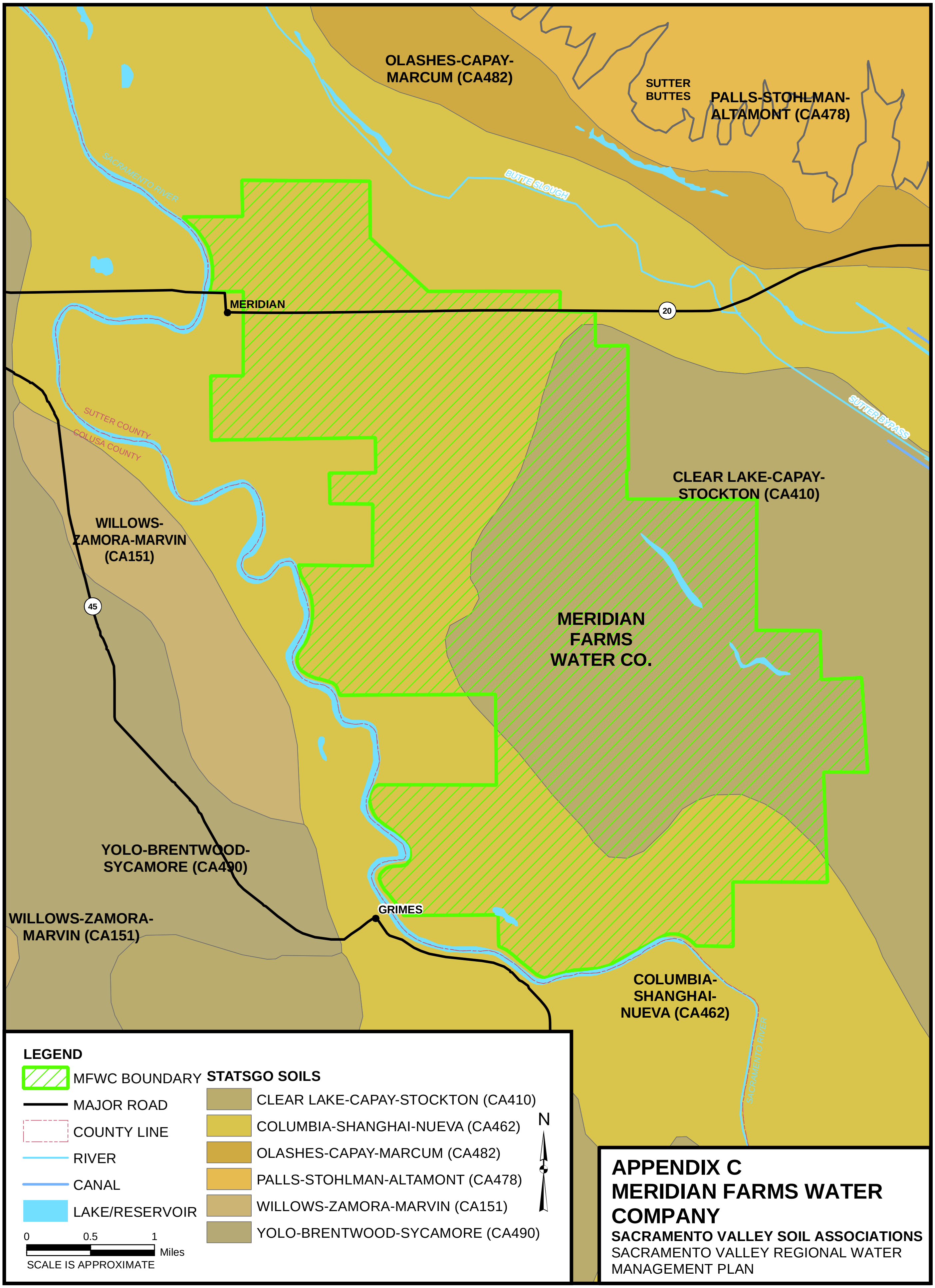
APPENDIX C
RECLAMATION DISTRICT NO. 1004
SACRAMENTO VALLEY SOIL ASSOCIATIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN



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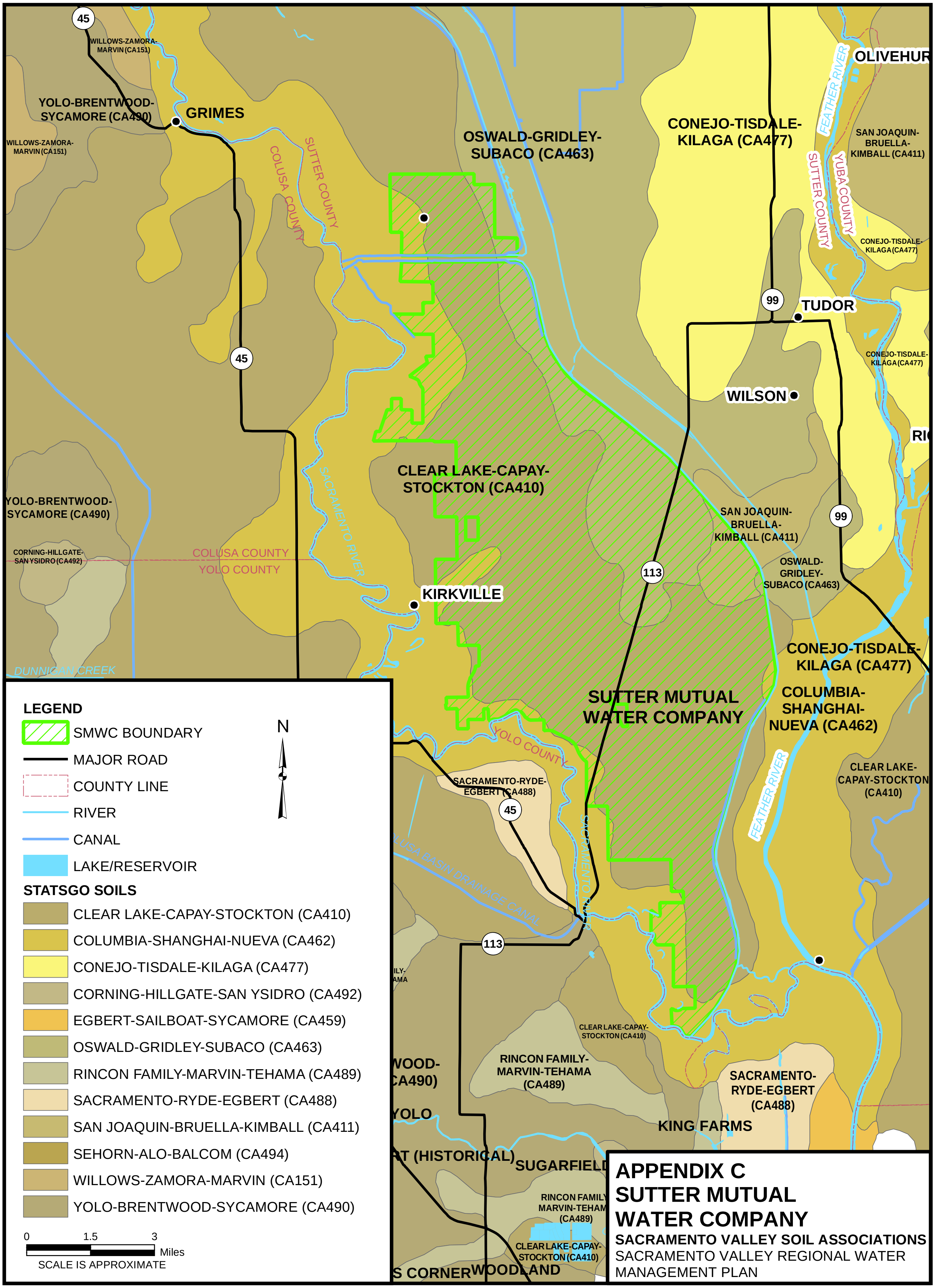

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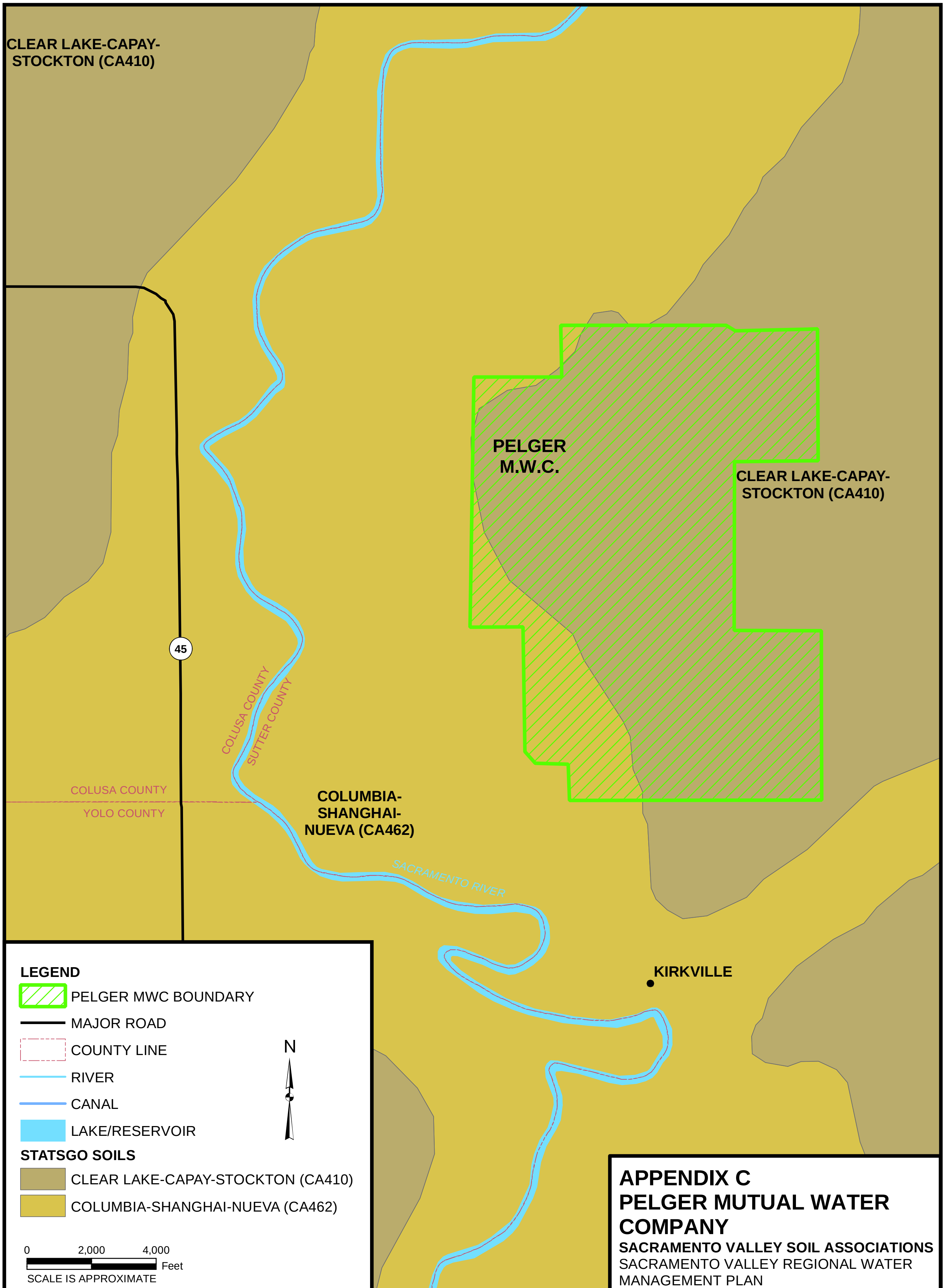
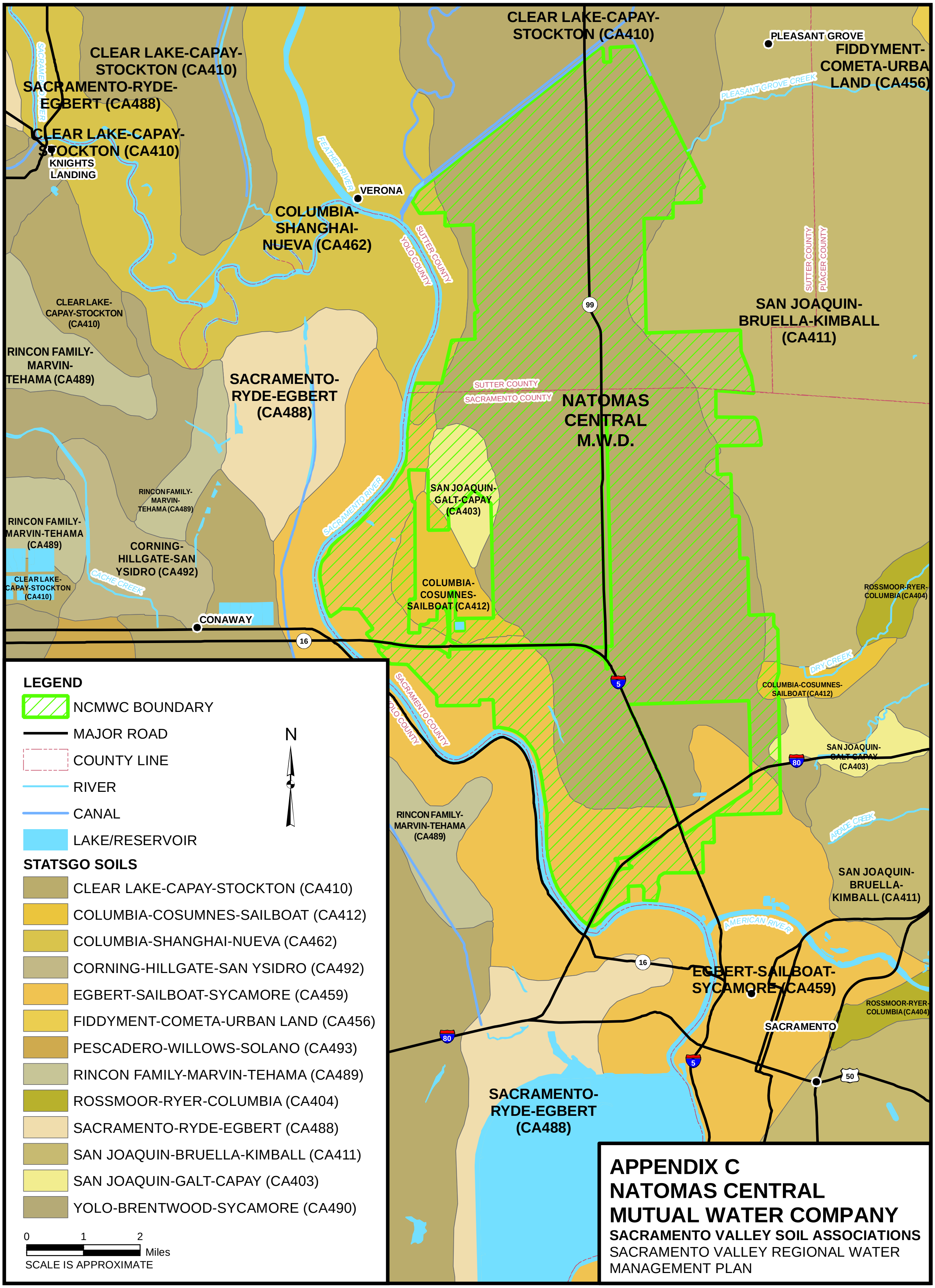


APPENDIX C
PELGER MUTUAL WATER COMPANY

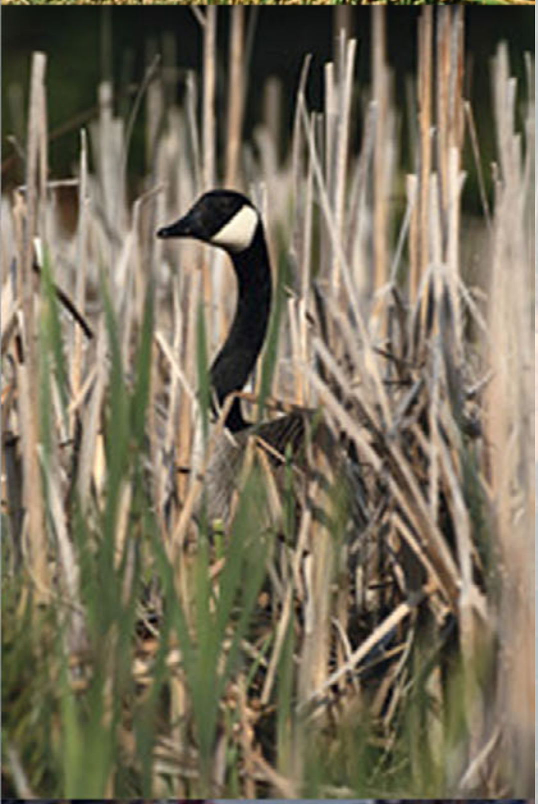
SACRAMENTO VALLEY SOIL ASSOCIATIONS

SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN



APPENDIX C
NATOMAS CENTRAL MUTUAL WATER COMPANY
SACRAMENTO VALLEY SOIL ASSOCIATIONS
SACRAMENTO VALLEY REGIONAL WATER MANAGEMENT PLAN

Appendix D
Sacramento River Basinwide Water Management Plan



FINAL

Sacramento River
B A S I N W I D E

Water Management Plan

Technical Memorandum No. 1
Project Goals and Objectives

Technical Memorandum No. 2
Current and Future Water Requirements

Technical Memorandum No. 3
Water Resources Characterization

Technical Memorandum No. 4
District Water Requirement and CVP Supply/
Sub-basin Water Balances

Technical Memorandum No. 5
Water Management and Supply Options

Technical Memorandum No. 6
Future Water Management Alternatives

Inventory of Existing Facilities

Prepared by

Sacramento River Settlement Contractors
in cooperation with
U.S. Bureau of Reclamation
and with assistance from
California Department of Water Resources

CH2MHILL

in association with

MONTGOMERY WATSON HARZA

MBK ENGINEERS

October 2004

Preface

General Background of the Basinwide Water Management Plan

The Sacramento River Basinwide Water Management Plan (BWMP) was prepared by the Sacramento River Settlement Contractors (SRSC) with assistance and input from the California Department of Water Resources (DWR) and the U.S. Bureau of Reclamation (Reclamation). The BWMP was prepared to meet the requirements of the January 1997 Memorandum of Understanding between the Settlement Contractors and the United States of America for the Preparation of Data in Aid of the Renewal of Settlement Contracts.

Extensive coordination among the SRSCs, Reclamation, DWR, and the consultant team took place throughout preparation of the BWMP. This coordination included monthly meetings to review project status and issues, preparation and review of draft technical memoranda and reports, and follow-up meetings to discuss review comments and other project issues among the project participants.

The BWMP process has been a successful, cooperative effort among the SRSCs, Reclamation, and DWR, as evidenced by the following:

- As an important precursor activity to the contract renewal process, the BWMP process provided for an open dialogue and increased understanding of the water resources issues facing the Sacramento River Basin, particularly the lands served by the SRSCs.
- The BWMP process provided a technical forum for addressing the different methodologies of water resources management and the associated technical issues.
- The BWMP process provided the necessary data and background to allow the ultimately successful completion of the contract renewal process.
- The BWMP process has provided the framework for the subsequent development of the successful Phase 8 negotiations to the Bay-Delta Water Rights Hearings (the Sacramento Valley Water Management Agreement). The foundation of regional cooperation, coupled with the dialogue and understanding that was established among the major project participants, provided an backdrop for the successful development and negotiation of the Phase 8 settlement.

The BWMP process has been a lengthy endeavor (beginning in 1998). However, the project objectives that were established for the BWMP process have been successfully met. This Preamble summarizes the overall development of the BWMP and outlines the anticipated next steps toward the development of a regional water management plan.

Strategy for Completing the Basinwide Water Management Plan

The final drafts of the BWMP and associated technical memoranda were prepared in May 2003.

Subsequent to the final draft of the BWMP, Reclamation submitted a series of additional comments on the documents (dated December 2003). In the interest of completing the BWMP, the SRSCs and Reclamation met to review the approach for incorporating the review comments. On the basis of those discussions, the following strategy was adopted for incorporating the comments:

- Evaluate all of the comments and identify those comments that could be easily incorporated into the final document (editorial comments) or readily incorporated following project team review (review comments). This evaluation identified that the vast majority of the comments could be easily incorporated/addressed within the final BWMP.
- Identify those comments that resulted in a substantial change to the document or had significant policy implications. This evaluation identified that fewer than 10 percent of the comments could not easily be incorporated into the final BWMP.
- Document under separate cover how each of the December 2003 comments were addressed. This was accomplished through a matrix summary that listed all of the comments and provided a response to each comment noting how the comment was handled in the final BWMP. The matrix summary was transmitted separately to Reclamation.
- Prepare this Preface to describe the context of the final BWMP documents and to address any comments that were not explicitly incorporated into the final BWMP documents.

Context of the Final Basinwide Water Management Plan

As stated above, the majority of the comments that were received from Reclamation on the final draft have been incorporated into this final document. The following summarizes the primary policy issues and provides background information.

General Time Frame for Basinwide Water Management Plan

The BWMP's original purpose was to provide documentation for the successful completion of the contract renewal process. In addition, the BWMP was to provide technical background information for the ongoing management of the water resources in the Sacramento Valley on a "basinwide basis."

Therefore, the general time frame for the BWMP was such that it describes activities in preparation for the contract renewal process and overall basinwide management. However, because of the extended period of time required to conclude the BWMP, many of these processes have been completed. For example, the contract renewal process has successfully completed the negotiations stage and is currently in the environmental documentation stage. Accordingly, Reclamation's December 2003 comments expressed a desire to update the entire BWMP document to reflect the contemporary period of 2004.

Given the desire to complete the document and original intent, it was determined that the time frame background for the BWMP would remain as described in the final draft document. The BWMP should be viewed as primarily a "pre-contract renewal document" and interpreted in that light during future reviews. Regardless, a number of revisions were made to update the state of proposed regional management in the Sacramento Valley. In many ways, the development of the BWMP was the catalyst for improving coordination and dialogue among SRSC water districts/companies across the Sacramento Valley toward developing regional and sub-basin water management solutions.

Methodology for Determining District Water Requirements

Technical Memorandum 2 (TM 2) provides extensive details for determining district water requirements on the basis of cropping patterns, crop type, and acreage. These data were obtained directly from DWR in consultation with Reclamation. Early contacts with DWR and Reclamation revealed that using DWR data was preferable because of the consistent approach used by DWR across California in determining land use and water requirements.

During the preparation of the document and subsequent analysis using the DWR data as a basis in all the TMs, it was recognized that this approach in some ways differed from Reclamation's approach to identifying water needs. This issue was the topic of numerous meetings and resulted in agreement that the two approaches would be identified. The similarities and differences in approach between the two methodologies are documented in TM 2. In general, it was confirmed that these two methods generally result in approximately the same water requirement. This fact was reinforced during the contract renewal process wherein full contract amounts were renegotiated for all but two of the SRSCs.

References to Contract Terms in the Renewal Contracts

As noted previously, the final draft BWMP was completed before the completion of the contract renewal process. Therefore, there are references to specific contract terms and items in the final draft BWMP that have subsequently been finalized with the contract renewal process. It was determined that these references would not be updated in the final BWMP because the context of the BWMP is as a "pre-contract renewal document."

One example of this approach is the amount of contract water supply for Sutter Mutual Water Company. After the final draft BWMP was completed, the contract amounts for Sutter Mutual Water Company were revised. These changes are not made to the final BWMP; instead, the actual contract amounts will be defined in the final renewal contract. It is noted that environmental documentation for the contract renewal process is currently ongoing, so, until that process is completed, the final contract amounts will be unknown.

Accounting for Return Flows

The method of accounting for return flows and how they are used and accounted for within the districts, sub-basins, and entire basin was also discussed extensively with the project participants during the technical work of the BWMP. This issue also was key to discussions related to efficiency and conservation, which was also agreed to be an area where the SRSCs and Reclamation had different perspectives. In the December 2003 comments, Reclamation noted that they would account for return flows differently. This policy difference is noted by the SRSCs and is agreed to be an area of continued discussion. Many potential projects and programs have been identified in TMs 5 and 6 of the BWMP and focus on district and sub-basin-level return-flow management.

The resulting policy difference between the SRSCs and Reclamation was not completely resolved within the context of the BWMP. Instead, accounting for this water use is addressed separately in the contract renewal process and will be further reviewed in the development of a regional water management plan.

Natomas Central Mutual Water Company Delivery of Central Valley Project Water for Municipal and Industrial Purposes

On the basis of the contract renewal process results, it was determined that Natomas Central Mutual Water Company has successfully negotiated the authority to use a portion of its water supply for municipal and industrial supply. This is noted. Details of Natomas Central Mutual Water Company's use of water supply for municipal and industrial purposes are documented in the renewal contract.

Extent of SRSC's Participation in the Basinwide Water Management Plan Process

Because of the need for significant coordination and information from the SRSCs to complete the BWMP, the SRSCs that participated in the BWMP process did so at various degrees of involvement.

The majority of the SRSCs participated to the full extent in the BWMP, including those that have Sacramento River Settlement Contracts for the majority of the water supply (i.e., Glenn-Colusa Irrigation District, Anderson-Cottonwood Irrigation District, Reclamation District No. 108, Sutter Mutual Water Company, and Natomas Central Mutual Water Company).

In some instances, however, a few of the smaller SRSCs did not participate to the fullest extent possible in the BWMP process. This is because, in many cases, a district's staff was limited to just the manager and one or two support staff, which made full participation difficult. Rather than eliminate the references to these SRSCs entirely, it was determined to include them to the greatest extent possible. In this way, the final BWMP provides as much background information for the contract renewal process as was available.

The information in the BWMP will also be valuable for future use in the proposed regional water management program. It is anticipated that each SRSC will determine whether they wish to participate in a regional water management program or participate only at a district level. The data available in the BWMP will be used as background for either program, with varying degrees of supplemental information needed by the SRSCs.

Those SRSCs that participated to a limited extent in the BWMP process are as follows:

- River Garden Farms Company
- M&T Chico Ranch
- Tidsdale Irrigation and Drainage Company

Integration of the Basinwide Water Management Plan into a Regional Water Management Program and Other Ongoing Water Conservation Efforts

In addition to using the BWMP data for contract renewal, the BWMP was intended for use as the regional water management plan for the Sacramento River Basin, particularly for the participating SRSCs. A determining factor for whether or not the BWMP could effectively serve as such a plan for the basin has been the definition of "regional criteria" for the regional water management plan. As mentioned above, the BWMP has in many ways been the impetus for increased inter-district discussion and has helped spawn programs such as the Sacramento Valley Water Management Program, the SRSC/Reclamation Cooperative Water Measurement Study, and the Sub-basin-level Water Measurement Study.

The development of the regional criteria has been an ongoing process between the SRSCs and Reclamation. Reclamation has released the proposed criteria for evaluating a regional plan and continues to accept public comments on the proposed approach.

Comparison of the final BWMP with the regional criteria requirements for the regional water management plan shows that some additional data must be prepared (on a district-by-district basis) to meet the requirements of the regional criteria. Key among the issues to be evaluated is the potential for meeting CALFED Quantifiable Objectives at a regional, sub-basin, and/or district level. Therefore, rather than wait for the additional data to be established and incorporated into the BWMP, it was decided that a stand-alone regional water management plan should be prepared. To the extent that the SRSCs complete a regional water management plan (the option remains for an individual SRSC to complete a district-specific plan), a separate, stand-alone document will be developed.

It is anticipated that key sections of the BWMP will be used to provide the majority of the framework for the regional water management plan.

Update of References to Contract Renewal Issues

Because a key aspect of the BWMP process was to provide background information for the subsequent negotiations of renewal contracts for the Sacramento River Settlement Contracts, there are extensive references to timing, contract renewal terms, and other contract issues.

As noted previously, subsequent to the preparation of the final draft BWMP documents, the SRSCs and Reclamation were able to successfully negotiate the terms of the renewal contracts. The information included in the BWMP documents was very important to this process.

However, given the timing of the final comments on the BWMP, it was not practical to update the entire BWMP document to reflect the conclusion of the contract renewal process. Therefore, it was determined that the references to contract renewal would remain contemporary with the production of the final draft BWMP (i.e., before the successful completion of the contract renewal process).

Preface Summary

In summary, the BWMP has met the goals and objectives that were established for this process many years ago. Sufficient background information has been developed on the water resources management issues affecting the Sacramento Valley to help promote the successful completion of the negotiations process for contract renewal of the Sacramento River Settlement Contracts. The framework of cooperation and understanding developed through the BWMP process has assisted in providing the backdrop for ongoing regional water resources solutions consistent with CALFED's regional focus, such as the upcoming regional water management program and the successful Phase 8 settlement negotiations. Joint SRSC/Reclamation and DWR efforts that are focused on identifying appropriate measurement practices, drainwater management, and system improvements will continue to be evaluated and submitted for potential funding (e.g., via the CALFED Water Use Efficiency Program), as well as potential conjunctive water management projects. It is hoped the data and relationships developed in the preparation of the BWMP will continue to foster improved water management across the Sacramento Valley.

Technical Memorandum No. 1

Sacramento River Basinwide Water Management Plan Project Goals and Objectives

CH2MHILL
in association with
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MBK

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Contents

Acronyms and Abbreviations

Accord	Bay-Delta Accord
Agreement	Sacramento Valley Water Management Agreement
BWMP	Basinwide Water Management Plan
Contract Renewal MOU	Memorandum of Understanding Between Named Sacramento River Settlement Contractors and the United States of America for the Preparation of Data in Aid of the Renewal of Settlement Contracts
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DWR	Department of Water Resources
Reclamation	U.S. Bureau of Reclamation
SRSC	Sacramento River Settlement Contractors
SWRCB	State Water Resources Control Board

Project Goals and Objectives

Introduction

Historical Context of Sacramento River Water Resources Management

The Sacramento River is a critical source of water for California, and the increasing needs of a growing state are placing increased demands on the river. Since 1944, the Central Valley Project (CVP) facilities have primarily managed the river flow. The CVP is a system of reservoirs and conveyance facilities that helps to deliver the river's water to users both within and outside the Sacramento River Basin.

The historical water rights of irrigation and water districts and water companies within the Sacramento River Basin are principal in managing the Sacramento River water resources. Prior to the construction of the CVP, water rights holders along the Sacramento River included pre-1914 holders, riparian holders, and holders of post-1914 State Water Resources Control Board (SWRCB) appropriative rights. Construction of Shasta Dam required that California, the U.S. Bureau of Reclamation (Reclamation), and the Sacramento Water User's Committee negotiate the rights to water in the Sacramento River, both its natural summer flows and the additional flows made available by the CVP. These efforts included a series of congressional hearings and cooperative studies, and, in 1964, culminated in the signing of a 40-year negotiated agreement with many of the more than 250 Sacramento River water users (Figure 1).

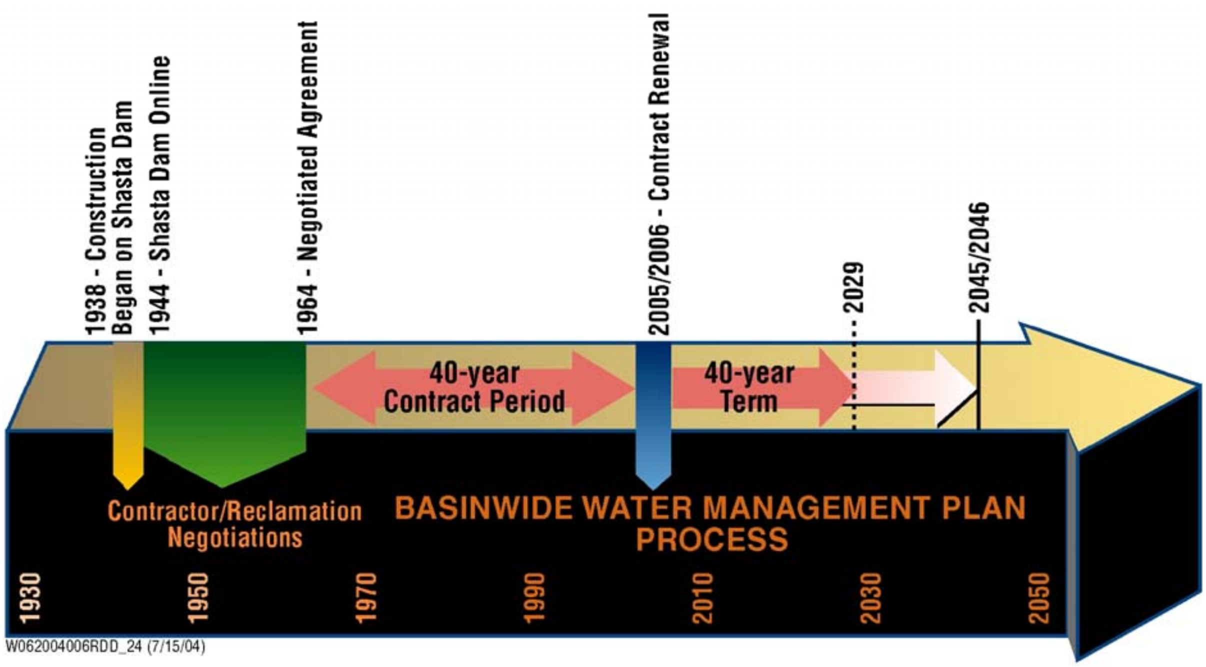

Figure 1
Settlement Contract Historical/Future Perspective

Most of these negotiated agreements (entered into by the Sacramento River Settlement Contractors [SRSC] and also referred to as "Settlement Contracts") are due to be renewed in 2006, given that their 40-year term of contract will expire. Negotiations were initiated in 2002 and were essentially completed in 2003. Renegotiation of these contracts was a significant effort, requiring extensive technical background development and a detailed negotiation process. It is expected that the renewal contracts will be executed in 2005.

In 1992, U.S. President George H. Bush signed into law the Central Valley Project Improvement Act (CVPIA). Among its many provisions was the requirement for an additional water charge designed to encourage early renewal of Project Water contracts (CVPIA Section 3404(c)(3)). This provision required existing contractors with Project Water contracts to pay an additional mitigation and restoration payment of one and one-half times the annual mitigation and restoration payment calculated under subsection 3407(c) of CVPIA for water sold and delivered by the CVP. In 1996, eight of the larger SRSCs commenced litigation against the United States and others for the purpose of establishing that Section 3404(c)(3) of the CVPIA did not apply to Sacramento River Settlement Contracts. Litigation reached settlement in January 1997, through a Stipulated Agreement wherein the federal defendants agreed that Section 3404(c)(3) of the CVPIA did not apply to the Settlement Contracts between the plaintiffs and Reclamation.

As part of that settlement, the SRSCs and Reclamation entered into a "Memorandum of Understanding between Named Sacramento River Settlement Contractors and the United States of America for the Preparation of Data in Aid of the Renewal of Settlement Contracts" (Contract Renewal MOU). The Contract Renewal MOU identified the following four major types of data or documents that were to be prepared as an aid in contract renewal negotiations:

- Update and extension of the 1956 Cooperative Study
- A Basinwide Water Management Plan (BWMP) for the Sacramento River
- Contracting principles
- Discussions of obligations, if any, of the SRSCs to meet water quality, endangered species, and other environmental needs, including the needs of the San Francisco Bay/Sacramento-San Joaquin Delta, and alternative means, if any, by which those obligations can be met

The basic objective of the BWMP is to provide the SRSCs with a comprehensive basis upon which to manage water resources to meet their existing and future water needs in a manner that can also serve other water needs in the Sacramento Valley, including but not limited to needs for the use of water for the environment. The basic objective can be more specifically defined as follows:

- Maintaining a permanent, reliable, adequate, and economical water supply to meet the existing and future needs of the SRSCs, including long-term soil salinity control and nonpoint discharge requirements.
- Identifying the opportunities to enhance the water supplies for wildlife refuges and other uses of water for the environment.

- Incorporating other water management considerations in the Sacramento River Basin, such as other water quality goals, agricultural economics, flood control, power operations, and recreation, to ensure a comprehensive and successful approach to meet the basic objectives of the BWMP.
- Allowing for the potential use with the updated and extended 1956 Cooperative Study and other existing, past, or ongoing studies to provide a common set of data on which negotiations for renewal of water Settlement Contracts could be based. Although Reclamation requested that the 1956 Cooperative Study be incorporated, it was not used in development of the BWMP.

In the Contract Renewal MOU, the parties agreed the BWMP would include the following:

1. Water conservation plans required under the Reclamation Reform Act and consistent with applicable California law will be addressed in the regional water management plan that is to be developed in cooperation with Reclamation in 2004/2005 on the basis of the information developed in this BWMP.
2. An evaluation of water delivery and use within the Sacramento Valley is presented in Technical Memoranda 2, 3, and 4.
3. A water balance for the Sacramento River watershed, including the identification of opportunities to meet full wildlife refuge water supply needs within the Sacramento Valley is presented in Technical Memorandum 4.
4. Best management practices and opportunities for conjunctive use of surface water and groundwater resources consistent with protecting safe yield of both resources and applicable law are presented in Technical Memoranda 5 and 6.
5. Opportunities for using incentives to improve water management, such as approaches to improving water measurement and for incentive pricing structures, are presented in Technical Memoranda 5 and 6.
6. Opportunities for environmental enhancement through modification in water management, such as decreasing diversion of surface water and altering the timing of diversions and releases to coincide with fishery needs are presented in Technical Memoranda 5 and 6.
7. An analysis of the use of water transfers to improve the water supplies of other water users within the Sacramento Valley is presented in Technical Memorandum 6.

Geographic Extent of the BWMP

The geographic scope of the BWMP is generally the portion of the Sacramento River Basin from Shasta Dam to the Sacramento metropolitan area. Figure 2 depicts the study area, which includes five hydrologic sub-basins and the participating SRSCs' service area boundaries. The American River is included in the BWMP only to the extent of its contribution as a major tributary to the Sacramento River at the downstream terminus of the Sacramento Basin. Ongoing water resources planning activities on the American River are included in the BWMP to the extent that they provide additional opportunities to optimize overall water resources management activities in the Sacramento Basin.

Similarly, the Feather River and its major tributaries are included in the BWMP only to the extent of their contribution as major tributaries to the Sacramento River. Requirements and water management considerations within the Feather River Basin are not directly addressed in the BWMP.

Participating SRSCs

Participants and/or sponsors that were signatories to the Contract Renewal MOU are as follows:

- Anderson-Cottonwood Irrigation District
- Glenn-Colusa Irrigation District
- Provident Irrigation District
- Princeton-Codora-Glenn Irrigation District
- Maxwell Irrigation District
- Reclamation District No. 108
- Reclamation District No. 1004
- Meridian Farms Water Company
- Sutter Mutual Water Company
- Pelger Mutual Water Company
- Natomas Central Mutual Water Company

The participating agency in the BWMP and signatory to the Contract Renewal MOU was Reclamation. The California Department of Water Resources (DWR), an assisting agency in the BWMP, provided information that was used in the preparation of this document.

Figure 3 identifies the total supply (meaning the sum of the Base Supply and Project Water) under the Settlement Contract with each of the participating SRSCs. These SRSCs account for over 85 percent of the total 2.2 million acre-feet of total supply in the Sacramento Valley currently under Settlement Contracts with Reclamation.

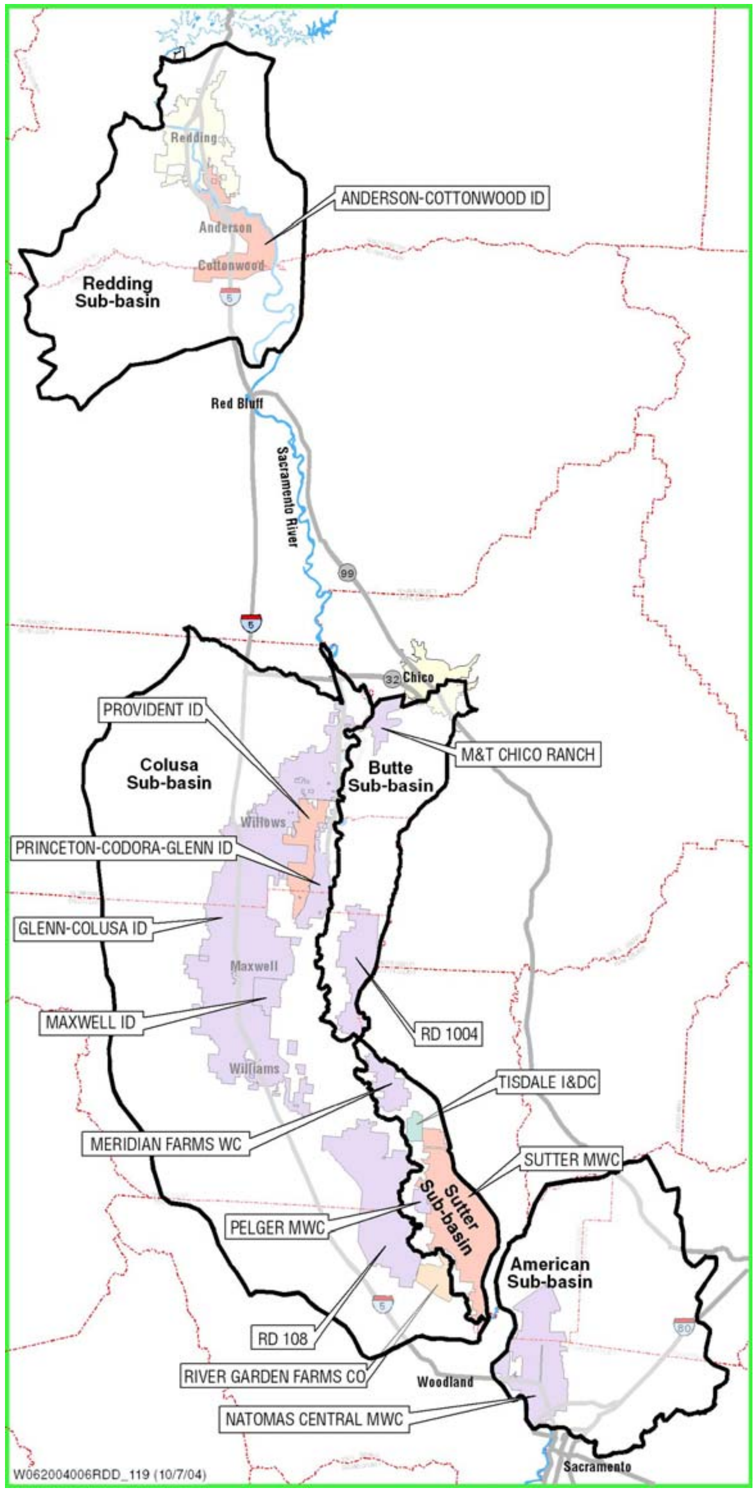

Figure 2
Participating SRSCs and Their Sub-basins

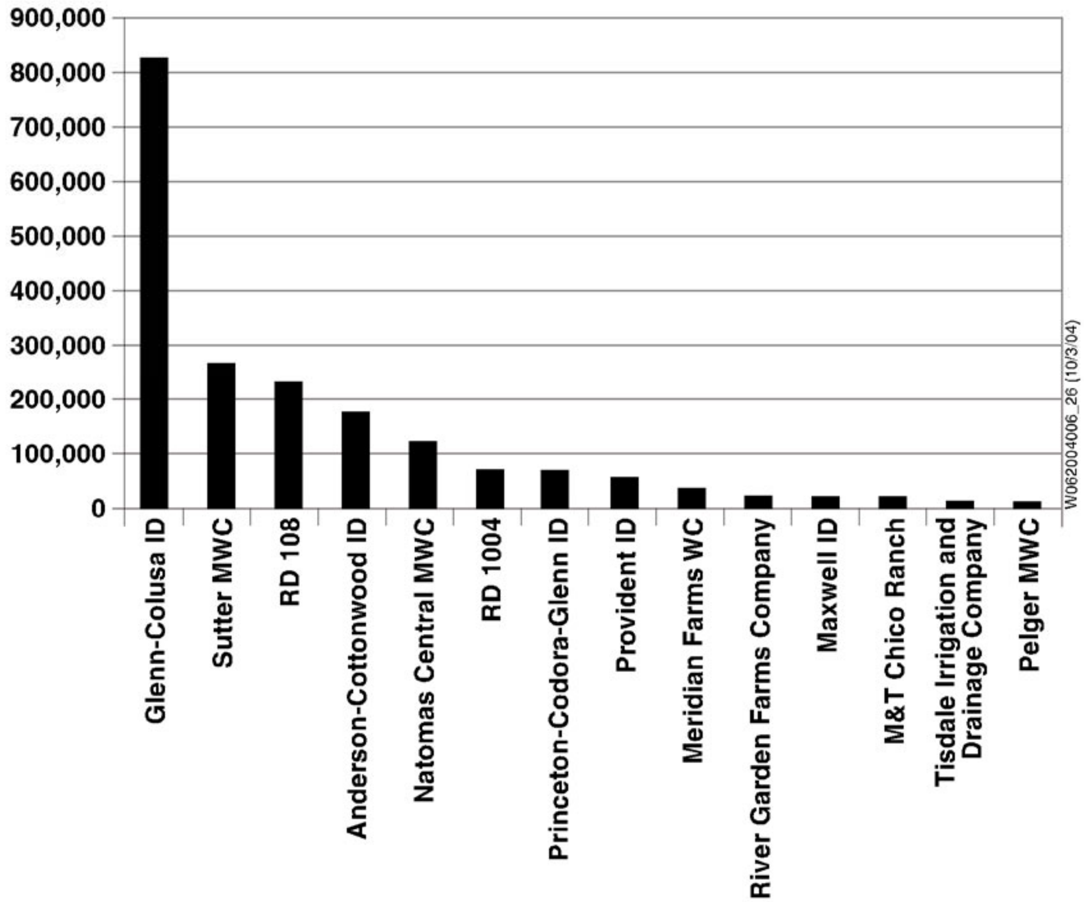

Figure 3
Total Water Supply for Each of the Participating SRSCs

Project Goals and Objectives

A series of team workshops and discussions were held with the project participants (SRSCs, Reclamation, and DWR staff) at the beginning of the BWMP process to define the specific project goals and objectives for the effort. The results of these workshops are described in the sections that follow.

Mission Statement for the BWMP

A mission statement was developed for the BWMP to guide and frame the plan and its associated goals and objectives. Following numerous discussions between the project participants, the following statement was adopted for the BWMP:

> *Develop and implement, through a collaborative inter-district approach, an integrated water management plan which provides a sustainable water supply for the preservation of the Basin's agricultural, industrial, and municipal economy while seeking to maximize environmental opportunities.*

The mission statement recognizes the primary desired outcome that the BWMP lay the groundwork for a sustainable management approach for all of the water users in the Valley (agricultural, urban, and environmental). In addition, the requirement for a collaborative solution was highlighted in the mission statement. This collaboration was achieved through the extensive meeting and review process employed for the BWMP.

Goals and Objectives

The following four primary goals and objectives were defined for the BWMP:

- Meet Valleywide water supply demands (including environmental needs) in a sustainable manner.
- Achieve mutual benefits with Reclamation.
- Evaluate opportunities to improve water management through coordinated actions.
- Develop a mutual data set for contract renewal.

Meet Valleywide Water Supply Demands in a Sustainable Manner

Given the ongoing challenges for water resources management in the Valley, developing sustainable supplies for all users was a key objective of the BWMP. Sustainability is achieved through working in a collaborative process to address issues and develop solutions.

Achieve Mutual Benefits with Reclamation

A unique relationship exists between the SRSCs and Reclamation. This relationship is based on decades of working together in the Valley. Because of this relationship, the SRSCs and Reclamation recognized that there were significant opportunities to realize mutual benefits as part of the BWMP process.

Evaluate Opportunities to Improve Water Management through Coordinated Actions

With the ever-increasing demands on the water resources of the Sacramento Valley, the need for improved water management through coordinated actions has become increasingly evident. Water resources solutions for conjunctive water management, water quality management, transfers, and a multitude of other areas are enhanced through coordinated actions. These actions include helping to maximize environmental benefits through meeting refuge demands, improving habitat, and improving water quality through coordinated efforts, including changes in timing of water use and/or diversions as mutually agreeable and beneficial.

Develop a Mutual Data Set for Contract Renewal

Renewal of the Settlement Contracts is a major effort for both the SRSCs and Reclamation. The requirements for technical background information as part of the contract renewal effort was clearly documented early in the BWMP process. Through the collaborative BWMP process, this information was developed such that the renewal discussions have proceeded in a positive manner toward completion, as discussed below.

Relationship of BWMP to Ongoing Management Efforts

Settlement Contract Renewal

The preparation of the BWMP has been a keystone document for the renewal negotiations of the Sacramento River Settlement Contracts. The negotiations have occurred throughout 2002 and well into 2003. The negotiations have resulted in an agreed-upon baseline contract for each SRSC. Contractor-specific negotiations have been ongoing with various degrees of completion among the SRSCs (as of spring 2003).

Information from the BWMP has been used to develop the technical basis for the contract renewal process. It will also provide background technical information for the environmental documentation associated with contract renewal.

Phase 8 Bay-Delta Water Rights Hearings

Competing agricultural, environmental, and urban uses have created serious water management challenges within the Sacramento Valley. Current forecasts predict continuing statewide water shortages in both average and drought years. Water managers are striving to ensure that the water supply is both of adequate quantity and quality for their many uses.

For nearly 40 years, California has struggled to develop the appropriate water quality standards for the Bay-Delta and to determine which water sources are required to meet those standards. This struggle has involved years of contention and litigation and has been elevated to the U.S. Supreme Court.

A major breakthrough occurred in late 1994 with the so-called Bay-Delta Accord (Accord). The Accord set water quality standards and required SWRCB to determine which water users would be responsible to meet those standards. In 1995, SWRCB adopted the Water Quality Control Plan as a tool to implement the Accord. DWR and Reclamation have been voluntarily meeting the Water Quality Control Plan water quality requirements on an interim basis. Meanwhile, the SWRCB held water rights proceedings to determine final responsibility for meeting the standards.

Phases 1 through 7 of the water rights proceedings involved the San Joaquin Valley and other Delta issues. After completion of these phases, the contentious Sacramento Valley issues (Phase 8) loomed over the state's water users.

In Phase 8, the DWR and Reclamation were expected to suggest that certain water rights holders in the Valley must cease diversions or release water from storage to help meet Delta water quality standards. Sacramento Valley water users believe their use has not contributed to water quality problems in the Delta; and as senior water rights holders and water users within the watershed and counties of origin, they contend they are not responsible for meeting these standards. Proceeding with Phase 8 was anticipated to involve litigation and judicial review for nearly 10 years. This extended process would have resulted in adverse impacts to the environment and undermined the progress of other statewide water management initiatives.

Using the principles of collaboration and watershed management developed in the BWMP, the Sacramento Valley water users, DWR, Reclamation, and export water users developed the Sacramento Valley Water Management Agreement (Agreement). This Agreement established a framework to meet water supply, water quality, and environmental needs in the areas of origin and throughout California. On January 31, 2003, SWRCB officially dismissed the Phase 8 proceedings and allowed implementation of the Agreement. The terms of the Agreement include the implementation of numerous conjunctive water management and district system improvement projects across the Sacramento Valley. The SRSCs participating in the BWMP proposed many of these projects. The projects are an outgrowth of the technical and water management investigations conducted as part of the preparation of the BWMP.

Technical Memorandum No. 2

Sacramento River Basinwide Water Management Plan Current and Future Water Requirements

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Acronyms and Abbreviations

ac-ft	acre-feet
ac-ft/yr	acre-feet per year
ACID	Anderson-Cottonwood Irrigation District
BWMP	Basinwide Water Management Plan
cfs	cubic feet per second
DWR	California Department of Water Resources
ET	evapotranspiration
ETAW	evapotranspiration of applied water
GCID	Glenn-Colusa Irrigation District
M&I	municipal and industrial
MFWC	Meridian Farms Water Company
MID	Maxwell Irrigation District
NCMWC	Natomas Central Mutual Water Company
NRCS	Natural Resources Conservation Service
PCGID	Princeton-Codora-Glenn Irrigation District
PID	Provident Irrigation District
PMWC	Pelger Mutual Water Company
RD 108	Reclamation District No. 108
RD 1004	Reclamation District No. 1004
RD 1500	Reclamation District No. 1500
Reclamation	U.S. Bureau of Reclamation
SMWC	Sutter Mutual Water Company
TDR	total district water requirement
TM	Technical Memorandum

Current and Future Water Requirements

Background

Technical Memorandum (TM) No. 2 is the second in a series of memoranda addressing demands, supplies, and needs associated with the Sacramento River Settlement Contractors participating in the Basinwide Water Management Plan (BWMP).

TM 2 identifies current and future water requirements for each of the districts. Appendix C contains district-specific land and water use tables developed and provided by DWR, which were used as the basis for all current and projected land and water requirements for each district in normal and dry conditions. Potential future cropping patterns were also discussed directly with each of the district managers, and projections made were based on their opinion as to the range of potential future changes. A summary of DWR's estimation approach is also provided and is based on direct input from DWR's Northern District staff and Bulletin 160-98. Current requirements were developed through data and assistance provided by the California Department of Water Resources (DWR-Northern and Central Districts), U.S. Bureau of Reclamation (Reclamation), water districts and companies, and relevant published data. Future practices, water requirements, and projections are described in the context of the uncertainty associated with a particular action.

In general, the actions of the districts will continue to be driven by economics and by decisions made by individual growers within their respective districts. Some districts will also continue to be affected by the actions of other adjacent districts, particularly those that use drainage or tailwater (water that is allowed to run off a field and is available for use) from an adjacent district as part of their typical operations. Individual district operations will also continue to be influenced by Reclamation's operation of the Central Valley Project; regulatory requirements administered by agencies such as the National Oceanic and Atmospheric Administration Fisheries (formerly known as National Marine Fisheries Service), U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers; and decisions issued by the California State Water Resources Control Board. Sources of supply are further discussed in TM 3.

TM 2 focuses on district water requirements given assumed cropping patterns and acreage. Therefore, individual district operations are summarized recognizing that operations are inherently variable given annual changes in weather conditions and hydrology. TM 3 discusses how each district uses available supplies, including Base and Project supplies, drainage, and groundwater. It is important to note that TM 2 focuses on water requirements, independent of where such water is obtained (TM 3 addresses sources of supply).

Water requirements are identified in the context of the following three key sectors:

- Agricultural
- Municipal and industrial (M&I)
- Environmental

Water requirements for each of these sectors are generally derived from associated land use. For example, the requirement for water within the agricultural sector is a function of the amount of water that is required to grow a particular crop given the total acreage of such a crop. The same is true of the other sectors; the water required to meet M&I and environmental demands is a function of the water needs for a particular use (i.e., a home or a 20-acre wetland area). Current and future M&I water requirements are identified within the context of the DWR Detailed Analysis Unit within which a particular district is located. Flood control issues are also discussed by district where such issues are a key component of the overall operational strategy.

District Water Requirements

TM 2 discusses and identifies water requirements for the following participating Sacramento River Settlement Contractor irrigation/reclamation/water districts/companies (districts) and/or sponsors that have entered into a negotiated agreement with Reclamation:

- Anderson-Cottonwood Irrigation District (ACID)
- Glenn-Colusa Irrigation District (GCID)
- Provident Irrigation District (PID)
- Princeton-Codora-Glenn Irrigation District (PCGID)
- Maxwell Irrigation District (MID)
- Reclamation District No. 108 (RD 108)
- Reclamation District No. 1004 (RD 1004)
- Sutter Mutual Water Company (SMWC)
- Meridian Farms Water Company (MFWC)
- Pelger Mutual Water Company (PMWC)
- Natomas Central Mutual Water Company (NCMWC)

Three additional Sacramento River Settlement Contractors (M&T Chico Ranch, Tisdale Irrigation and Drainage Company, and River Garden Farms Company) have also subsequently elected to participate in the BWMP. Specific water requirements and operations for these districts are not included in this TM.

The majority of the districts, other than the most northerly (ACID) and southerly (NCMWC) are generally rural and are surrounded by agricultural uses. Urban development has become an increasingly important factor for ACID as Redding continues to encroach upon ACID from the north and for NCMWC as Sacramento grows toward NCMWC from the south. Rice is the predominant crop for most of the districts given the clay soils that are prevalent within many of the districts, and many of the growers within such districts have acquired equipment and expertise specific to rice. Other key crops include processing tomatoes, vineseed, corn, orchard crops where suitable soils are present, pasture, and alfalfa.

A summary graphic is included within each of the district-specific discussions that provides the following information:

- On-field Water Requirements (DWR 1995 estimates)
  - Irrigated acreage by crop
  - Annual applied on-field water requirement by crop (normal and drought)
  - Monthly-applied on-field water requirement
- District-applied Water Requirements

Current Land Use and Water Requirements

On-field Water Requirements

Annual land use and on-field water requirement data by district were obtained through DWR and verified with district staff. On-field use refers to water use "at the turnout," which is the point where an individual grower takes water from a given district canal or lateral and applies it to his or her field. These on-field data incorporate cultural practice requirements (quantity of water required to grow a particular crop above the specific needs of the plant, i.e., water needed to leach soluble salts below the crop root zone, allow for germination, or for frost protection or cooling) on an annual basis for the development of the total on-field water requirement.

Current crop acreage estimates and associated applied on-field water requirements are presented for each district in the context of a range around a projected normalized (condition developed by DWR, which assumed a 1995 cropping pattern that would have occurred absent the effects of 1987 to 1992 drought) year. These data were obtained from DWR in a tabular form, and included the following:

- Total irrigated acreage for each district by crop
- Evapotranspiration of applied water (ETAW): the portion (acre-feet [ac-ft] per acre) of the total evapotranspiration [ET] that is provided by irrigation; thus, ETAW = actual ET minus the ET met by precipitation [effective precipitation])
- Unit-applied water (ac-ft per acre): the quantity of water delivered to the farm headgate needed to meet the ETAW, accounting for such application factors as evaporation, leaching requirement, deep percolation, and other cultural practices; thus, unit-applied water = ETAW divided by on-farm efficiency
- Total on-field applied water requirements

Figure 1 provides an example of the data obtained for on-field land and water use for each district and defines key terms used in the tables.

Appendix C includes the specific data obtained from DWR for each district, including total on-field crop acreage, unit-applied water requirements for each crop, and annual on-field applied water requirements (the amount of water needed to allow for growth of a particular crop, accounting for water that is evaporated, or percolates downward through the soil and enters the groundwater table) for the following normalized years and conditions:

- 1995 (normalized) drought and normal condition
- 2020 (normalized) drought and normal condition

On-field water requirements are presented for both normal and drought conditions (estimates assume that the same acreage is planted, but that additional water is required in a drought condition as less natural precipitation occurs and where greater ET rates might be experienced from higher temperatures). DWR's projected 1995 condition is used for each district with the range of crop acreage developed with the districts to reflect variable condition trends.

Water requirements and associated diversions pursuant to their negotiated Settlement Contracts have typically been limited to the growing season (April through October) associated with the water requirements for a particular crop. Water requirements tend to be highest for most districts during mid-summer (July and August), because these are typically the warmest, driest months, and a secondary peak demand occurs in May during flood-up for rice production. Annual diversions fluctuate by district according to rainfall, farm program, individual practices, and cropping patterns.

Irrigation Management and Forecasting in California – Summary of DWR Agricultural Water Use Estimation Approach

Currently, there are over 9 million irrigated acres of cultivated land in California, which is composed of a wide range of climate, soil types, and crops. To meet the water needs of extensive agricultural development, an accurate understanding of the factors affecting crop water use is essential. Sound conceptual and mathematical models that quantify crop water use, as well as predicting cropping trends, are critical in projecting future water needs. This is particularly important in California, where increasing populations and urbanization will require increasingly careful management of water resources. This discussion briefly summarizes the approach used by DWR to quantify current and future agricultural water use.

Irrigation management and forecasting in California are dependent on accurate assessments of current crops and their respective water use, irrigation practices, environmental factors, and cultivation methods. The water requirement for a given crop is the water lost through ET, primarily determined by solar radiation, humidity, wind, crop growth stage, and crop canopy. Because these factors vary by region and time, direct measurement is impractical. Typically, crop ET may be estimated within 10 percent using evaporation rates measured in a U.S. Weather Bureau Class A evaporation pan adjusted with crop coefficients (which vary by crop and growth stage). Pan evaporation, meteorological, and crop coefficient data are available from the California Irrigation Management Information System. Crop water requirements may be further augmented by water for cultural requirements (an important component in support of rice production), such as to leach soluble salts from the root zone (leaching fraction), protect crops from frost, or germinate seeds.

Some of the water required for crop growth may be supplied by rainfall, where the amount stored in the soil and available for crops is called “effective rainfall” or “effective precipitation.” Thus, the crop’s actual water requirement (ETAW) is calculated as the difference between actual ET and effective precipitation. The efficiency at which overall water needs are met is typically quantified by a seasonal application efficiency, defined as the sum of ETAW and cultural water requirement divided by total applied water. In practice, the quantity of water used on each field may be compared to diversion data to determine the quantity of reuse within a larger region, such as a county subarea (e.g., DWR’s standard Detailed Analysis Unit).

On a farm scale, seasonal application efficiency may be diminished by evaporation during conveyance, irrigation system leaks, and losses to deep percolation from the soil. However, irrigation water that percolates to groundwater or becomes tailwater from surface drainage can be recovered on other farms. Unless water drains to an unusable pool (commonly termed an “unrecoverable loss”), such as contaminated or saline groundwater or water that is hydrologically at the end of the irrigation network (e.g., drainage water flows to the

SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

Agricultural Land and Water Use for 199X[1]

DAU #: XXX — XXX IRRIGATION DISTRICT — PSA: XXX

DAU Name: XXX — *XXX County* — HR: XXX

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit-applied Water (acre-feet/acre)		Net Irrigated Acreage[2] (1,000s of acres)			ET of Applied Water (1,000s of acre-feet)			Applied Water (1,000s of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70% 0.7	85% 0.6	5.0	0.0	5.0	2.5	0.0	2.5	3.5	0.0	3.5
RICE	3.5	58% 6.0	68% 5.1	40.0	0.0	40.0	140.0	0.0	140.0	240.0	0.0	240.0
COTTON	2.9	70% 4.1	75% 3.9	10.0	0.0	10.0	29.0	0.0	29.0	41.0	0.0	41.0
SUGAR BEETS	2.7	65% 4.2	75% 3.6	10.0	0.0	10.0	27.0	0.0	27.0	42.0	0.0	42.0
CORN	2.3	65% 3.5	70% 3.3	5.0	5.0	10.0	11.5	11.5	23.0	17.5	16.5	34.0
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	65% 5.1	75% 4.4	5.0	0.0	5.0	16.5	0.0	16.5	25.5	0.0	25.5
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	70% 3.0	75% 2.8	0.0	1.0	1.0	0.0	2.1	2.1	0.0	2.8	2.8
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	10.0	1.0	11.0	14.0	1.4	15.4	19.0	1.8	20.8
OTHER TRUCK	1.2	70% 1.7	75% 1.6	5.0	0.0	5.0	6.0	0.0	6.0	8.5	0.0	8.5
ALMONDS + PISTACHIOS	2.7	75% 3.6	80% 3.4	5.0	0.0	5.0	13.5	0.0	13.5	18.0	0.0	18.0
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES	2.0	75% 2.7	80% 2.5	0.0	1.0	1.0	0.0	2.0	2.0	0.0	2.5	2.5
EUCALYPTUS												
Totals				**95.0**	**8.0**	**103.0**	**260.0**	**17.0**	**277.0**	**415.0**	**23.6**	**438.6**
Double Crop Acreage				**2.1**	**0.0**	**2.1**						
Total Irrigated Land Area				**92.9**	**8.0**	**100.9**						

[1] Source: Department of Water Resources, XXX District

[2] Net irrigated acreage is equal to 95 percent of the gross acreage

Definition of Terms Used on Sample Agricultural Land and Water Use Table

Unit ET of Applied Water

The portion (ac-ft per acre) of the total ET that is provided by irrigation; thus, ETAW = actual ET minus the ET met by precipitation (effective precipitation).

Unit-applied Water

The quantity of water delivered to the farm headgate needed to meet the ETAW, accounting for such application factors as evaporation, leaching requirement, deep percolation, and other cultural practices; thus, unit-applied water = ETAW divided by on-farm efficiency.

Irrigation (On-farm) Efficiency

The percentage of applied water that is used by the crop (the remainder is assumed to be "unavailable[3]" due to seepage to the groundwater table, evaporation) *(e.g., 58% - 68% for rice)*. Irrigation efficiency is influenced by crop requirements, soil characteristics, system limitations, and management practices. *(Unit ET of Applied Water)/(Unit Applied Water).*

Net Irrigated Acreage

Crop acreage for a given parcel of land, less the acreage associated with facilities such as canals, roads, and outbuildings using either surface water or groundwater supplies.

ET of Applied Water

The total consumptive water (surface or ground) use by a crop for the district or region met by irrigation *(Unit ET of Applied Water)* X *(Net Irrigated Acreage).*

Applied Water

The total quantity of irrigation water (surface or ground) required to produce a particular crop for a given district or region *(Unit Applied Water)* X *(Net Irrigated Acreage).*

[3] The majority of the water that is not used by the crop is typically available for use by other downstream users.

FIGURE 1
SAMPLE AGRICULTURAL LAND AND WATER USE TABLE

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W062004006RDD_02_TM 2 (7/22/04)

ocean), it can be reused. Therefore, regional seasonal application efficiency is typically higher than field-level seasonal application efficiency because of successive, downstream recovery and re-application of drainage water. Improvements in irrigation practices, planning, technology, and policies are expected to increase the water distribution uniformity of irrigation systems in California from 73 to 80 percent by 2020.

Future crop acreage predictions provided by Sacramento River Settlement Contractors are based on land survey trends, crop market outlook studies, land retirement (elimination of agricultural land with drainage problems), urban expansion projections, production models, and other variables.

Water savings do not necessarily generate new water, particularly because excess water in one area becomes available for use in another area, but have benefits such as reduced groundwater-quality degradation or reduced agricultural drainage. Agriculture drainage reductions carry the ancillary benefit of protecting sensitive receptor environments, such as estuaries or wildlife habitats.

Reclamation is continuing to promote water management actions that achieve their desired goal of 80 percent efficiency at a district level having water quality concerns such as the Colusa Basin Drain, and 85 percent for all others

Monthly Water Requirement Estimates

Monthly on-field water requirements were developed for each district using the DWR annual data as a basis. The data were developed into a monthly distribution pattern based on the specific crop types and acreage in each district, as well as the typical irrigation patterns for each individual crop (including cultural practices). These district-specific monthly distribution patterns are in turn influenced by the dominant crops within each district. For example, the typical on-field applied water distribution pattern for rice has two peak periods – one in May associated with flood-up, and a second in July/August associated with the ET of the crop. Therefore, the monthly distribution patterns for those districts, which are dominated by rice, include two distinct peaks; whereas the distribution patterns for districts that grow less rice have either less pronounced peaks or one peak in the July/August period (primarily associated with crop ET only). In response to increasingly stringent limitations on burning, many of the districts' rice growers flood a portion of their fields in the winter months to clear their land of leftover rice straw by allowing the rice stubble to decompose. This practice is more common in some districts than others and represents a relatively new agriculturally based water requirement that has not been tracked until recently. Typical water requirements for this practice range from 0.5 to 2.5 ac-ft of water per acre per winter season depending on soil type. The flooding of rice fields has resulted in additional winter habitat for waterfowl that use the overall Sacramento Valley as part of the Pacific Flyway. These monthly data are not shown on the attached figures because the demand is outside of the irrigation season, but total quantities are identified for each district where information was available for this practice.

DWR and Reclamation Water Requirement Calculation Approaches

Crop-specific water requirement calculation approaches have been developed by both DWR and Reclamation. DWR data were used as a basis, given the land use data allow for a more consistent comparison across districts (Reclamation crop acreage data are obtained directly from each of the districts, each of which tend to report acreage in a slightly different manner, but DWR data are collected through DWR field reviews).

Although DWR and Reclamation use different methods to estimate a crop's applied water requirements, a review of the methods indicates that requirements are relatively close for the major crops grown by the majority of the districts (within 2 percent for rice and 4 percent for tomatoes). The greatest difference between the two methods is for sugar beets and pasture; the Reclamation method identifies water requirements to be 13 and 12 percent less than the DWR method, respectively.

Applied water requirements in the BWMP are developed on the basis of a method used by DWR. Applied water requirements represent the total amount of water that must be diverted to a field, regardless of source, to allow for sufficient growth of a particular crop. ETAW, which is the amount of applied water used by a particular crop, is determined by multiplying effective ET (total ET minus effective precipitation) by irrigated acreage to determine total crop needs. ETAW is then divided by on-farm efficiency to determine total on-farm applied water requirements for each water district by using the following equation:

$$\text{Applied Water Requirement}_{\text{DWR}} = \frac{\text{ETAW}}{\left(\frac{\text{Efficiency}_{\text{DWR}}}{100}\right)} \tag{1}$$

The DWR method varies slightly from the method employed by Reclamation for determining water requirements. The Reclamation method explicitly identifies water requirements for cultural practice (water needed to promote growth of a particular crop but not used directly by the crop, e.g., water for flooded rice cultivation) and leaching requirements when calculating applied water requirements in the following equation:

$$\text{Applied Water Requirement}_{\text{Reclamation}} = \frac{\text{ETAW}}{\frac{\text{Efficiency}_{\text{USBR}}}{100} \times (1 - \text{LR})} + \frac{\text{CP}}{\frac{\text{Efficiency}_{\text{USBR}}}{100}} \tag{2}$$

Where:

CP = Cultural practice
LR = Leaching requirement

The DWR method addresses cultural practice and leaching requirements by adjusting irrigation efficiencies to achieve the appropriate applied water requirements. The DWR method, where leaching requirement water is inferred from reduced water use efficiency, is more empirically based than the Reclamation method, which uses models based on irrigation water and target soil salinity levels. Although the DWR and Reclamation methods differ in the way they address cultural practice and leaching requirement, both methods produce similar applied water requirements.

District Water Requirements

Total district water requirements (TDR) were developed by including the amount of water required to convey and distribute water to individual farmers (primarily water that seeps from district canals and laterals, as well as operational spills) to the on-field requirement:

District Water Requirement =

On-field requirement + leakage associated with conveyance to farms + operational spills

Conveyance-related requirement estimates (i.e., accounting for the quantity of water that is either evaporated or that seeps through a canal wall and is no longer available for conveyance) are included for each district. These data were developed through conversations with each district, and represent either measured quantities (actual canal seepage testing conducted by districts and/or derived from water measurement data along the canal reach [i.e., mass balance approach]) and/or best estimates including review of Reclamation irrigation studies and design criteria. In general, the majority of water that seeps from canals and laterals either returns to the groundwater aquifer, and/or is available for reuse (this is discussed further in TM 3). An example of the calculation for canal seepage/deep percolation is provided below:

Example for Reclamation District No. 1004: On the basis of discussions with RD 1004 staff, it was estimated that approximately 15 percent of the District's TDR is attributed to canal seepage and deep percolation. Using this percentage, the volume of deep percolation was estimated in ac-ft, as is illustrated by the following example calculation:

Volume of Deep Percolation (1995 Normal) = Percentage of Deep Percolation * TDR (1995 Normal)

Accordingly, for RD 1004,

Volume of Deep Percolation (1995 Normal) = 15% * 93,500 ac-ft = 14,000 ac-ft

Future Land Use and Water Requirements

Future land use and water requirement assumptions are presented both quantitatively and qualitatively given the inherent uncertainty of future conditions. Future crop estimates provided by the Sacramento River Settlement Contractors and associated on-field crop water requirements are presented in relation to current estimates for normal and drought conditions. These data for the projected 2020 condition were developed by DWR using the same general assumptions and methodology used to estimate current conditions to allow for comparison. These projections were then presented and discussed with each of the districts and generally agreed to be a reasonable approximation of future conditions for most districts, unless otherwise noted below.

In general, it is assumed that most of the districts will continue to operate in generally the same manner and maintain approximately the same crop mix and acreage as the current condition. Changes in operations or irrigated acreage that are anticipated to occur are driven by individual farmer decisions, economics, and/or by the expected continued urban encroachment, as in the case of ACID and NCMWC. Future operations do not include the potential for incentives (i.e., outside payments to line unlined canals or other presently cost-prohibitive system modifications) to alter operations or cropping patterns. Such incentives would likely influence operations, potentially significantly, given the particular practice and application for any district.

Future flooding of rice fields to allow for decomposition of rice stubble is anticipated to increase, but could remain at current levels or decline if other uses for rice stubble (i.e., for the production of methanol fuel) were to become economical. Future operation and management are also anticipated to be influenced by an increasing need to manage salinity and other constituents that affect crop production and sustainability. Salinity and other constituents and their associated effects on district operations were not included in projected future needs, but are currently being evaluated by the Sacramento River Settlement Contractors.

For additional and detailed information, see Appendix A, Calculation of Water Requirements Memorandum.

Redding Sub-basin

- **Anderson-Cottonwood Irrigation District**

Anderson-Cottonwood Irrigation District

Formation and Right

Anderson-Cottonwood Irrigation District (ACID or District) was formed under Division 11 of the State Water Code and is the oldest such district in the Sacramento Valley. On November 24, 1914, McCoy Fitzgerald posted a "Notice of Appropriation of Water" on the west bank of the Sacramento River in Redding. In December of that same year, title to this appropriation was deeded to ACID. The State Division of Water Rights issued a certificate in June 1918, prescribing the time to complete application of water to the proposed place of use. ACID subsequently made beneficial use of the water and established a pre-1914 water right. In June 1967, ACID entered into a negotiated agreement with Reclamation quantifying the amount of water ACID could divert from the Sacramento River. The resulting negotiated agreement recognized ACID's annual entitlement to a "Base Supply" of 165,000 acre-feet per year (ac-ft/yr) of flows from the Sacramento River and also provided for a 10,000 ac-ft allocation of "Project Water," resulting in a total contract entitlement of 175,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Sacramento River Settlement Contract, and the recently negotiated Exhibit A's for each of the districts (except ACID because negotiations are currently in progress) are included in Appendix A to TM 3.

Service Area and Distribution System

ACID's service area encompasses approximately 32,000 acres and extends south from the City of Redding within Shasta County to northern Tehama County, encompassing the City of Anderson and the Town of Cottonwood. Although ACID overlaps the service area boundaries of these water purveyors, the District does not currently provide water for M&I uses in these communities. Approximately 90 percent of ACID's customers irrigate pasture for haying or livestock; however, some orchard and other food crops are also grown. In total, ACID's service area accounts for about two-thirds of all irrigated pasture in the Redding Sub-basin.

ACID uses a rotation schedule to deliver irrigation water to District customers. Very little groundwater is used within the District for agricultural purposes, except occasionally during drought years. ACID's facilities and irrigation are significant contributors to groundwater recharge in the Redding Sub-basin. Annual canal seepage associated with the ACID main canal is estimated to be approximately 44,000 ac-ft. The District is currently exploring the potential for future conjunctive water management options.

ACID's water supply is diverted from the Sacramento River near Redding. Water pools behind the District's seasonal dam (creating Lake Redding) and travels by gravity flow through a screen, tunnel, and ultimately into the main canal. The District's fish ladders and fish screen were replaced as part of a CALFED-funded effort to enhance the Sacramento River anadromous fishery. These facilities were dedicated June 2001. The distribution system designed in 1915 includes unlined canals, laterals, sublaterals, drains, inverted siphons, and pumping plants. A flume, which carried water across the Sacramento River to the Churn Creek Bottom area, is no longer in operation and was replaced with a pumping plant in the 1940s.

Several wasteways are located along the canal route at creek crossings and natural drains. These wasteways return water to the river or local streams when flow exceeds the capacity of the canal which, when it occurs, is typically in the winter months during storm runoff. Additionally, the District operates five pumping plants that recapture some return flows. A portion of the main canal is concrete- or gunite-lined, with automatic gate controls. Further, the District has a continuing program of replacing farm laterals with pipe. ACID currently maintains agreements with the City of Redding, Anderson, and the California Department of Transportation to accept stormwater-related flows on an as-needed basis.

Topography and Soils

The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Complete descriptions of the soil associations and the corresponding acreage of each association in the District are provided in the Natural Resources Conservation Service (NRCS) (formerly Soil Conservation Service) Soil Surveys for Shasta and Tehama Counties**.** The soil associations that are found within the District are as follows:

- Newtown-Red Bluff: Nearly level to steep, well-drained and moderately well-drained clays and clay loams formed in old alluvium on high terraces.
- Churn Perkins-Tehama: Nearly level to moderately steep, well-drained and moderately well-drained clay loams and silty clay loams formed in recent alluvium on low terraces.
- Tuscan-Igo: Nearly level to gently sloping, well-drained cobbly clay loams and gravely loams that contain a hardpan and were formed in old basic alluvium on high terraces.
- Reiff Cobbly alluvial land association: Nearly level to gently sloping, moderately well-drained to excessively drained loamy fine sands to loams and frequently flooded cobbly land on valley bottoms and floodplains.
- Maywood-Tehama: Very deep to moderately deep silt loam, nearly level to very gently sloping soils on floodplains and terraces along tributaries of the Sacramento River.
- Corning-Redding: Nearly level to sloping, gravely, medium-textured soils that are moderately deep to shallow to claypan or hardpan on terraces west of the Sacramento River and along its tributaries.
- Newville-Dibble: Shallow to deep gravely loam and silt loam, moderately steep or steep, medium- to fine-textured soils underlain by soft sedimentary rock.

Identification of the limitations on ACID agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the District and/or individual farmers in the District.

Agricultural

Land use within ACID's service area is primarily pasture, in addition to alfalfa and some deciduous orchard crops. Pasture use is typically in the range of 75 percent of the total crop mix served by the District (DWR, Northern District). Water requirements are typically highest during the summer months (June, July, and August) due to the area's hot, dry climate. Little groundwater is used across the District; the small portion used is limited primarily to deciduous crops. Annual cropping patterns have not varied a great deal since the mid-1970s. Associated on-field crop water requirement needs and diversions therefore have been more a function of water-year type and climate than changes in cropping.

Table 1 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates ("+/- percentage" figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 1
ACID Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Pasture	10,500 (+/- 5%)[c]	9,900 (+/- 5%)[c]
Other Deciduous	1,600 (+/- 5%)[c]	1,600 (+/- 5%)[c]
Alfalfa	400 (+/- 5%)[c]	200 (+/- 5%)[c]
Almonds and Pistachios	200 (+/- 5%)[c]	200 (+/- 5%)[c]
All Other Crops	1,200 (+/- 5%)[c]	1,200 (+/- 5%)[c]
Total Irrigated Acreage	**13,900 (+/- 5%)[c]**	**13,100 (+/- 5%)[c]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be "normal," i.e., drought or wet condition assumed not to occur). Source: DWR, Northern District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern District.

[c] Percentages obtained from ACID.

Figure 2 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current needs in terms of crop mix; however, the District anticipates an overall decrease in irrigated acreage associated with continued urban encroachment.

Municipal and Industrial

ACID's service area overlays several municipal water purveyors, but the District currently does not serve any major M&I users. Many of these users are projecting increased demands in the year 2020. DWR estimates growth in the M&I sector in the vicinity of ACID to result in an increased annual water requirement of approximately 30,000 ac-ft by the year 2020, which would represent an increase of about 75 percent (DWR, Northern District). A majority of the increase is assumed to be met by surface water taken from the Sacramento River. The District is currently exploring programs that would increase supply to these purveyors.

Examples of programs include direct supply to water treatment facilities, direct supply for municipal irrigation, provision of water for cooling buildings and industrial developments, water marketing, and assisting with the fulfillment of area of origin needs. The District is currently working with the following entities to identify their potential requirements:

- City of Shasta Lake (to meet long-term growth projections)
- Bella Vista Water District
- Anderson Union High School (use of District water for cooling operations)
- City of Redding (potential South Bonnyview water treatment plant using ACID supplies)

In addition to these potential M&I demands, the District is currently participating in the Shasta County Water Resources Master Plan, which is assessing needs in the year 2030. Additional demands, as well as the potential for water transfers, may arise during the process of formulating the plan.

Environmental

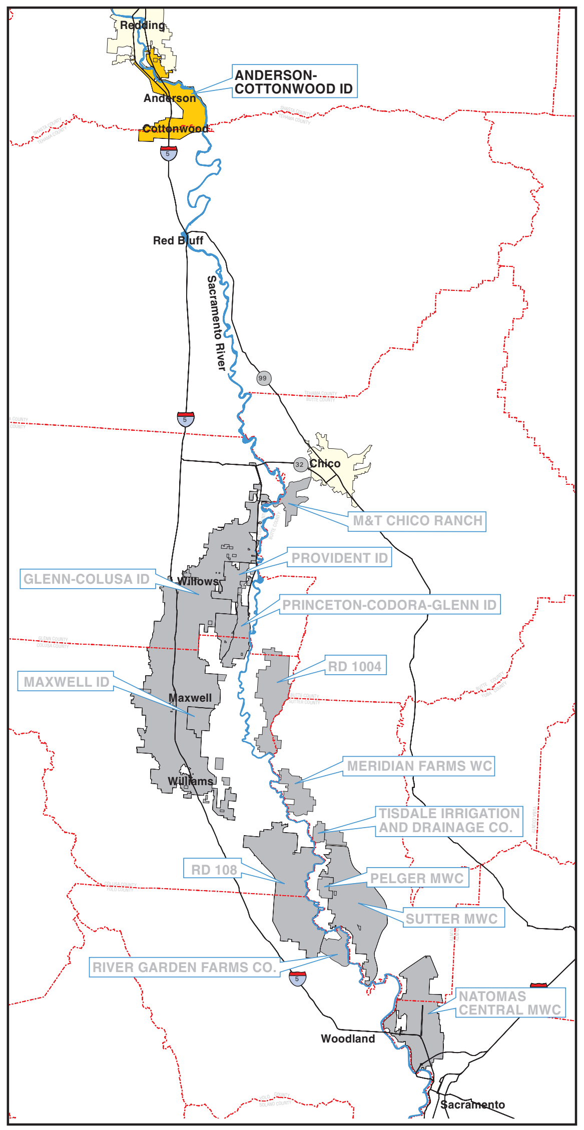
There are no managed designated environmental or wetlands areas within the District. Approximately 3,000 acres of riparian vegetation are estimated to be incidentally supplied by irrigation associated with delivery laterals or adjacent lands (CH2M HILL, 1997). The application of water to pasture lands (historically ranging from 10,000 to 12,000 acres) and associated vegetation provides habitat to common and special-status terrestrial and avian species that use such habitat. Additionally, pasture provides habitat for a number of species of small mammals, ground-dwelling birds, and reptiles and amphibians, all of which provide a prey base for predatory birds. Dryland pasture in the region often supports a vernal pool ecosystem that is occupied by a number of special-status plant and animal species.

Anderson-Cottonwood Irrigation District

Manager: Dee Swearingen • 2810 Silver Street • Anderson, CA 96007 • (530) 365-7329

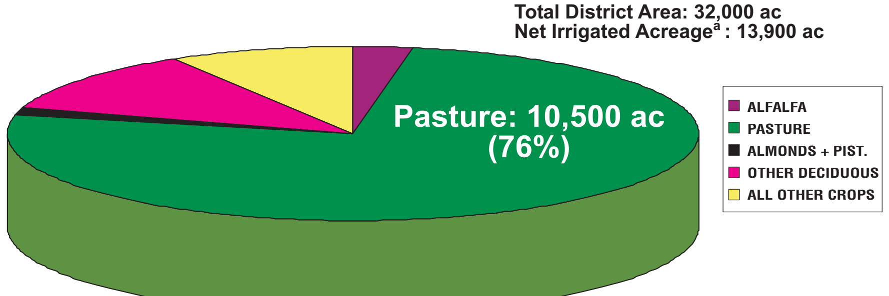
Settlement Contract:	175,000 af
Base Supply:	165,000 af
Project Supply:	10,000 af

Location Map



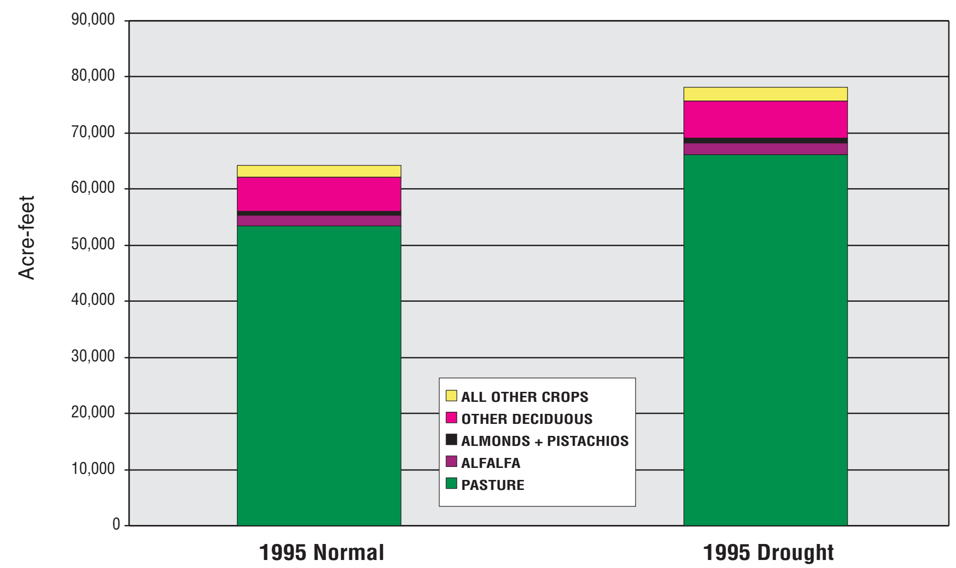
Irrigated Acreage by Crop

Total District Area: 32,000 ac
Net Irrigated Acreage[a] : 13,900 ac

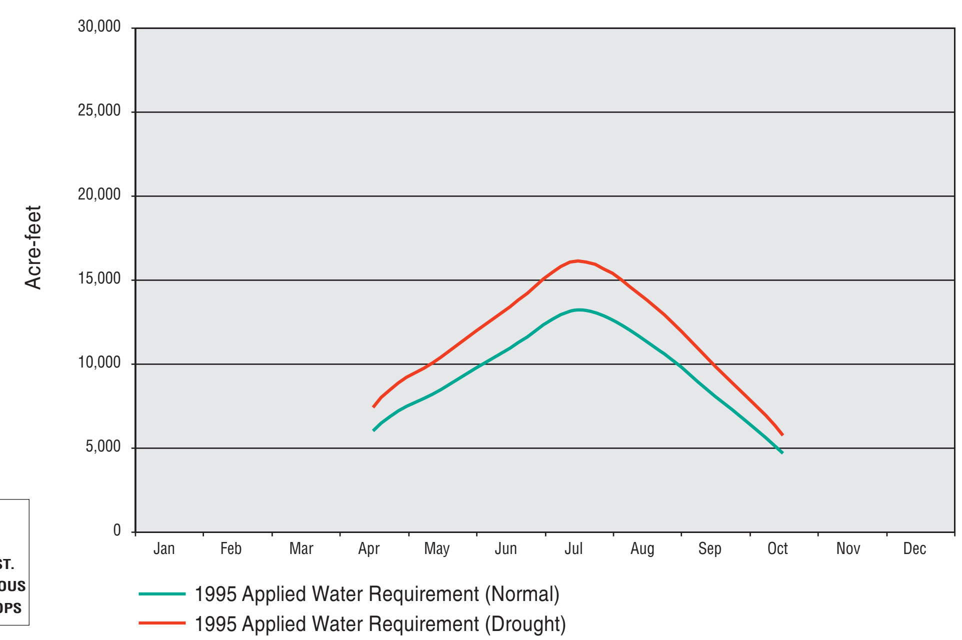


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

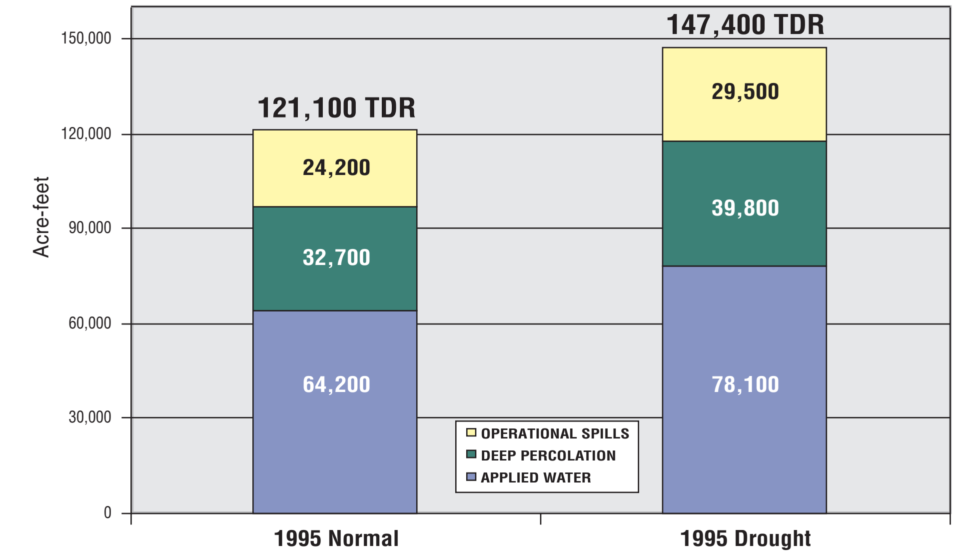


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

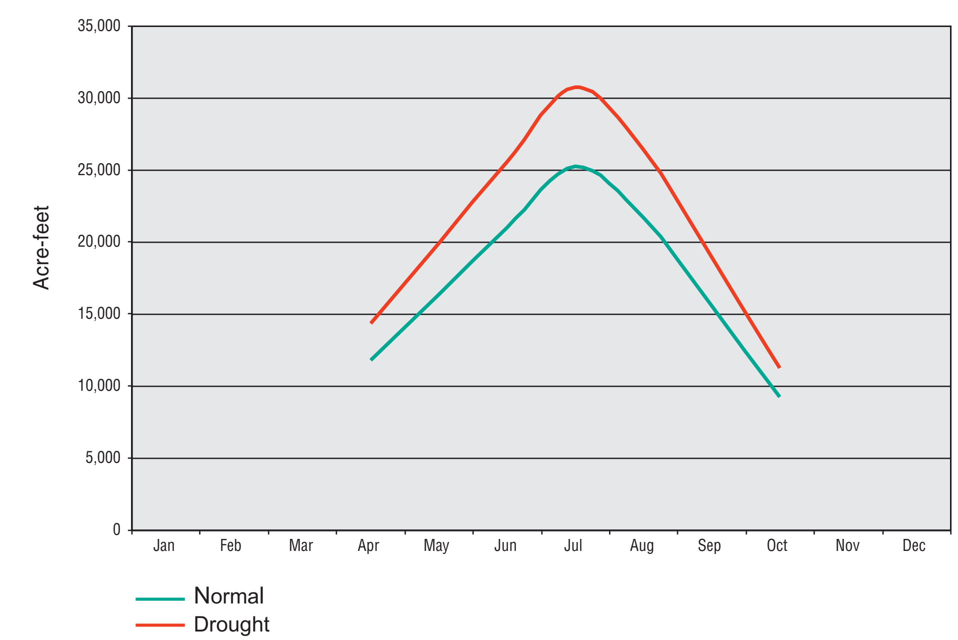


District Water Requirements

Annual Total District Water Requirement
(Includes 20% Operational Spills and 27% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 20% Operational Spills and 27% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 2
ANDERSON-COTTONWOOD IRRIGATION DISTRICT
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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in association with
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MBK

W062004006RDD_16_TM 2 (10/5/04)

Colusa Sub-basin

- **Glenn-Colusa Irrigation District**
- **Provident Irrigation District**
- **Princeton-Codora-Glenn Irrigation District**
- **Maxwell Irrigation District**
- **Reclamation District No. 108**

Glenn-Colusa Irrigation District

Formation and Right

Glenn-Colusa Irrigation District (GCID or District) claims a water right, under pre-1914 postings, to divert water from the natural flow of the Sacramento River. The water right dates back to 1883, when Will S. Green posted notices for the appropriation and diversion of irrigation water on the west bank of the Sacramento River, at the upstream end of the Oxbow Channel near the current diversion at the Main Pump Station. GCID also has adjudicated pre-1914 water rights under the Angle Decree, issued in 1930 by the Federal District Court, Northern District of California, to divert water from the natural flow of Stony Creek, a tributary to the Sacramento River.

GCID entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water GCID could divert from the Sacramento River. The resulting negotiated agreement recognized GCID's annual entitlement of a Base Supply of 720,000 ac-ft/yr of flows from the Sacramento River and also provided for a 105,000 ac-ft allocation of Project Water, resulting in a total contract entitlement of 825,000 ac-ft/yr. The 825,000 ac-ft/yr entitlement recognized under contract for GCID is inclusive of their entitlement recognized under their Angle Decree rights, which, on average, yield about 15,000 to 18,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3.

Service Area and Distribution System

GCID is located in the central portion of the Sacramento Valley on the west side of the Sacramento River and is the largest irrigation district in the Sacramento Valley, encompassing approximately 170,000 acres. The District's service area extends from northeastern Glenn County near Hamilton City to south of Williams in Colusa County. District boundaries also encompass the communities of Willows and Maxwell. GCID does not currently supply M&I water to any of the regions that overlie its service area. Rice is the predominant crop, accounting for approximately 85 percent of the District's irrigated acreage. Other important crops include tomatoes, orchards, vineseeds, cotton, alfalfa, and irrigated pasture.

GCID conveys water to three National Wildlife Refuges (Sacramento, Delevan, and Colusa) encompassing approximately 22,500 acres. The District has been selected as the preferred alternative to convey water to the refuges on a year-round basis. The construction of a large siphon at Stony Creek in 1998, and various other siphons and cross-drainage structures in 1999/2000, has eliminated the need for a seasonal dam and allows for winter deliveries. During the winter, many of the District's landowners flood a portion of their fields to clear the land of leftover rice straw by allowing the rice stubble to decompose. This practice provides valuable habitat for migratory waterfowl and reduces the need to burn rice straw, thus decreasing air quality impacts.

GCID's main facilities within its service area include a 3,000-cubic-foot-per-second (cfs) pumping plant and fish screen structure, a 65-mile Main Canal, and approximately 900 miles of lateral canals and drains. The pump station is situated on an oxbow off the main stem of the Sacramento River. Waterflow passes through the fish screens where a portion of it is pumped into GCID's main irrigation canal. The remaining flow in the oxbow passes by the screens and then back into the main stem of the Sacramento River.

The District's diversion was identified as a significant impediment to the downstream migration of juvenile salmon because the lower water surface elevations contributed to unacceptable fish losses at the existing drum screen facility. Following the state and federal listing of the winter-run Chinook salmon as endangered through the Endangered Species Act, pumping restrictions were imposed on GCID by a court-ordered injunction in the early 1990s, preventing the District from diverting its full water entitlement.

To temporarily address the concerns of the resource agencies, an interim flat-plate screen was installed in front of the rotary drum screens in August 1993. A long-term solution was then developed to meet two major objectives: (1) provide safe fish passage past the GCID diversion facilities and (2) ensure a reliable water supply to GCID by allowing the District to divert their maximum capacity, 3,000 cfs.

Key components to the implementation of the long-term solution included the enlargement and improvement of the fish screen structure at the Hamilton City Pump Station and the construction of a gradient facility in the main stem of the Sacramento River to stabilize the river channel. These facilities were dedicated in June 2002.

GCID uses an arranged schedule to deliver irrigation water to District customers. The main canal is the primary conveyance of water for the District, running generally along the west side of the District and supplying various laterals that supply individual farms and refuges. GCID currently receives a portion of its water supply through the Tehama-Colusa Canal Authority via two points of interconnections with the Tehama-Colusa Canal. The connections have a total capacity of approximately 1,200 cfs, and consist of an intertie near the Glenn and Colusa County boundary line and a cross-tie west of Williams.

The District manages a number of programs aimed at improving water use efficiency. These include a water reuse program, water conservation program, groundwater conjunctive water management program, and an in-basin water transfer program. An aggressive drainwater recapture program, which recaptures both deep percolation to the groundwater and tailwater runoff from cultivated fields, is a part of GCID's overall water management program. GCID recaptures this water with both gravity and pump systems. Recaptured water is delivered either to laterals or to the main canal for reuse. Much of GCID's drainwater is captured for use by downstream districts such as the Provident Irrigation District and the Princeton-Codora-Glenn Irrigation District.

The District implemented an emergency water conservation program as a result of the endangered species limitations associated with the District's previous fish screen operation. The emergency conservation measures were partially alleviated through use of the Tehama-Colusa Canal. GCID also manages and operates a voluntary groundwater conjunctive water management program to increase capacity when water supply does not meet demand. Nearly 100 landowners have participated in the program, representing a combined capacity of approximately 500 cfs. Implementation of the drain management program, coupled with the water conservation measures described above have reduced overall river diversions, but may have contributed to increased salt build-up in portions of the southern service area.

GCID is currently obtaining data as to the extent of soil salinity across the District, as well as the potential effect to crop growth and associated need for additional water flow.

GCID adopted a Water Transfer Policy in 1995. This policy identifies agricultural water users within the Sacramento Valley as the highest priority, and environmental purposes as the second highest priority for future water transfers. An In-basin Water Transfer Program was introduced in 1997, which provides for up to 20,000 ac-ft to be transferred to neighboring lands in full water supply years.

Topography and Soils

The District's topography consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Glenn County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Glenn and Colusa Counties.

Soil associations in the Glenn County area of GCID are as follows:

- Arbuckle-Kimball-Hillgate: Sandy loam, well-drained, moderately permeable to very slowly permeable soils on low terraces.
- Tehama-Plaza: Silt loam, deep, well-drained to somewhat poorly drained soils mainly on alluvial fans.
- Myers-Hillgate: Clay loam well-drained, slowly and very slowly permeable soils mainly on alluvial fans.
- Willows-Capay: Clay, somewhat poorly drained and poorly drained, fine-textured soils.
- Willows-Plaza-Castro: Clay loam, somewhat poorly drained and poorly drained, medium- to fine-textured soils.
- Wyo-Jacinto: Sandy loam, well-drained to somewhat excessively drained, medium-textured and moderately coarse-textured soils on young alluvial fans or on wind-deposited material.
- Cortina-Orland: Gravely sandy loam, shallow to deep, well-drained to excessively drained soils on recent alluvial fans and on floodplains.

Soil profile characteristics in the Colusa County area of GCID are as follows:

- Young alluvial fan and basin soils with moderately compacted subsoils.
- Older alluvial fan and basin soils with moderately compacted subsoils.
- Older plain or terrace soils with dense clay subsoils.
- Upland soils formed in place from the underlying softly consolidated sedimentary materials.

Soils in Colusa County are currently classified according to profile characteristics. Soil profile characteristics for Colusa County will be updated and grouped into soil association descriptions pending publication of a new NRCS Soil Survey for the county. Identification of the limitations on GCID agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the District and/or individual farmers in the District.

Agricultural

Land use within GCID's service area is primarily rice, due to the presence of fine-textured and poorly drained soils within the majority of the District. Other key crops include alfalfa, tomatoes, and cotton. Rice accounts for approximately 80 to 85 percent of the District's irrigated acreage on an annual basis (DWR, Northern District). Water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Although surface water is the primary source of irrigation water, groundwater is used in drought years on an individual grower basis, as well as per agreements with the District.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 2 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 2
GCID Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	99,300 (+/- 10%)[c]	99,100 (+/- 10%)[c]
Grain	5,500 (+/- 10%)[c]	5,000 (+/- 10%)[c]
Alfalfa	4,300 (+/- 50%)[c]	4,500 (+/- 50%)[c]
Pasture	4,100 (+/- 20%)[c]	3,300 (+/- 20%)[c]
Tomatoes	3,800 (+/- 40%)[c]	6,400 (+/- 40%)[c]
All Other Crops	13,200 (+/- 10%)[c]	18,500 (+/- 10%)[c]
Total Irrigated Acreage	**130,200 (+/- 10%)[c,d]**	**136,800 (+/- 10%)[c,d]**

[a] Figures are estimates derived from field data that have been normalized (data has been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Northern District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern District.

[c] Percentages obtained from GCID.

[d] Includes 200 double-cropped acres for 1995, and 3,700 double-cropped acres for 2020.

Figure 3 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 20,000 acres have been flooded in the past, a trend that is expected to continue or increase, assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. GCID estimates that approximately 30,000 acres were flooded in 1999, and that future totals could be as high as 50,000 acres. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation-season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Municipal and Industrial

Although GCID overlays the agricultural communities of Willows, Maxwell, and Williams, the District currently does not serve these or other major M&I users. The District has been involved in water transfer programs with municipalities in the past where growers within GCID are given incentives to pump groundwater that can in turn be transferred to eligible candidates. Future transfers will be dependent on water availability and overall economics. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 10,000 ac-ft compared to 1995 estimated levels (DWR, Northern District). All water (in addition to current demands) is assumed to be groundwater. Although lands that are incorporated within a municipality are currently uncoupled from the District, GCID could serve at least a portion of the current and/or future M&I water requirement given a mutual agreement.

Environmental

GCID conveys water to three National Wildlife Refuges (Sacramento, Delevan, and Colusa), encompassing approximately 22,500 acres. Level 4 (total quantity of water identified for each refuge to optimize management by the year 2002 identified by the Central Valley Project Improvement Act) water requirements for these three refuges total 105,000 ac-ft. The District has recently upgraded its water system to better supply the refuges. Additionally, the District serves approximately 700 acres of privately owned duck clubs. Approximately 8,350 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes elderberry shrubs, which provide habitat for the listed valley elderberry longhorn beetle, and habitat used by the giant garter snake.

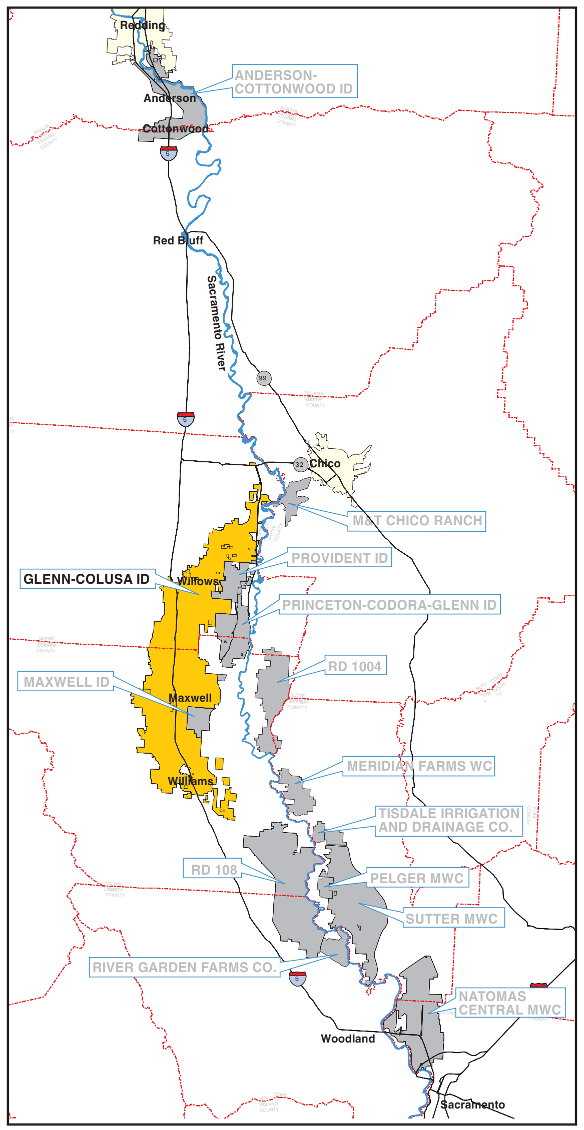
As previously described, up to 30,000 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

Glenn-Colusa Irrigation District

Manager: O. L. Van Tenney • 344 East Laurel Street • Willows, CA 95988 • (530) 934-8881

Settlement Contract:	825,000 af
Base Supply:	720,000 af
Project Supply:	105,000 af

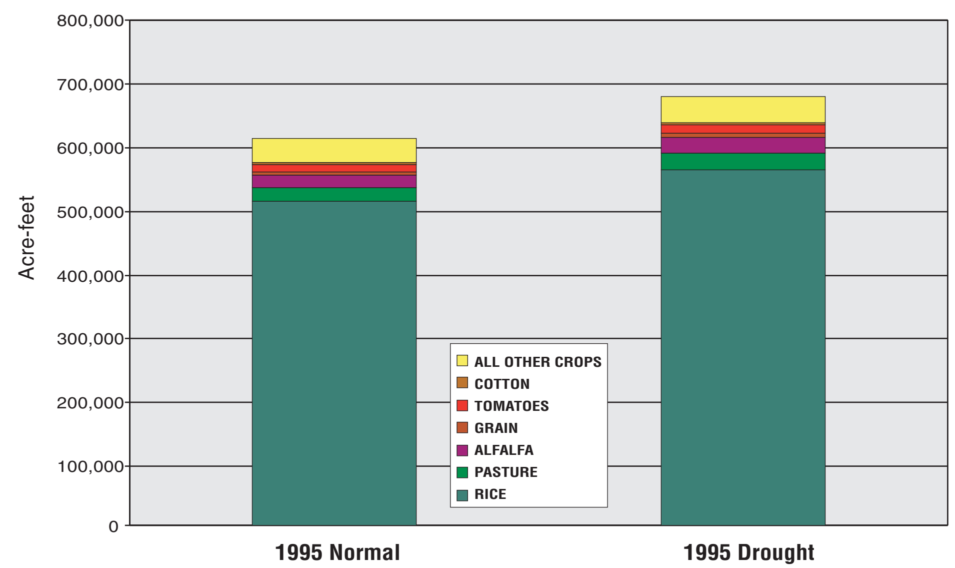
Location Map



On-field Water Requirements

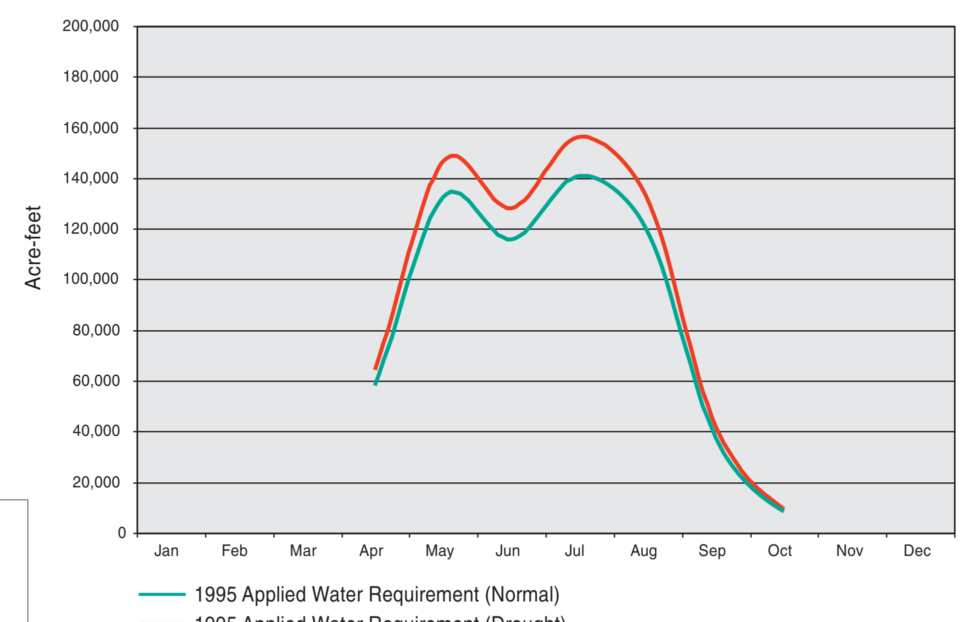
Annual Applied On-field Water Requirement by Crop[b]

(Normal and Drought)



Monthly Applied On-field Water Requirement[b]

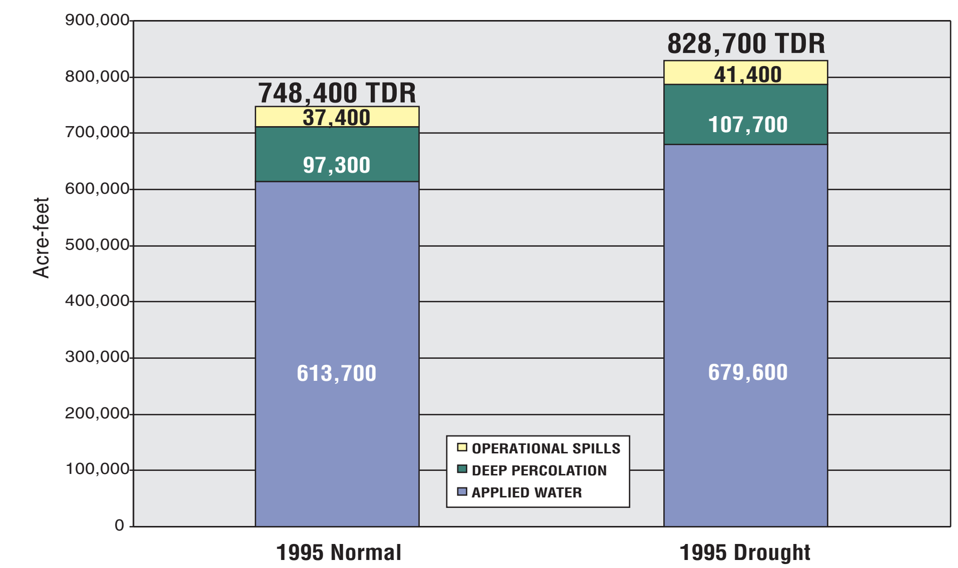
(Normal and Drought)



District Water Requirements

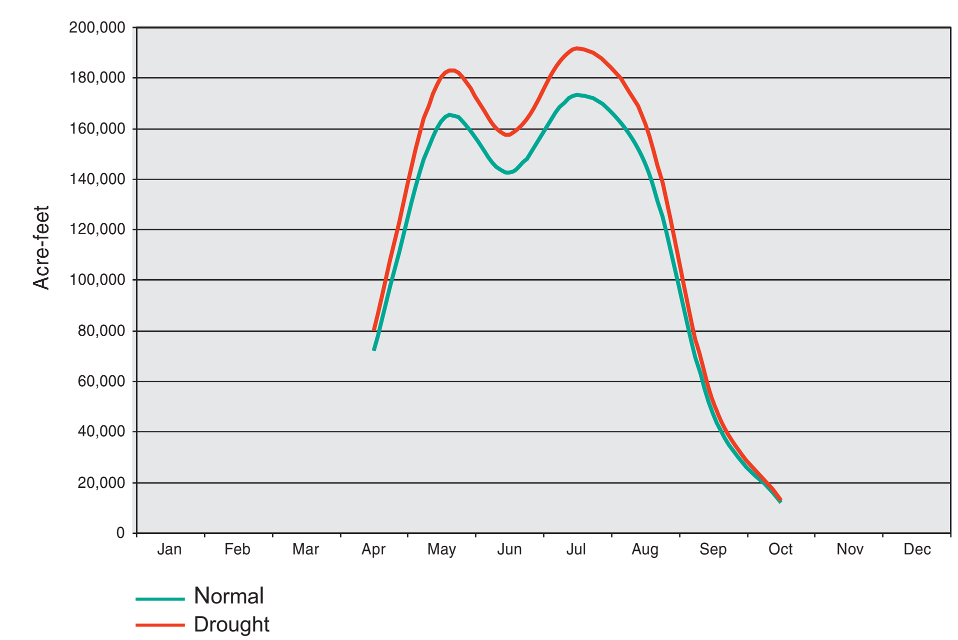
Annual Total District Water Requirement

(Includes 5% Operational Spills and 13% Deep Percolation Estimates)



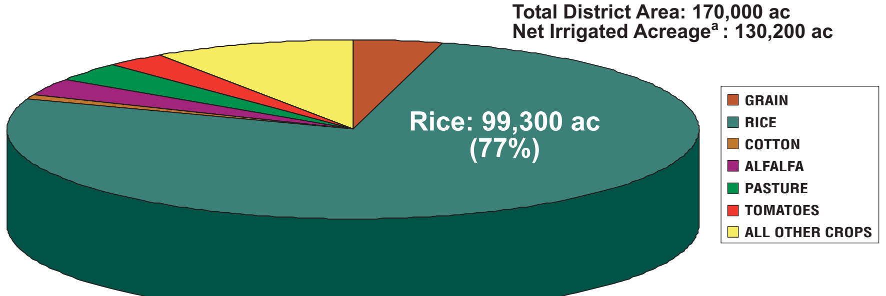
Monthly Total District Water Requirement

(Includes 5% Operational Spills and 13% Deep Percolation Estimates)



Irrigated Acreage by Crop

Total District Area: 170,000 ac
Net Irrigated Acreage[a] : 130,200 ac



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 3
GLENN-COLUSA IRRIGATION DISTRICT
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

W032003010RDD_13_TM 2 (4/29/03)

Provident Irrigation District

Formation and Right

Provident Irrigation District (PID or District) was formed on April 27, 1918. A small part of the land in what is now PID was once within the old Central Irrigation District. In 1931, when PID was reorganized and refinanced, certain lands were excluded. Some of the lands that were excluded were later organized into the Willow Creek Mutual Water Company. In 1964, PID and Reclamation entered into a negotiated agreement quantifying the amount of water PID could divert from the Sacramento River. The negotiated agreement recognized PID's annual entitlement to a Base Supply of 49,730 ac-ft/yr of flows from the Sacramento River and also provided for a 5,000 ac-ft allocation of Project Water, resulting in a total contract entitlement for 54,730 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3.

Service Area and Distribution System

PID lies to the west of the Sacramento River in the Colusa Basin in the Counties of Glenn and Colusa, approximately 7 miles east of the City of Willows. The District encompasses approximately 15,965 acres (including 800 acres recently annexed into the District) and serves 120 landowners. Rice is the predominant crop accounting for approximately 98 percent of irrigated acreage in the District. Many of PID's operations are coordinated with the Princeton-Codora-Glenn Irrigation District, located directly adjacent and east of the District. PID operates one pumping plant on the Sacramento River located at Sidds Landing north of the community of Glenn, which includes six pump/motor units of various horsepower ratings and a combined capacity of approximately 300 cfs.

The District's distribution and conveyance system includes approximately 58 miles of canals and laterals, including the 12 miles of main canal from the diversion point on the Sacramento River. Leakage associated with the operation of the main canal is typically in the range of 12 percent (percentage of diversion water that seeps through the canal wall and is lost from the conveyance system). PID makes extensive use of drainwater, using sources such as Willow Creek and the 2047 Drain.

In addition to the contract entitlement water, PID pumps water during the nonirrigation season for wetlands and rice straw decomposition. The methods and quantities of diversions have varied in the past. A groundwater study was conducted in 1963; and during the drought years of 1976 to 1977, PID installed three agricultural groundwater wells to supplement its water supply. An additional well was installed in 1991. These District wells can supply as much as 3,000 to 4,000 ac-ft of groundwater. During the drought of 1986 to 1993, several private groundwater wells were installed. PID maintains informal agreements with some landowners for use during mutually agreeable periods.

PID uses an arranged schedule to deliver irrigation water to District customers. All water pumped from the Sacramento River is measured with water meters that are monitored by PID and Reclamation. Records of all pumped water are kept by PID. All water pumped at recirculating plants or from drains is also measured by PID. District wells and some of the private wells are equipped with meters to measure the amount of water pumped.

Topography and Soils

The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Glenn County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage of each individual soil association and soil profile within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Glenn and Colusa Counties.

Soil associations in the Glenn County area of PID are as follows:

- Zamora-Marvin: Silt to silty clay loam, well-drained to somewhat poorly drained, moderately fine-textured and fine-textured soils on floodplains.
- Tehama-Plaza: Silt loam, deep, well-drained to somewhat poorly drained soils mainly on alluvial fans.
- Willows-Plaza-Castro: Clay loam, somewhat poorly drained and poorly drained, medium- to fine-textured soils.

Soil profile characteristics in Colusa County area of PID are as follows:

- Older alluvial fan and basin soils with moderately compacted subsoils.

Soils in Colusa County are currently classified according to profile characteristics. Soil profile characteristics for Colusa County will be updated and grouped into soil association descriptions pending publication of a new NRCS Soil Survey for the county. Identification of the limitations on PID agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the District and/or individual farmers in the District.

Agricultural

Rice is the overwhelmingly predominant crop grown within PID's service area, due to the presence of clayey soils within the majority of the District. Other crops include a small amount of pasture and grains. Rice accounts for more than 98 percent of the District's irrigated acreage on an annual basis (DWR, Northern District).

As is the case with most of the other districts, water requirements are typically highest during the summer months (June, July, and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. The vast majority of irrigation water requirements are met through the contract surface water supply, although groundwater is used in drought years on an individual grower basis and as per agreements with the District.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 3 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 3
PID Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	14,600 (+/- 10%)[c]	14,600 (+/- 10%)[c]
All Other Crops	200 (+/- 10%)[c]	400 (+/- 10%)[c]
Total Irrigated Acreage	**14,800 (+/- 10%)[c]**	**15,000 (+/- 10%)[c]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Northern District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern District.

[c] Percentages obtained from PID.

Figure 4 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Municipal and Industrial

PID does not overlay any municipal or industrial centers and does not currently have plans to provide water for these uses other than continuing to pump and deliver water to the Willow Creek Mutual Water Company, which is an agricultural user. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 5,000 ac-ft compared to 1995 estimated levels (DWR, Northern District). All future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the District does not preclude the possibility of serving such needs in the future.

Environmental

Approximately 50 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. PID drainwater contributes varying levels of flow depending on year type to the Delevan National Wildlife Refuge through Willow Creek during the irrigation season. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

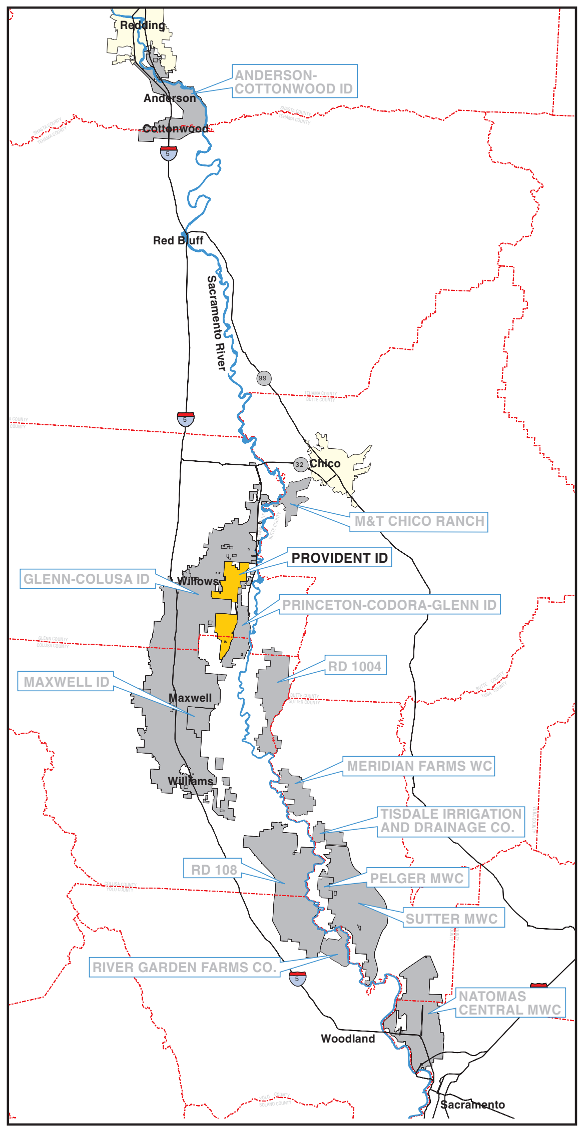
Up to 8,500 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. Additionally, the District serves approximately 1,000 acres of privately owned duck clubs. No managed designated environmental or wetlands areas are within the District.

Provident Irrigation District

Manager: Lance Boyd • 258 South Butte Street • Willows, CA 95988 • (530) 934-4801

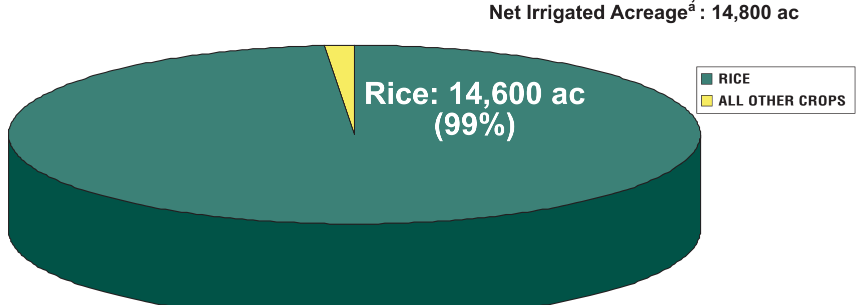
Settlement Contract:	54,730 af
Base Supply:	49,730 af
Project Supply:	5,000 af

Location Map



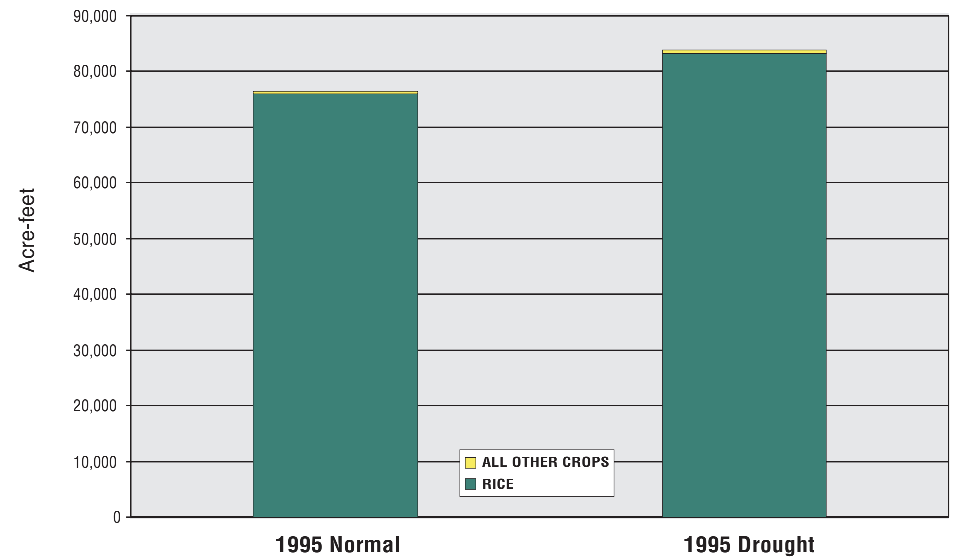
Irrigated Acreage by Crop

Total District Area: 15,965 ac
Net Irrigated Acreage[a] : 14,800 ac

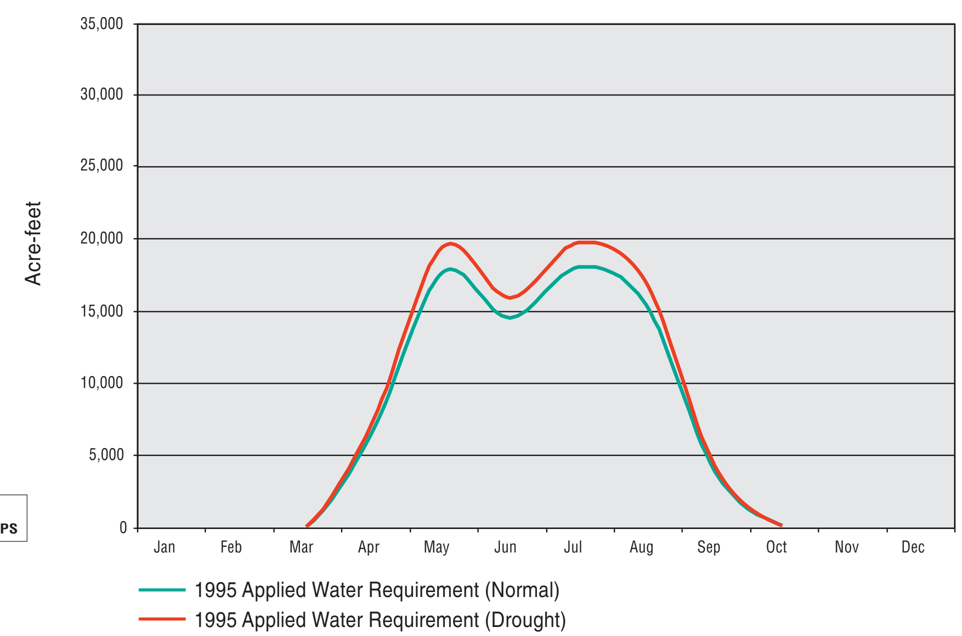


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

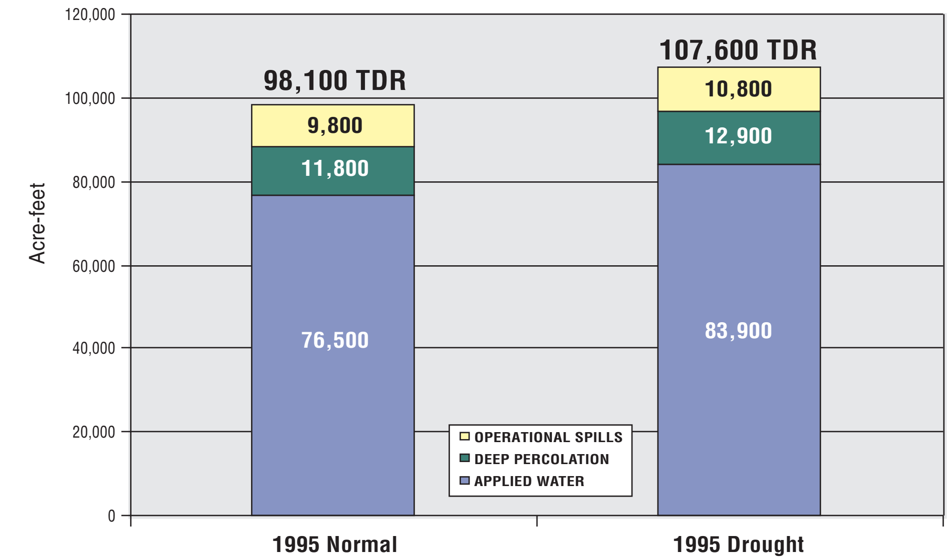


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

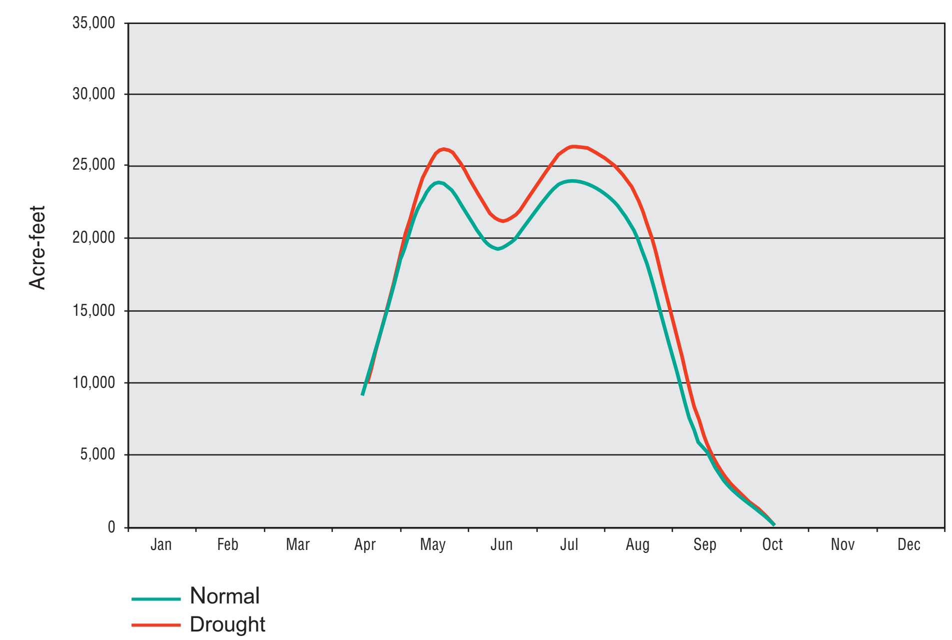


District Water Requirements

Annual Total District Water Requirement
(Includes 10% Operational Spills and 12% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 12% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 4
PROVIDENT IRRIGATION DISTRICT
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

W032003010RDD_14_TM 2 (4/28/03)

Princeton-Codora-Glenn Irrigation District

Formation and Right

Princeton-Codora-Glenn Irrigation District (PCGID or District) was organized on December 9, 1916, under the California Irrigation District Act of 1897. The District was organized to take over from the receiver of the Sacramento Valley West Side Canal Company a portion of the River Branch canal system.

In 1964, the District entered into a negotiated agreement with Reclamation quantifying the amount of water PCGID could divert from the Sacramento River. The resulting negotiated agreement recognized PCGID's annual entitlement to a Base Supply of 52,810 ac-ft/yr of flows from the Sacramento River and also provided for a 15,000 ac-ft allocation of Project Water, resulting in a total contract entitlement of 67,810 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3. In addition to the contract water, PCGID has entitlements to pump water during the nonirrigation season for wetlands and rice straw decomposition. Approximately 20 privately owned wells and five District-owned wells are within the District's boundaries. These wells are used in conjunction with the river pumps on an as-needed basis.

Service Area and Distribution System

PCGID is located west of the Sacramento Valley adjacent to the Sacramento River, in Glenn and Colusa Counties. The Colusa Basin Drain runs along most of PCGID's western boundary, beyond which lies PID. The community of Princeton lies within PCGID's boundaries. The District encompasses approximately 11,700 acres and serves 125 landowners. Rice is the primary crop grown within the District. The balance of irrigable acreage consists of orchards and row crops. PCGID does not supply M&I water to any entity. District operations are coordinated with PID, located directly adjacent and west of the District. PCGID operates two pumping plants on the Sacramento River. The Sidds Pumping Plant is located north of the community of Glenn at Sidds Landing and includes five pump/motor units of various horsepower ratings and a combined capacity of approximately 210 cfs. The Schaad Plant is similar to the Sidds facility in design and construction and is located 1 mile north of the town of Princeton. The Schaad Plant includes three pump/motor units and has a capacity of approximately 130 cfs.

The District's distribution and conveyance system includes approximately 63 miles of canals and laterals, including the 15 miles of main canal from the Sacramento River diversion point. Based on testing conducted in 1997, main canal seepage has been found to be approximately 20 percent. Due to the proximity of the river and associated soils, seepage among the other district canals is assumed to vary from 15 to 25 percent. There are now four recapture plants within PCGID to increase efficiency and timeliness of deliveries to individual farmers.

As described above, approximately 20 privately owned wells and five District-owned wells are within the District's boundaries. The District wells are capable of providing approximately 3,000 to 4,000 ac-ft of groundwater. Operations of these wells are coordinated with the river pumps to maximize flexibility and serve those within the District during times of short water supplies (i.e., drought conditions).

PCGID uses an arranged schedule to deliver irrigation water to District customers. All water pumped from the Sacramento River is measured with water meters. These meters are read by Reclamation and PCGID. All water pumped at the recirculation plants is measured by PCGID. District wells and semi-private wells are also equipped with meters to measure the amount of pumped water.

Topography and Soils

The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Glenn County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Glenn and Colusa Counties.

Soil associations in the Glenn County area of PCGID are as follows:

- Zamora-Marvin: Well-drained to somewhat poorly drained silt to silty clay loam, moderately fine-textured and fine-textured soils on floodplains.
- Willows-Plaza-Castro: Somewhat poorly drained and poorly drained clay loam, medium- to fine-textured soils.

Soil profile characteristics in the Colusa County area of PCGID are as follows:

- Recent alluvial fan and floodplain soils with deep permeable profiles.
- Older alluvial fan and basin soils with moderately compacted subsoils.

Soils in Colusa County are currently classified according to profile characteristics. Soil profile characteristics for Colusa County will be updated and grouped into soil association descriptions pending publication of a new NRCS Soil Survey for the county. Identification of the limitations on PCGID agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the District and/or individual farmers in the District.

Agricultural

Rice is the major crop grown within PCGID's service area, in addition to orchard and row crops. Class I soils are generally present in the portions of the District directly adjacent to the river, which allow for orchards, but in turn result in greater seepage from the laterals and canals throughout the District. Rice accounts for approximately 75 percent of the District's irrigated acreage on an annual basis. As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Water application requirements for orchards are typically greatest in June, July, and August.

The vast majority of irrigation water requirements are met through the contract surface water supply, although groundwater is used in drought years on an individual grower basis and as per agreements with the District. Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 4 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 4
PCGID Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	7,700 (+/- 20%)[c]	7,700 (+/- 30%)[c]
Other Deciduous	700 (+/- 20%)[c]	700 (+/- 30%)[c]
Alfalfa	200 (+/- 10%)[c]	500 (+/- 10%)[c]
All Other Crops	1,400 (+/- 10%)[c]	1,400 (+/- 10%)[c]
Total Irrigated Acreage	**10,000 (+/- 10%)[c,d]**	**10,300 (+/- 10%)[c,d]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Northern District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern District.

[c] Percentages obtained from PCGID.

[d] Includes 100 double-cropped acres for 1995 and 2020.

Figure 5 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and crops will likely shift, but overall associated water requirements are anticipated to remain relatively the same as current conditions.

Municipal and Industrial

PCGID does not serve any municipal or industrial centers, including Princeton, and does not currently have plans to provide water for these uses. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 5,000 ac-ft compared to 1995 estimated levels (DWR, Northern District). All future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the District does not preclude the possibility of serving such needs in the future.

Environmental

Approximately 50 acres of riparian vegetation are estimated to be incidentally supplied by irrigation including vegetation directly adjacent to delivery laterals or influenced through leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

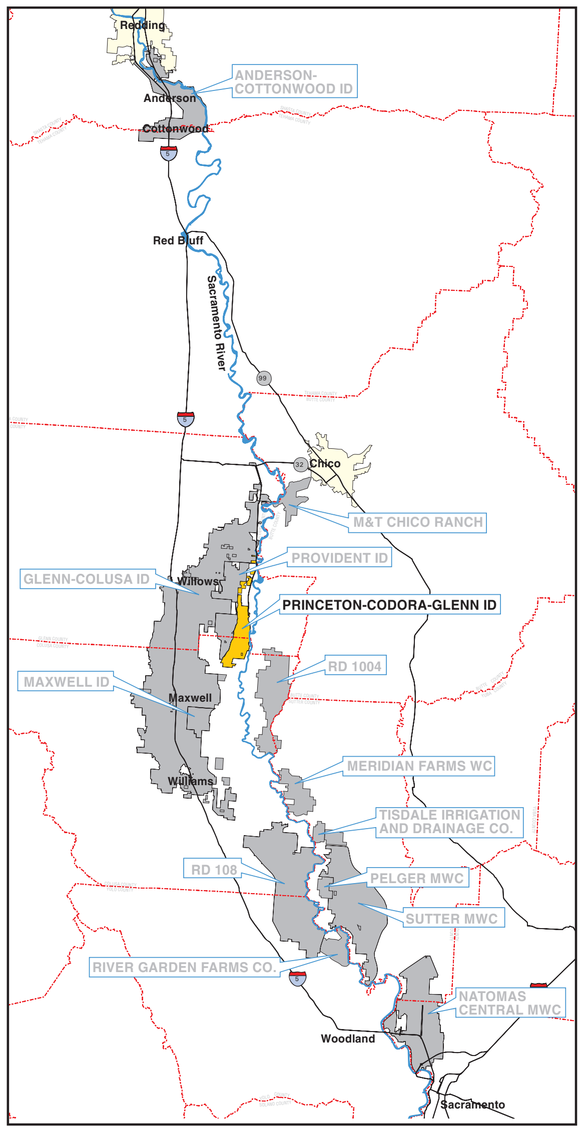
Up to 2,500 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. Future estimates indicate that up to 4,000 acres may eventually be flooded. No managed designated environmental or wetlands areas are within the District.

Princeton-Codora-Glenn Irrigation District

Manager: Lance Boyd • P.O. Box 98 • Princeton, CA 95970 • (530) 439-2248

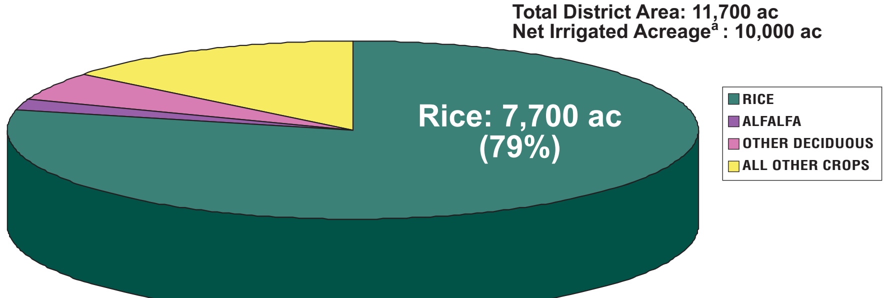
Settlement Contract:	67,810 af
Base Supply:	52,810 af
Project Supply:	15,000 af

Location Map



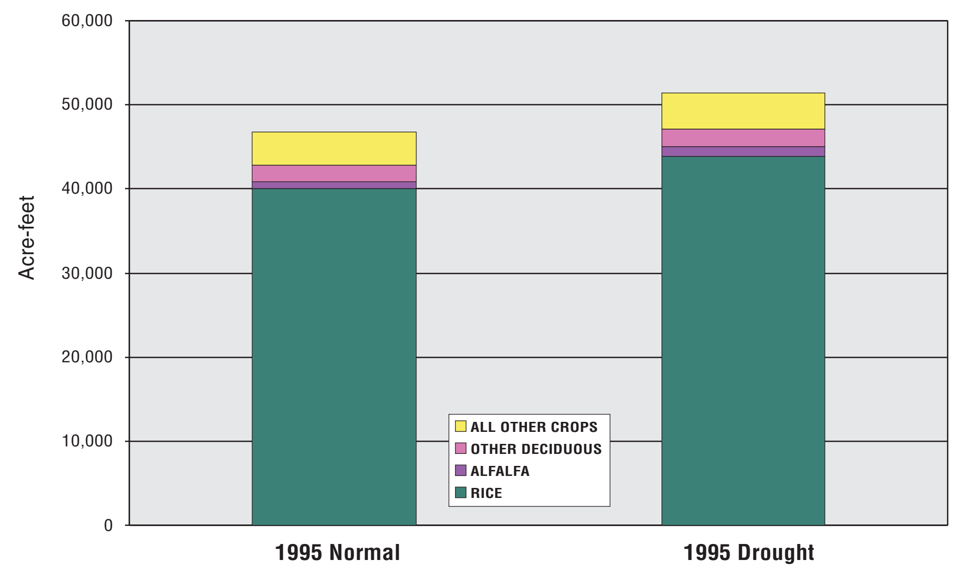
Irrigated Acreage by Crop

Total District Area: 11,700 ac
Net Irrigated Acreage[a] : 10,000 ac

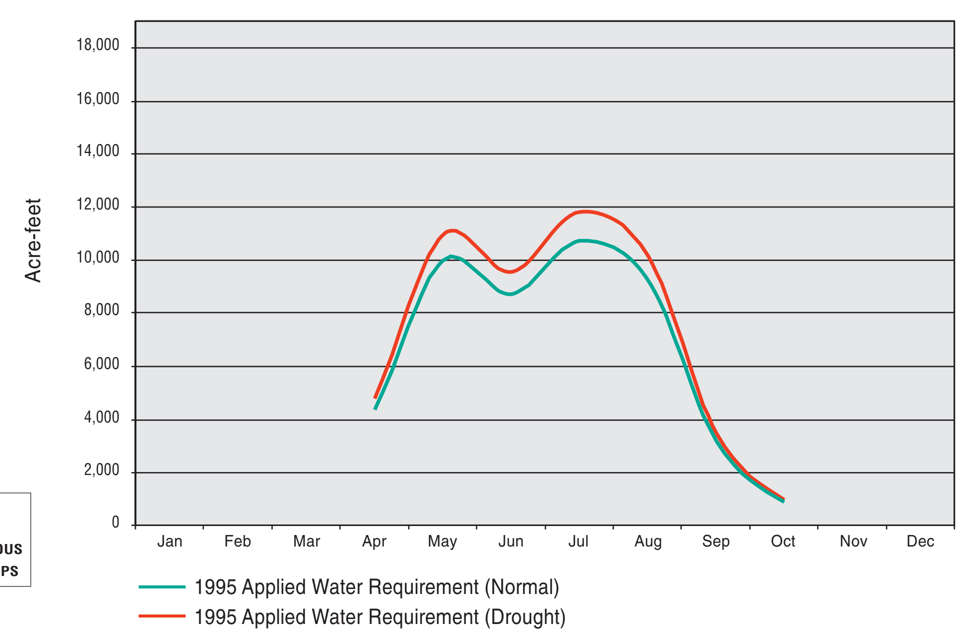


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



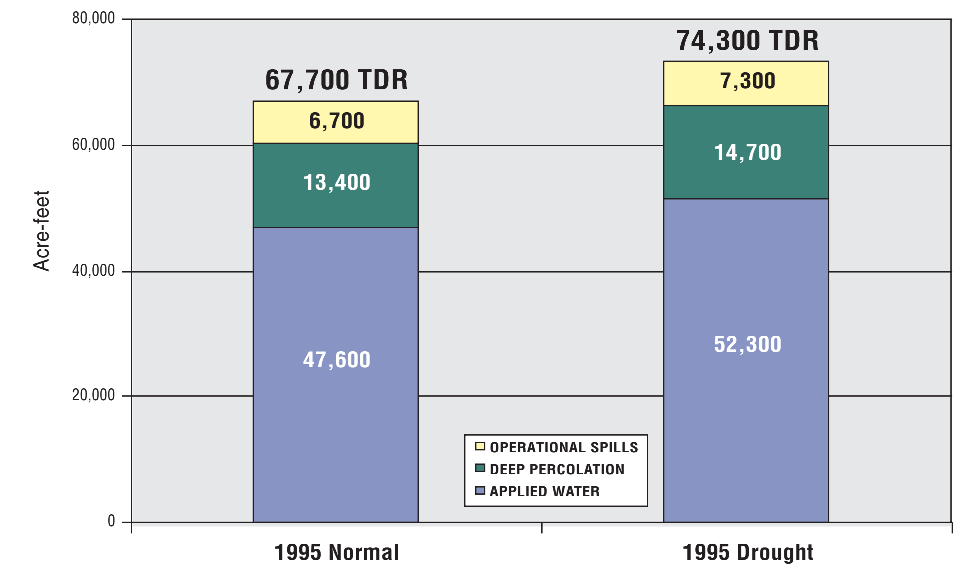
Monthly Applied On-field Water Requirement[b]
(Normal and Drought)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 10% Operational Spills and 20% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 20% Deep Percolation Estimates)

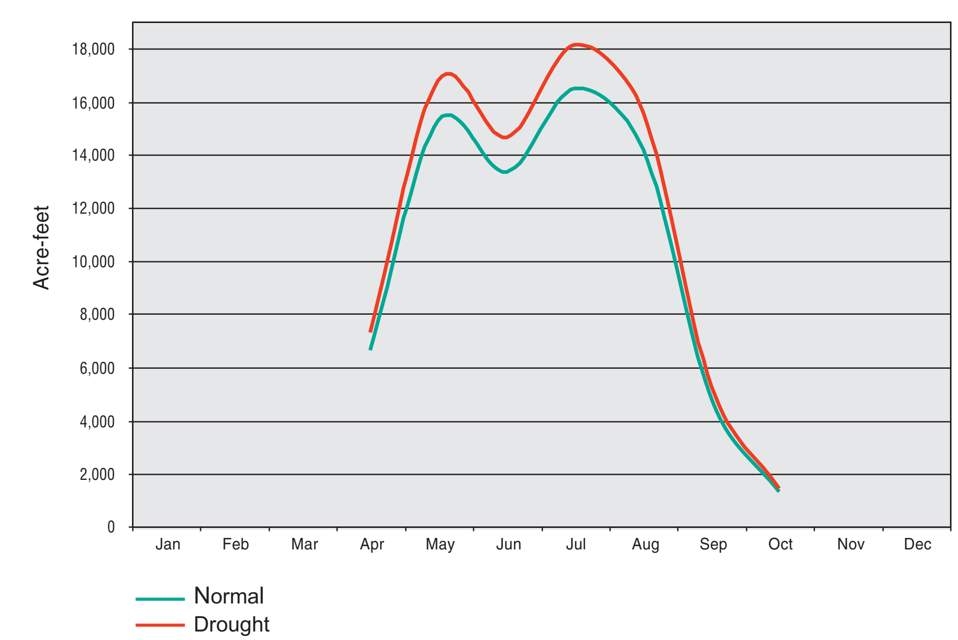


FIGURE 5
PRINCETON-CODORA-GLENN IRRIGATION DISTRICT
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK
W032003010RDD_15_TM 2 (4/29/03)

Maxwell Irrigation District

Formation and Right

Maxwell Irrigation District (MID or District) holds water right License 7210 (Application No. 8631, Permit No. 5128) to divert up to 63 cfs from the Sacramento River. The District entered into a negotiated agreement with Reclamation in 1972, quantifying the amount of water MID could divert from the Sacramento River. The resulting negotiated agreement recognized MID's annual entitlement of a Base Supply of 11,980 ac-ft/yr of flows from the Sacramento River and also provided for a 6,000 ac-ft allocation of Project Water, resulting in a total contract entitlement of 17,980 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3.

Service Area and Distribution System

MID is located on the west side of the Sacramento River approximately 5 miles northwest of the town of Colusa in Colusa County. The District is located directly east of the southern portion of GCID and south of the Delevan National Wildlife Refuge. The District's service area encompasses approximately 6,134 acres and includes 28 landowners. Rice is the predominant crop grown within the District. Operations are influenced by the actions of GCID because MID uses return water from the GCID water system that is diverted from the Colusa Basin Drain. MID operates one pumping plant on the west bank of the Sacramento River in Colusa County, which includes three pump/motor units of various horsepower ratings and a combined capacity of approximately 80 cfs.

The District's distribution and conveyance system includes approximately 4 miles of canals and laterals. Leakage associated with the operation of the main canal is typically in the range of 15 percent (percentage of diversion water that seeps through the canal wall, and as a result, is unavailable for conveyance). MID has made extensive use of drainwater in past years, at times supplying up to 80 percent or more of its supply by diversion from area drains. The District's use of drainwater in past years was motivated by the lack of reliable diversion capacity on the Sacramento River. Relocation and improvement of their Sacramento River pump station has allowed the District to begin using its Sacramento River supply more reliably, with a corresponding decrease in drainwater use. Drainage from the District is released into the Colusa Basin Drain.

MID uses an arranged schedule to deliver irrigation water to District customers. In addition to the contract entitlement water, MID pumps water during the nonirrigation season for wetlands and rice straw decomposition. The methods and quantities of diversions have varied in the past.

Topography and Soils

The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

The soil associations that are found within the District are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the District are provided in the NRCS Soil Surveys for Colusa County.

Soil associations in the Colusa County area of MID are as follows:

- Corbiere: Occasionally flooded, somewhat poorly drained silty clay loam with 0 to 2 percent slope.
- Willows: Deep, poorly drained silty clay soils with 0 to 1 percent slope. Includes frequently and occasionally flooded phases.

Soil profile characteristics in the Colusa County area of MID are as follows:

- Alluvium soils on basin floors and basin floor rims.
- No depth to restrictive features noted.

Identification of the limitations on MID agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the District and/or individual farmers in the District.

Agricultural

Land use within MID's service area is primarily rice, due to the presence of fine-textured and poorly drained soils within the majority of the District. Rice accounts for over 95 percent of the District's irrigated acreage on an annual basis (DWR, Northern District). Water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 5 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 5
MID Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	4,900 (+/- 10%)[c]	4,900 (+/- 10%)[c]
All Other Crops	100 (+/- 10%)[c]	100 (+/- 10%)[c]
Total Irrigated Acreage	**5,000 (+/- 10%)[b]**	**5,000 (+/- 10%)[c]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Northern District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern District.

[c] Percentages obtained from MID.

Figure 6 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's land-owners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 346 acres have been flooded in the past, a trend that is expected to continue assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Municipal and Industrial

MID does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by approximately 3,800 ac-ft compared to 1995 estimated levels (DWR, Northern District). Although it is considered unlikely, MID could provide M&I water; but current estimates of future M&I requirements are minimal.

Environmental

Approximately 20 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes elderberry shrubs, which provide habitat for the listed valley elderberry longhorn beetle, and habitat used by the giant garter snake.

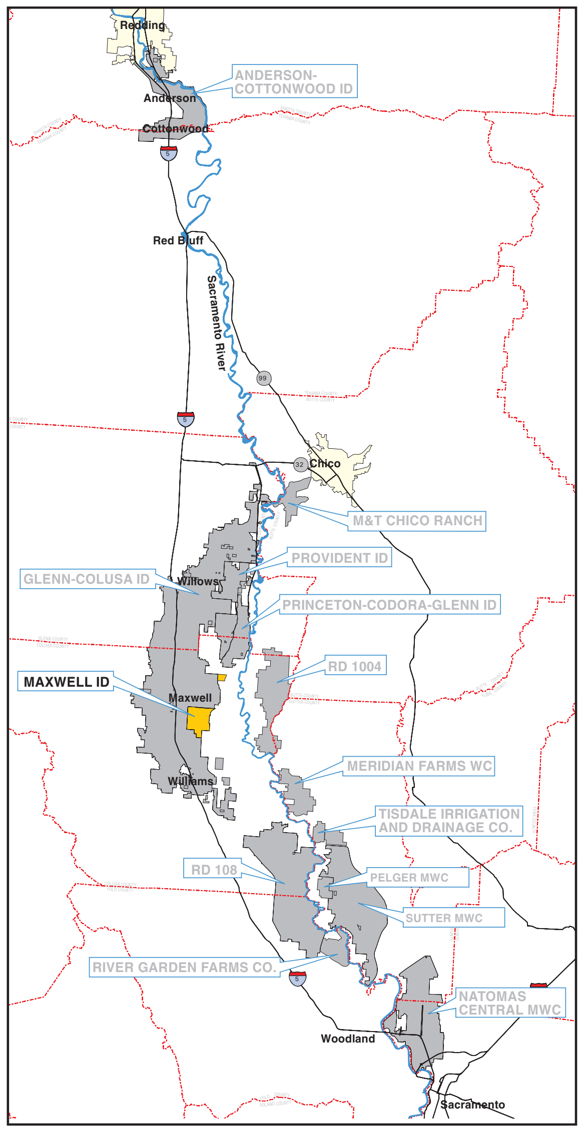
As described above, up to 346 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. Additionally, the District serves approximately 3,453 acres of privately owned duck clubs. No managed designated environmental or wetlands areas are within the District.

Maxwell Irrigation District

President: Douglas B. McGreoghegan • P.O. Box 581 • Arbuckle, CA 95912 • (530) 438-2773

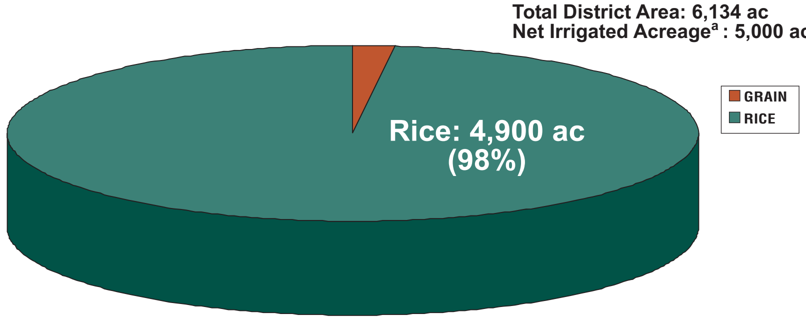
Settlement Contract: 17,980 af
Base Supply: 11,980 af
Project Supply: 6,000 af

Location Map



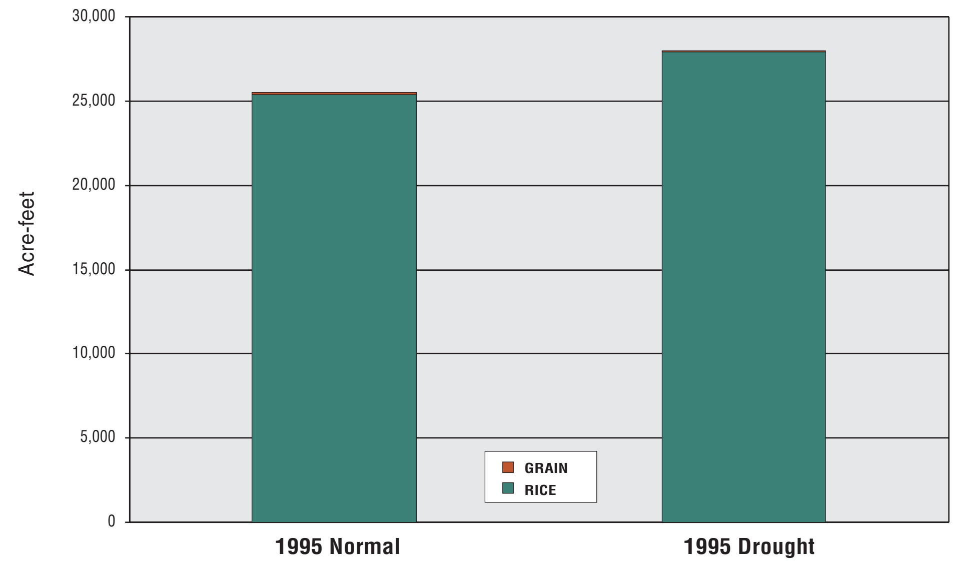
Irrigated Acreage by Crop

Total District Area: 6,134 ac
Net Irrigated Acreage[a] : 5,000 ac

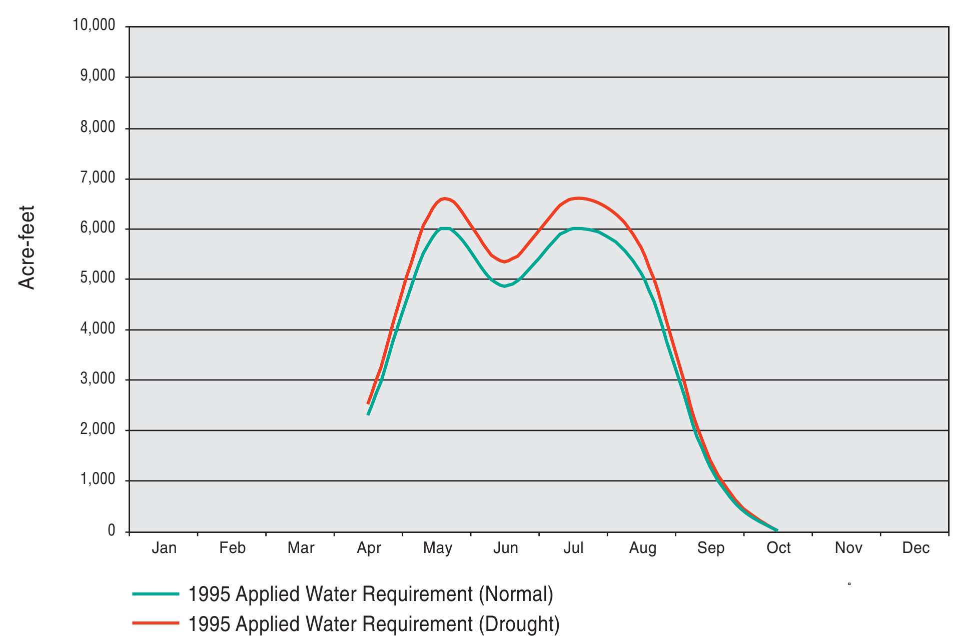


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



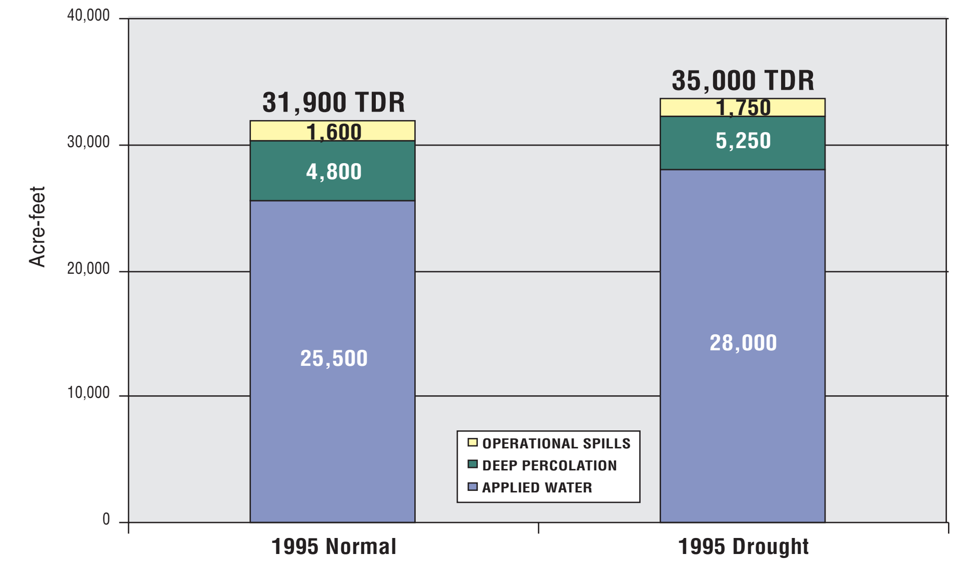
Monthly Applied On-field Water Requirement[b]
(Normal and Drought)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)

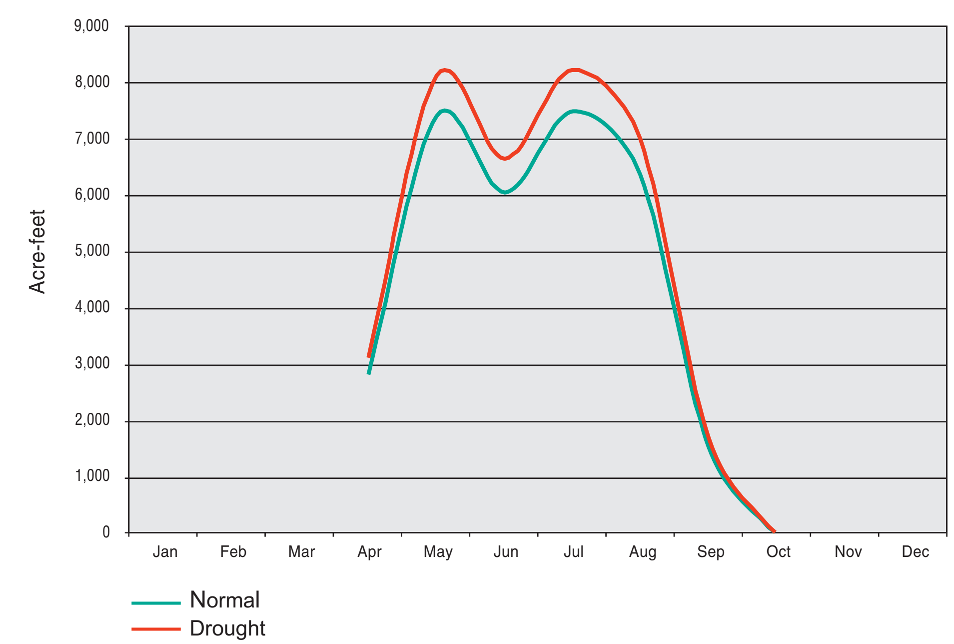


FIGURE 6
MAXWELL IRRIGATION DISTRICT
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

W032003010RDD_23_TM 2 (4/29/03)

Reclamation District No. 108

Formation and Right

Reclamation District No. 108 (RD 108 or District) was formed in 1870 under the general Reclamation District Law of 1868 for the purpose of constructing levees to provide flood protection to over 100,000 acres of farmland along the west side of the Sacramento River from north of Colusa to Knights Landing. In the early 1900s, RD 108 was consolidated to approximately 58,000 acres to provide irrigation water service, flood control, and drainage for lands within its service area. In 1917, the District began construction of major irrigation distribution system facilities for delivery of water from the Sacramento River to approximately 48,000 acres. RD 108 entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water RD 108 could divert from the Sacramento River. The resulting negotiated agreement recognized RD 108's annual entitlement of Base Supply of 199,000 ac-ft/yr of flows from the Sacramento River and also provided for a 54,500 ac-ft allocation of Project Water. In 1974, the District reduced its Project Water allocation to 33,000 ac-ft with the expectation that conservation efforts including canal lining and recirculation of drainage water by the District would reduce diversion requirements from the Sacramento River. The subsequent contract entitlement is for a total of 232,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3.

Service Area and Distribution System

The District's 48,000-acre service area is located within southern Colusa County and northern Yolo County along the west side of the Sacramento River, between the towns of Grimes and Knights Landing. The service area is surrounded on three sides by flood control levees, i.e., on the east by the westerly levee of the Sacramento River, on the west and southwest by the Colusa Basin Drain (commonly referred to as the "Back Levee"), and on the southeast by the northerly levee of Reclamation District No. 787. RD 108 obtains its water supply from the Sacramento River under its riparian water rights and licenses for appropriation of surface waters. This water supply is supplemented when necessary from groundwater, using the District's three wells and several privately owned wells, and by diversion of water from the Colusa Basin Drain under the District's appropriative license. Approximately 130 landowners and water users grow a wide variety of crops including rice, wheat, corn, safflower, sugar beets, tomatoes, beans, vineseeds, fruits, and nuts. Rice is the predominant crop.

RD 108 uses an arranged schedule to deliver irrigation water to District customers. RD 108 owns and operates an irrigation system that includes 11 pumping plants, 7 of which are located along the Sacramento River. Irrigation canals totaling about 120 miles convey the river water to farms within the District's service area. The District also owns and operates a drainage system used for removing drainage water and winter storm runoff. Because the District has no natural drainage outlet, excess drainage water and rainfall runoff, which accumulate in over 300 miles of District drains, are channeled to the Rough and Ready Pumping Plant (850-cfs capacity) near the southeast corner of the District where the water is pumped into the Sacramento River for use downstream. The Riggs Pumping Plant on the northwest side of the District, adjacent to the Colusa Basin Drain, is a multipurpose facility. Drainage of water from the north can be discharged into the Colusa Basin Drain or pumped into the irrigation canal system for reuse. The plant is also used to divert water from the Colusa Basin Drain for irrigation of District lands as a supplemental supply.

Because a large portion of RD 108 lies within an area of relatively little slope, the District has a unique capability of recirculating all drainage water so that no drainage is pumped into the Sacramento River. This "lock-up" capability allows the District to control rice pesticide-contaminated water within its drainage and irrigation systems for the prescribed holding period, thereby permitting early release of pesticide water from rice fields. In addition, RD 108 has recirculated a certain amount of drainage water beyond the normal 2-month lock-up period as a water management practice. However, after about 15 years of water reuse during the peak irrigation season, it was found that continued recycling of drainage water created a detrimental effect on crop production within certain areas of the District caused by the build-up of salts in the soil. As a result, in 1997, RD 108 suspended the lock-up program and has curtailed its recirculation of drainage water.

The District is responsible for maintaining the integrity of the Back Levee, the primary flood control feature along the Colusa Basin Drain. The eastern boundary portion of the levee of the Sacramento River is maintained by the Sacramento River West Side Levee District, a sister district to RD 108. Flood maintenance involves patrolling the levee and making repairs as necessary during high water condition, which have occurred in 3 of the last 5 years, in the Colusa Basin Drain. More substantial repairs were subsequently made by the U.S. Army Corps of Engineers.

The DWR is conducting and managing a long-range investigation of the groundwater resources within the District, including drilling of groundwater exploration and testing wells and monitoring changes in water levels and quality. The purpose of this investigation is to develop sufficient information to provide a reliable basis for the District and other districts in close proximity to formulate water resource management plans integrating both surface water and groundwater subject to locally adopted groundwater management plans.

Topography and Soils

The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Yolo County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Yolo and Colusa Counties.

Soil associations in the Yolo County area of RD 108 are as follows:

- Sycamore-Tyndall: Somewhat poorly drained, nearly level, very fine sandy loams to silty clay loams on alluvial fans.
- Sacramento: Poorly drained, nearly level silty clay loams and clays in basins.
- Capay-Sacramento: Moderately well-drained to poorly drained, nearly level, silty clay loams to clays in basins.

Soil profile characteristics in the Colusa County area of RD 108 are as follows:

- Young alluvial fan and basin soils with moderately compacted subsoils.
- Recent alluvial fan and floodplain soils with deep permeable profiles.
- Older alluvial fan and basin soils with moderately compacted subsoils.

Soils in Colusa County are currently classified according to profile characteristics. Soil profile characteristics for Colusa County will be updated and grouped into soil association descriptions pending publication of a new NRCS Soil Survey for the county. Identification of the limitations on RD 108 agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the District and/or individual farmers in the District.

Agricultural

Rice is the predominant crop grown within RD 108's service area. Other key crops include tomatoes, safflower, wheat, alfalfa, corn, and vineseed. Rice accounts for approximately 40 to 50 percent of the District's irrigated acreage on an annual basis. As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. Irrigation water requirements are met through the contract surface water supply, although groundwater is used by a few individual growers to supplement the surface supply, particularly in dry years.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 6 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 6
RD 108 Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	21,500 (+/- 10%)[c]	21,600 (+/- 10%)[c]
Grain	8,200 (+/- 45%)[c]	8,100 (+/- 45%)[c]
Safflower	5,500 (+/- 35%)[c]	5,100 (+/- 35%)[c]
Tomatoes	5,400 (+/- 70%)[c]	6,600 (+/- 70%)[c]
All Other Crops	10,400 (+/- 30%)[c]	9,300 (+/- 30%)[c]
Total Irrigated Acreage	**51,000 (+/- 5%)[c,d]**	**52,500 (+/-5%)[c,d]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Northern and Central Districts.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern and Central Districts.

[c] Percentages obtained from RD 108.

[d] Includes 1,400 double-cropped acres for 1995, and 1,800 double-cropped acres for 2020.

Figure 7 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

With the phase-out of rice straw burning over the past several years, there has been an increased interest by rice growers in fall and winter flooding of rice fields to enhance decomposition of rice straw and stubble. Approximately 6,000 acres were flooded during each of the past 3 years. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture. The District is actively working with Yolo County Resource Conservation District and Reclamation on a demonstration program of planting native vegetation along the District's irrigation and drainage canals to prevent erosion of levee slopes, to improve water quality, and to enhance wildlife habitat.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Municipal and Industrial

RD 108 does not currently serve water to any municipal or industrial users. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by approximately 2,500 ac-ft compared to 1995 estimated levels (DWR, Central and Northern District). All future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the District does not preclude the possibility of serving such needs in the future.

Environmental

Approximately 100 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas.

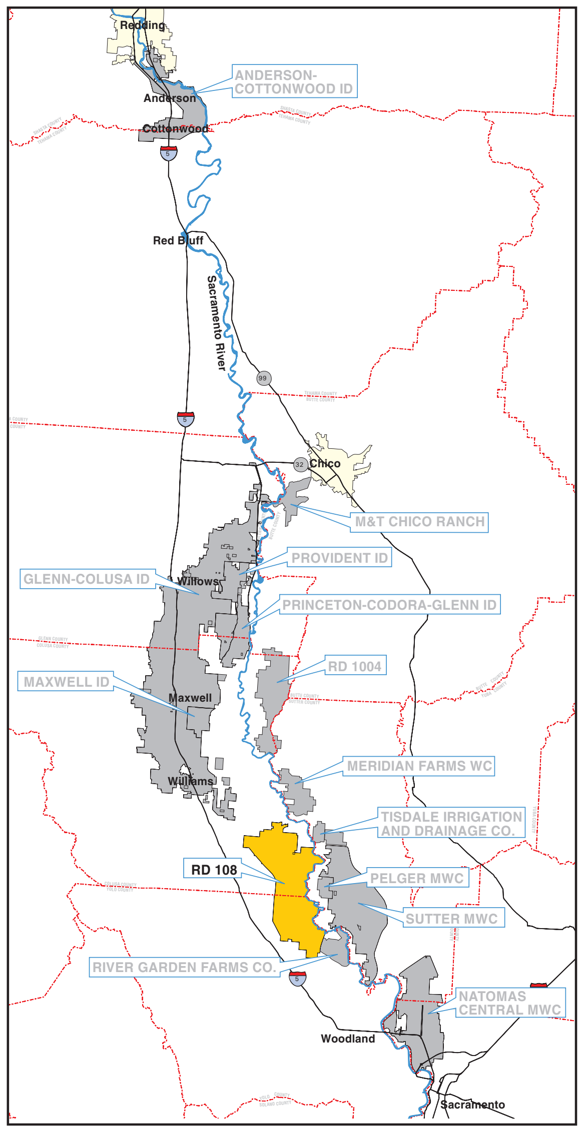
As described above, up to 6,000 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. No managed designated environmental or wetlands areas are within the District.

Reclamation District No. 108

General Manager: Luther P. Hintz • P.O. Box 50 • Grimes, CA 95920 • (530) 437-2221

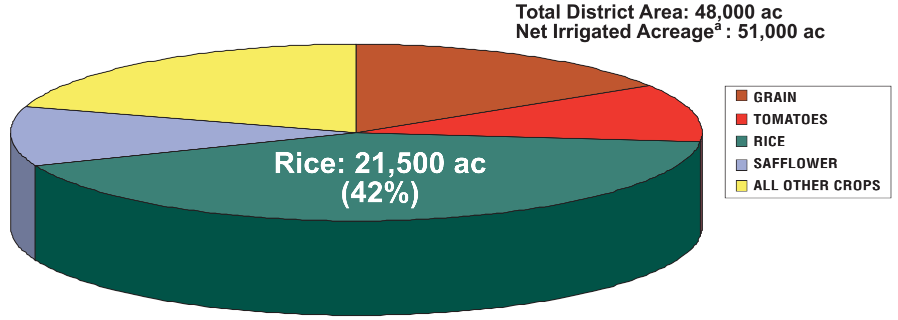
Settlement Contract:	**232,000 af**
Base Supply:	**199,000 af**
Project Supply:	**33,000 af**

Location Map



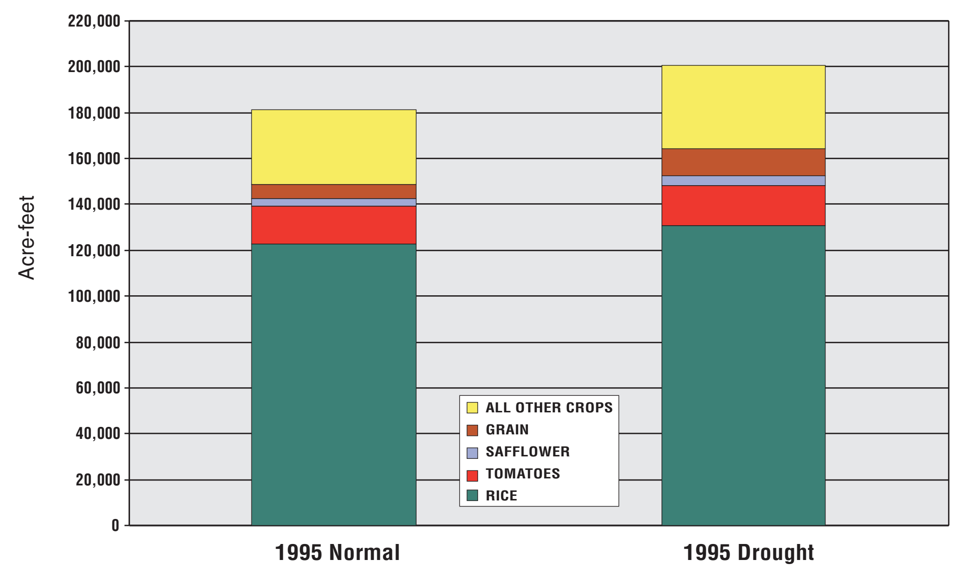
Irrigated Acreage by Crop

Total District Area: 48,000 ac
Net Irrigated Acreage[a]: 51,000 ac

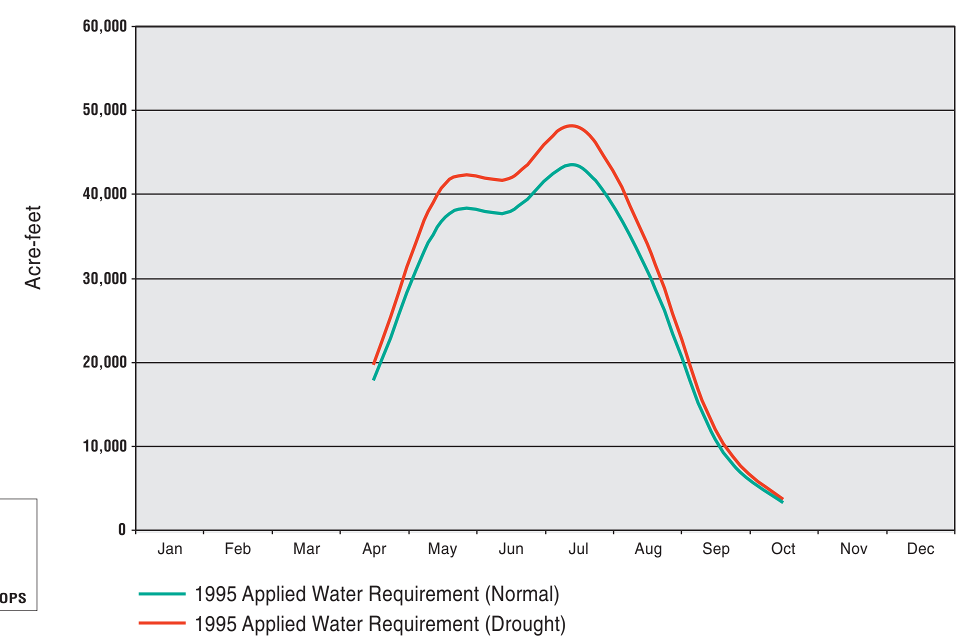


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

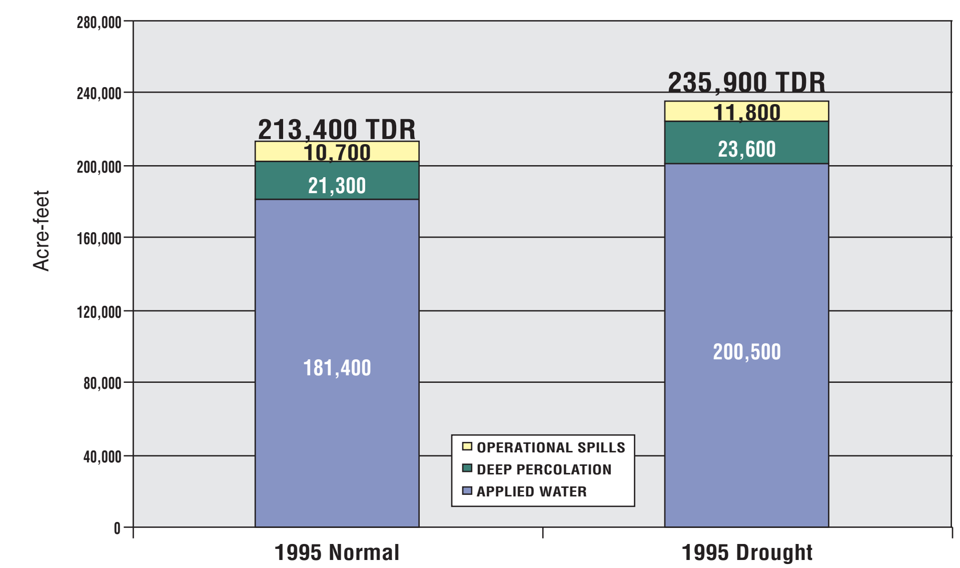


NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates. Includes 1,400 double-cropped acres for 1995.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)

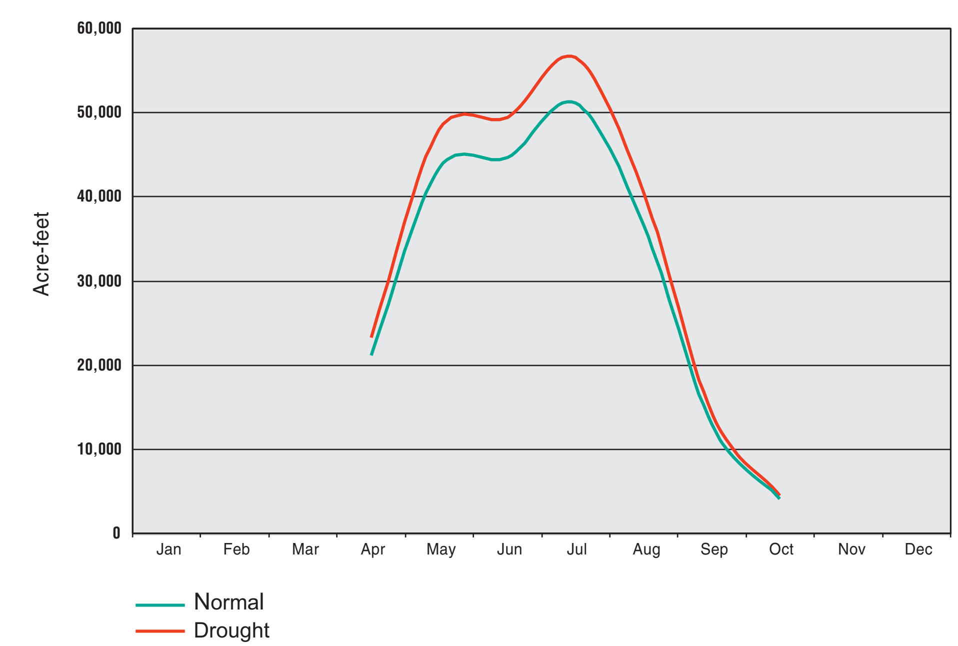


FIGURE 7
RECLAMATION DISTRICT NO. 108
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

W032003010RDD_17_TM 2 (5/2/03)

Butte Sub-basin

- ❑ **Reclamation District No. 1004**

Reclamation District No. 1004

Formation and Right

Reclamation District No. 1004 (RD 1004 or District) entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water RD 1004 could divert from the Sacramento River. The resulting negotiated agreement recognized RD 1004's annual entitlement of a Base Supply of 56,400 ac-ft/yr of flows from the Sacramento River and also provided for a 15,000 ac-ft allocation of Project Water, resulting in a total contract entitlement of 71,400 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3.

Service Area and Distribution System

RD 1004 is located on the east side of the Sacramento River approximately 2 miles east of the town of Colusa and directly west of the Sutter Buttes. The District is primarily in Colusa County, with the southeasternmost portion extending into Sutter County. Butte Creek runs along a portion of the eastern edge of RD 1004. The District's service area encompasses approximately 26,000 acres and includes 48 landowners. Rice is the predominant crop grown within the District. RD 1004 operates one pumping plant on the Sacramento River, which includes six pump/motor units of various horsepower ratings and a combined capacity of approximately 360 cfs. Butte Creek is also used as a source of supply.

RD 1004 uses an arranged schedule to deliver irrigation water to District customers. The District's distribution and conveyance system includes approximately 75 miles of canals and laterals. Leakage associated with the operation of the main canal is typically in the range of 15 percent (percentage of diversion water that seeps through the canal wall, and as a result, is unavailable for conveyance). In addition to the contract entitlement water, RD 1004 pumps water during the nonirrigation season for wetlands and rice straw decomposition. The methods and quantities of diversions have varied in the past.

Topography and Soils

The District's topography generally consists of nearly level to gently sloping terrain. Because the District is relatively flat, the impact of the area's terrain on District water management practices is negligible.

Soil associations for the Sutter County area and soil profile characteristics for the Colusa County area of the District are listed below. The total acreage for the individual soil associations and soil profiles within the District is shown in the General Soils Map and Profile Characteristic Map provided in the NRCS Soil Survey for Sutter and Colusa Counties.

Soil associations in the Sutter County area of RD 1004 are as follows:

- Zamora-Marvin: Well-drained to somewhat poorly drained silt to silty clay loam, moderately fine-textured and fine-textured soils on floodplains.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.
- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.

Soil profile characteristics in the Colusa County area of RD 1004 are as follows:

- Young alluvial fan and basin soils with moderately compacted subsoils.
- Recent alluvial fan and floodplain soils with deep permeable profiles.
- Older alluvial fan and basin soils with moderately compacted subsoils.

Soils in Colusa County are currently classified according to profile characteristics. Soil profile characteristics for Colusa County will be updated and grouped into soil association descriptions pending publication of a new NRCS Soil Survey for the county. Identification of the limitations on RD 1004 agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the District and/or individual farmers in the District**.**

Agricultural

Land use within RD 1004's service area is primarily rice, due to the presence of fine-textured and poorly drained soils within the majority of the District. Other key crops include cotton and wheat. Rice accounts for over 80 percent of the District's irrigated acreage on an annual basis (DWR, Northern District). Water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields. Although surface water is the primary source of irrigation water, groundwater is used in drought years on an individual grower basis and as per agreements with the District.

Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 7 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the District service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the District to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 7
RD 1004 Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	12,800 (+/- 10%)[c]	11,600 (+/- 10%)[c]
Dry Beans	1,400 (+/- 10%)[c]	1,200 (+/- 15%)[c]
Cotton	500 (+/-10%)[c]	1,500 (+/- 10%)[c]
Tomatoes	300 (+/-5%)[c]	300 (+/- 5%)[c]
Concurbits	200 (+/-10%)[c]	600 (+/- 10%)[c]
All Other Crops	500 (+/-5%)[c]	500 (+/- 5%)[c]
Total Irrigated Acreage	**15,700 (+/-10%)[c]**	**15,700 (+/- 10%)[c]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Northern District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern District.

[c] Percentages obtained from RD 1004.

Figure 8 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the District's land-owners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 12,000 acres have been flooded in the past, a trend that is expected to continue or increase assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to remain relatively the same as current conditions.

Municipal and Industrial

RD 1004 does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by less than 100 ac-ft compared to 1995 estimated levels (DWR, Northern District). All future M&I water requirements are assumed to be met by groundwater supplies. Although it is considered unlikely, RD 1004 could provide M&I water, but current estimates of future M&I demand are minimal.

Environmental

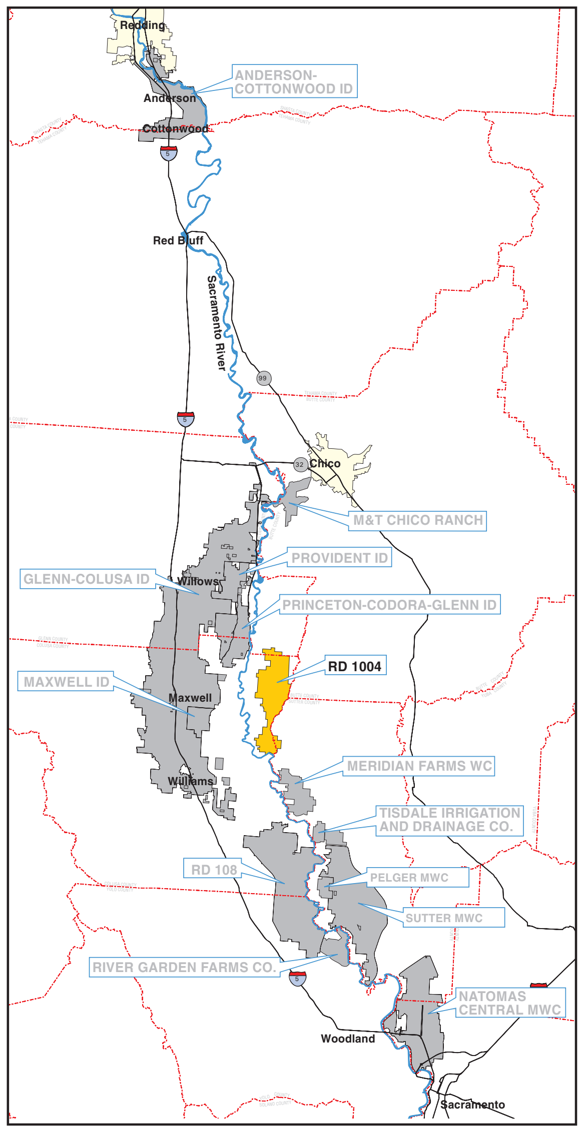
Approximately 35 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes elderberry shrubs, which provide habitat for the federally listed valley elderberry longhorn beetle, and habitat used by the giant garter snake.

Reclamation District No. 1004

Manager: Kelly Boyd • 134 5th Street • Colusa, CA 95932 • (530) 458-7459

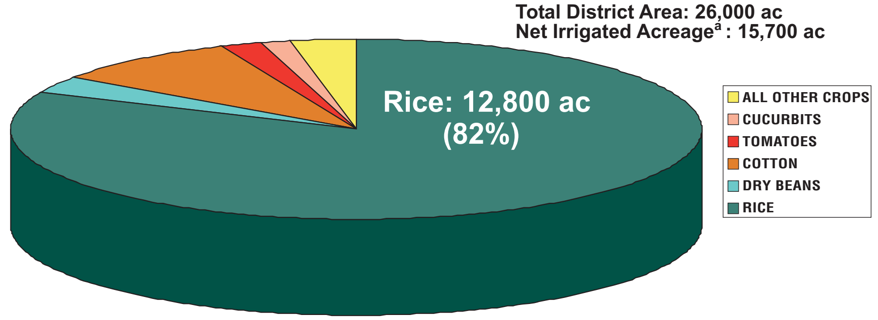
Settlement Contract:	71,400 af
Base Supply:	56,400 af
Project Supply:	15,000 af

Location Map



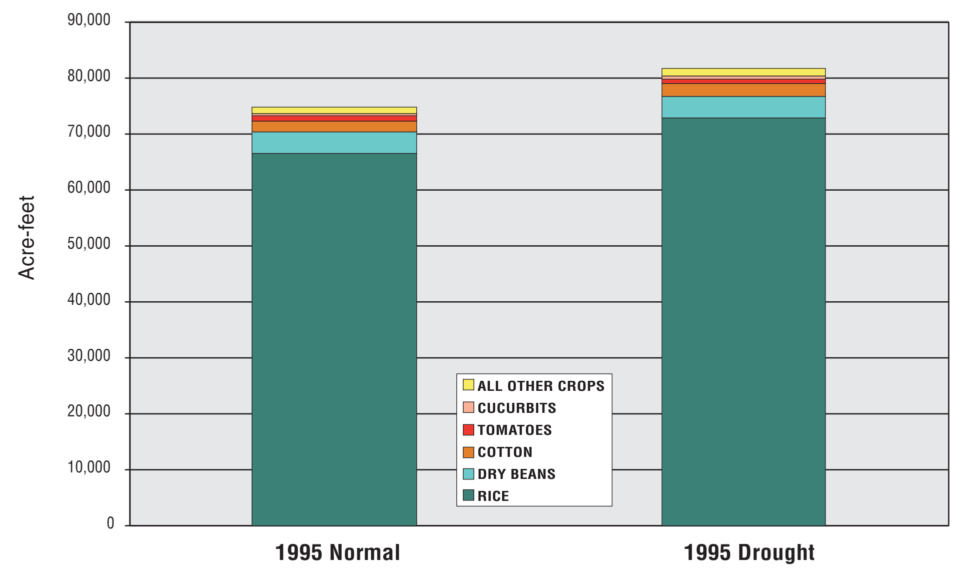
Irrigated Acreage by Crop

Total District Area: 26,000 ac
Net Irrigated Acreage[a] : 15,700 ac

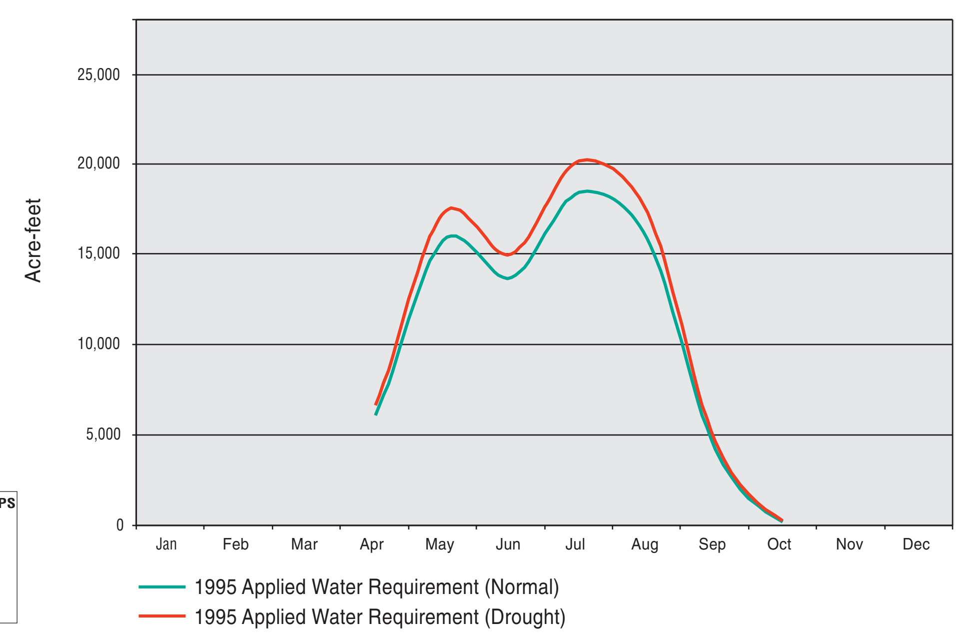


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

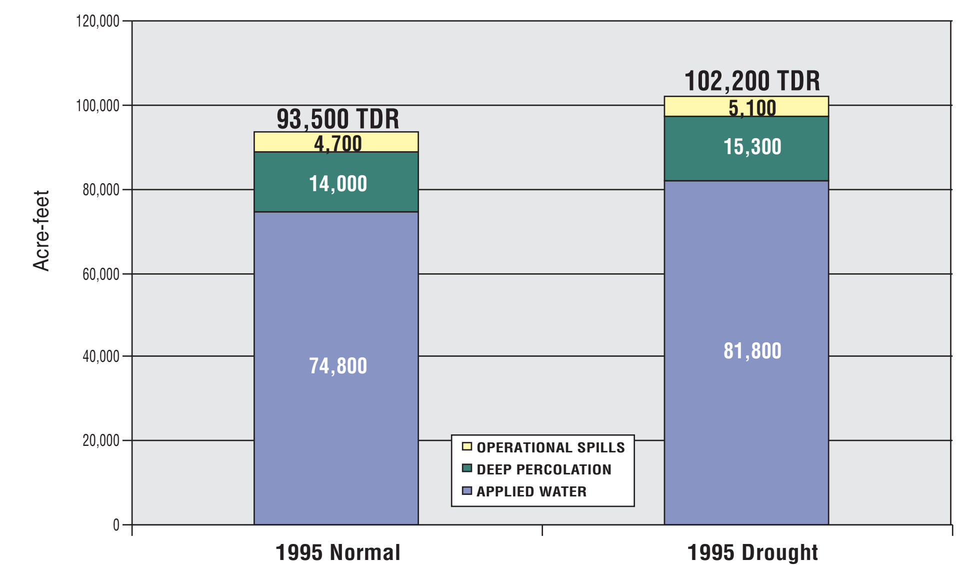


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

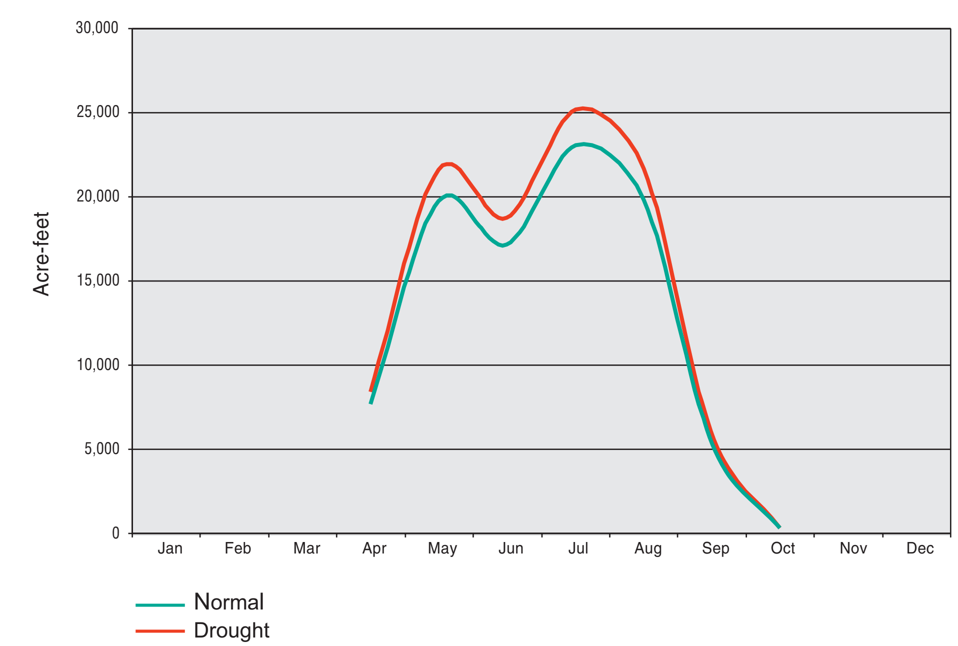


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 8
RECLAMATION DISTRICT NO. 1004
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK

Sutter Sub-basin

- **Meridian Farms Water Company**
- **Sutter Mutual Water Company**
- **Pelger Mutual Water Company**

Meridian Farms Water Company

Formation and Right

Meridian Farms Water Company (MFWC or Company) was formed in 1926, under the state corporation laws and codes. The Company entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water MFWC could divert from the Sacramento River. The resulting negotiated agreement recognized MFWC's annual entitlement of a Base supply of 23,000 ac-ft/yr of flows from the Sacramento River and also provided for a 12,000 ac-ft allocation of Project Water, resulting in a contract entitlement of 35,000 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3. In addition to the contract water, MFWC has entitlements to pump water from drains within the service boundary for water recycling. The Company operates five wells to supplement surface water supplies. These wells are used in conjunction with the river pumps and drainwater recycling pump to meet irrigation needs.

Rice, tomatoes, alfalfa, and other deciduous crops, such as walnuts, have historically been the predominant crops grown within the Company. In addition, rotation crops such as wheat and safflower are rotated on rice and tomato fields. Rotation crops are not typically irrigated, except for a brief irrigation immediately following planting. Due to a recent change in market conditions, MFWC has been experiencing an increase in rice production in the service area, and a drop in tomato production due to the closure of two nearby tomato processing facilities.

Service Area and Distribution System

MFWC is located on the east side of the Sacramento River east of the community of Meridian and directly southwest of the Sutter Buttes. The Company encompasses approximately 9,900 acres and serves 73 landowners. The main pumping facility is located at River Mile 134 on the Sacramento River.

MFWC uses an arranged schedule to deliver irrigation water to Company customers. MFWC also pumps water from the Sacramento River using two other pump stations. The Company's distribution and conveyance system includes approximately 16 miles of main canals and 19 miles of major laterals. Seepage from the canals and laterals is approximately 15 percent. MFWC coordinates all drain operations with Reclamation District No. 70, and the Company has no specific agreements in place to handle floodwaters. MFWC has usable groundwater resources within its boundaries and uses groundwater as a normal part of its resource mix, although some nearby wells have low-quality groundwater as a result of connate water upwelling. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These landowners, called "rimlanders," are not within Company boundaries, but contribute drainwater that may be reused by Company farmers. Past efforts to coordinate operations with these landowners have failed.

The Company relies heavily on drainwater to supplement their own water sources. The Company is able to reuse a large portion of its drainwater due to the flat physiography of the area and the use of Long Lake and several pumps that can "step" water to the upper reaches of the Company. MFWC currently uses an average of 15,000 ac-ft/yr of drainwater, equivalent to approximately 60 percent of the Company's average Sacramento River diversion.

Topography and Soils

The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter County.

- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.
- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.

Identification of the limitations on MFWC agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the Company and/or individual farmers in the Company.

Agricultural

MFWC operates similarly to larger districts in terms of cropping patterns and cultural practices. In the recent past, rice has typically accounted for less than half of the Company's irrigated acreage on an annual basis; other key crops include tomatoes, safflower, alfalfa, and walnuts (DWR, Central District). As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of the crops grown and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. Local rice production is assisted by using recycled drainwater and storing water in canals and Long Lake. Recycling and brief storage allow for warming of the water, which benefits rice production. Also, several fields have recently been certified as organic rice farms. Organically grown rice is a higher-value crop that requires additional water to offset herbicides commonly used for weed control. Irrigation water requirements are met through the contract surface water supplies, drainwater recycling, and groundwater.

As noted above, the Company has been experiencing an increase in rice production in the service area, and a reduction in tomato production due to changing market conditions. This increase in rice production has placed additional demands on the water service system, which has limited capacity in the middle of the Company due to a relatively flat slope and the need to maintain full canals to recirculate drainwater. Currently, tomato crops are trending toward the use of greenhouse-grown seedlings. Use of seedlings allows for farmers to plant as soon as weather forecasts are favorable, which may be as early as March, earlier than typical start dates for seed-grown tomatoes. Seedlings use less water because the soil does not need to be kept as moist as typically required for seed emergence.

Table 8 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 8
MFWC Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	3,500 (+/- 44%)[c]	3,500 (+/- 44%)[c]
Safflower	2,400 (+/- 11%)[c]	2,400 (+/- 11%[c]
Tomatoes	1,300 (+/- 32%)[c]	1,300 (+/- 32%)[c]
Grain	1,000 (+/- 13%)[c]	1,000 (+/- 13%)[c]
Other Deciduous	600 (+/- 8%)[c]	600 (+/- 8%)[c]
All Other Crops	900 (+/- 5%)[c]	11,100 (+/- 5%)[c]
Total Irrigated	**9,700 (+/- 5%)[c,d]**	**9,700 (+/- 5%)[c,d]**

[a] Figures are estimates derived from field data which have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Central District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Central District.

[c] Percentages obtained from MFWC.

[d] Includes 500 double-cropped acres for 1995 and 2020.

Figure 9 summarizes irrigated acreage by crop, on-field water requirements, and total Company requirements.

The Company's Board of Directors issued a policy directive against the use of winter water for rice straw decomposition. The policy directive was issued in response to concerns regarding flood pumping capacity – if a flood were to occur during decomposition, existing drain pumps would not be able to remove floodwater and decomposition water. Removal of rice straw has not been a large issue in the service area because of the regular practice of crop rotation. Rice straw is usually disked under after the growing season, before the field is planted with a different crop the following year.

Future irrigation season cropping patterns and associated water requirements are anticipated to continue the current trend toward increased rice production and a reduction in tomato production, with rotations of beans, wheat, and safflower.

Municipal and Industrial

MFWC is near the agricultural and residential Town of Meridian, but does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the District is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to be negligible to 1995 estimated levels (DWR, Central District). All future M&I requirements are assumed to be met by groundwater supplies. Although M&I requirements are not currently being served, the Company does not preclude the possibility of serving such requirements in the future.

Environmental

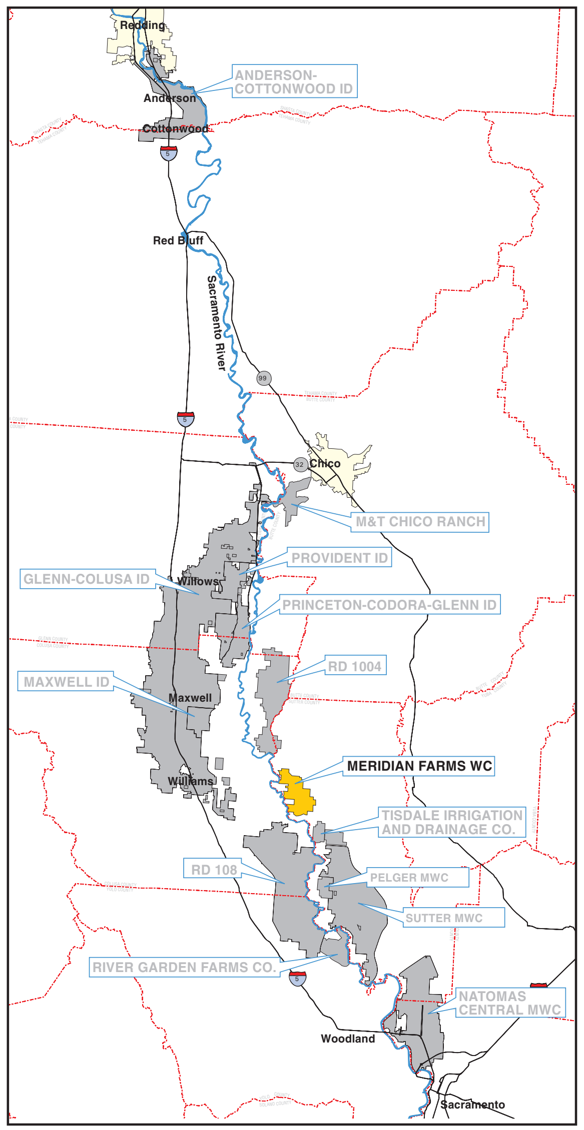
Long Lake is a substantial, privately owned environmental resource within the Company boundary, supporting migratory waterfowl, including pelicans. Additionally, the lake has catfish, crappie, bass, frogs, and crawdads, supporting a modest local sport fishery. The flooding of rice fields in the spring and summer provides wetlands, habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. The Company does not serve any private duck clubs, nor are there any formally designated wetlands habitat areas.

Meridian Farms Water Company

Manager: Harold Webster • P.O. Box 308 • 1138 4th Street • Meridian, CA 95957 • (530) 696-2456

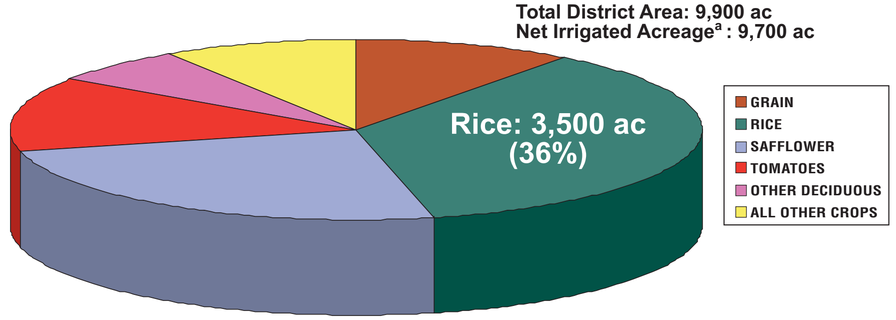
Settlement Contract:	35,000 af
Base Supply:	23,000 af
Project Supply:	12,000 af

Location Map



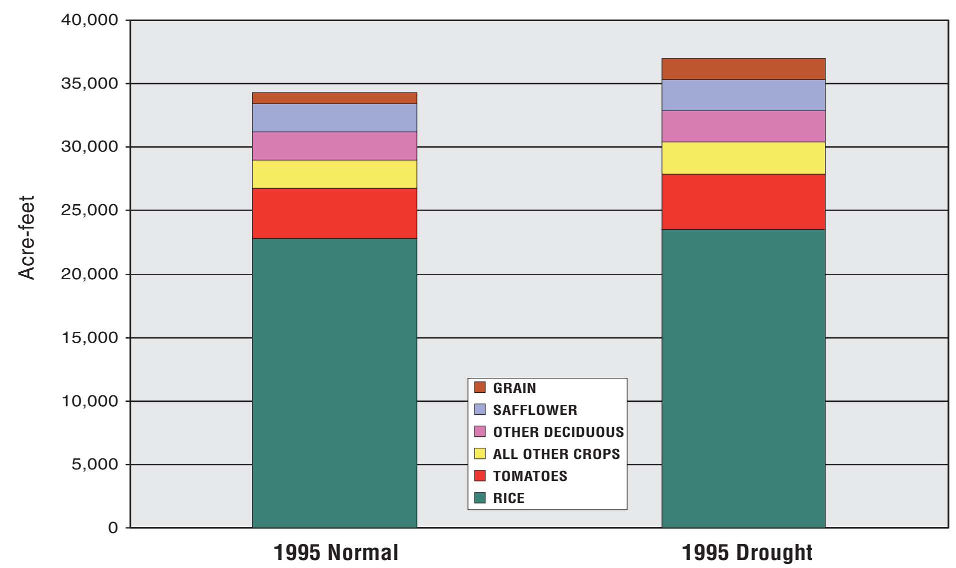
Irrigated Acreage by Crop

Total District Area: 9,900 ac
Net Irrigated Acreage[a] : 9,700 ac

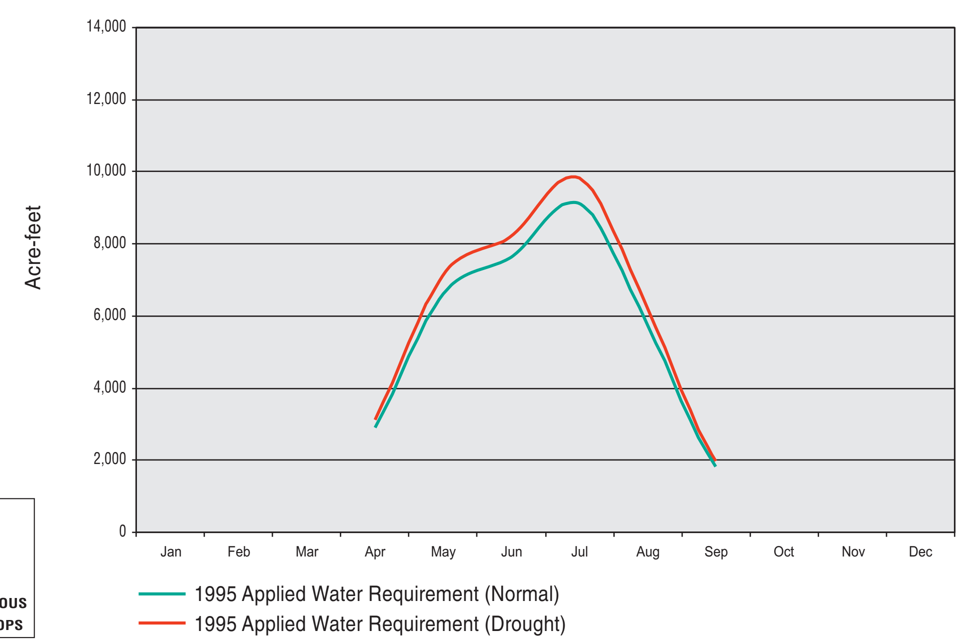


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)



Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

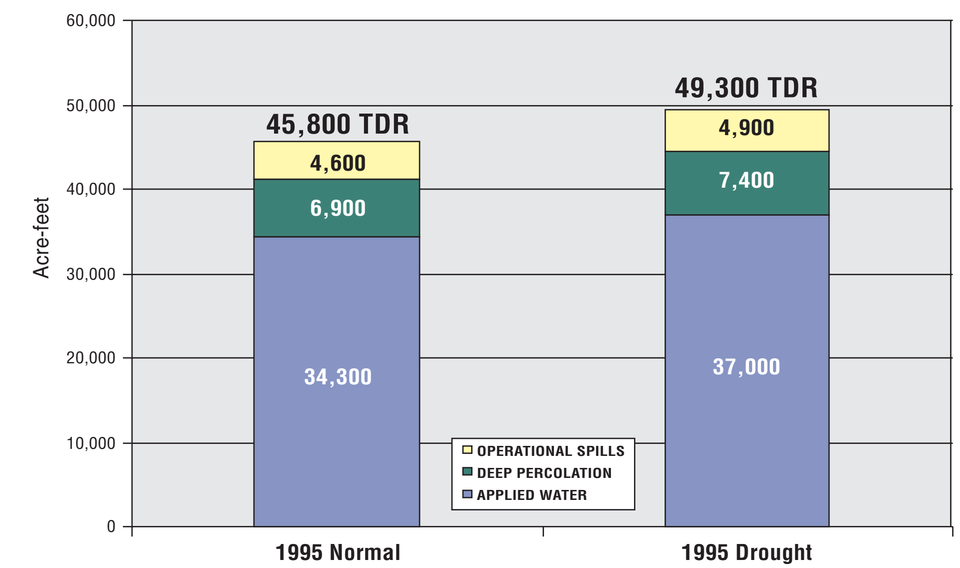


NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

District Water Requirements

Annual Total District Water Requirement
(Includes 10% Operational Spills and 15% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 15% Deep Percolation Estimates)

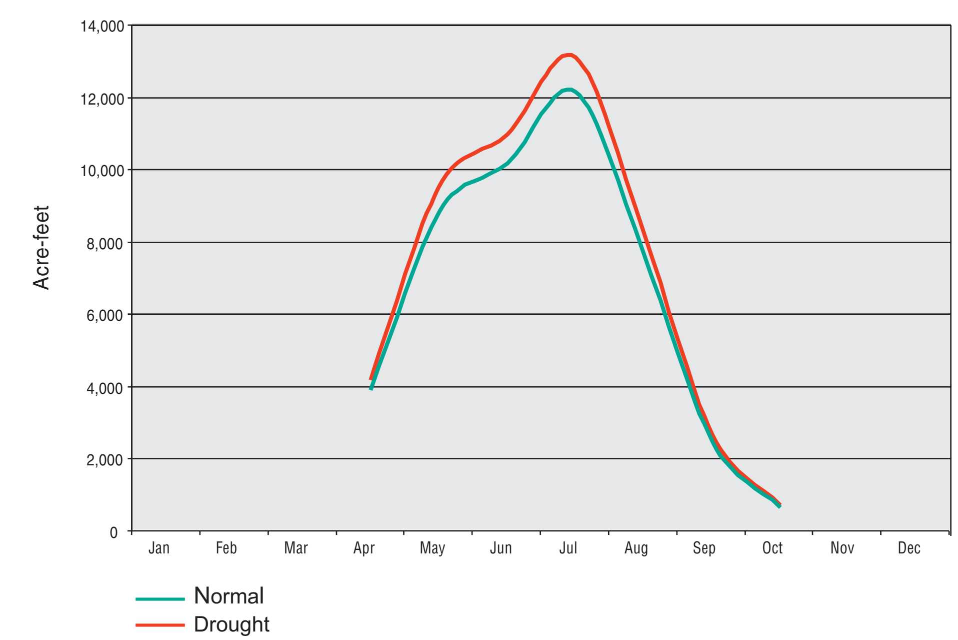


FIGURE 9
MERIDIAN FARMS
WATER COMPANY
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK

W032003010RDD_24_TM 2 (4/29/03)

Sutter Mutual Water Company

Formation and Right

Sutter Mutual Water Company (SMWC or Company) was formed February 5, 1919, under the state corporation laws and codes. The Company entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water SMWC could divert from the Sacramento River. The resulting negotiated agreement recognized SMWC's annual entitlement of a Base Supply of 172,900 ac-ft/yr of flows from the Sacramento River and also provided for a 95,000 ac-ft allocation of Project Water, resulting in a total contract entitlement of 267,900 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3. In addition to the contract water, SMWC has entitlements to pump water during the nonirrigation season for wetlands and rice straw decomposition given appropriative rights during the winter months of approximately 250 cfs.

Service Area and Distribution System

SMWC is located approximately 45 miles northwest of Sacramento and is bordered by three levee systems. The Company encompasses approximately 50,000 acres and serves 150 landowners. Company boundaries encompass the Town of Robbins. The Company operates three pumping plants: Tisdale Pumping Plant (960-cfs capacity), State Ranch Bend Pumping Plant (125 cfs), and Portuguese Bend Pumping Plant (100 cfs). SMWC also has eight booster pump sites (they typically operate four to five in any given year) and one internal recirculation system with a total combined capacity of 290 cfs/day. These facilities are used for drainwater reuse and are located in the central and northeast portions of the Company.

SMWC is interlaced with drainage ditches (all of which are operated and maintained by Reclamation District No. 1500 [RD 1500]) that carry water toward the Main Drain and eventually out of the service area at the southern end of the Company at the Kaenak Pump Station. Drainage ditches in the eastern portion of the Company intercept naturally occurring saline groundwater, called "connate water." This saline groundwater tends to be most prevalent toward the eastern portion of the Company associated with artesian pressure through the Sutter Basin Fault. Salinity concentrations tend to increase with depth (U.S. Department of Agriculture/NRCS, 1996). Irrigation practices using Sacramento River water and drainage systems have allowed the Company and other districts/landowners to maintain suitable crop yields and keep the connate water below the crop root zones.

The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These landowners, called "rimlanders," are not within Company boundaries, but contribute drainwater that may be reused by Company farmers. Company operations are coordinated with RD 1500 and Pelger Mutual Water Company. RD 1500 manages drainage in the service area, and SMWC delivers water to the majority of water users in the area.

SMWC uses an arranged schedule to deliver irrigation water to Company customers. The Company's distribution and conveyance system includes approximately 56 miles of irrigation water delivery canals and 144 miles of laterals. Delivery system leakage associated with the operation of the Company is approximately 15 percent of the diversion during the spring, summer, and early fall irrigation season. Approximately 38 wells have been drilled within the Company boundaries, but most have been abandoned due to high salinity levels and lack of sustained yield as discussed above. Reuse of water is driven in part by year type; however, the high water table and its saline nature limit the amount of water that can be successfully reused without impacting crop yields and salt accumulation in the soil profile. Winter operations call for most drains to be opened around Labor Day of each year to allow for the dewatering of the basin in preparation for the passage of winter flows.

Topography and Soils

The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter County.

- San Joaquin-Cometa: Moderately deep and very deep, level to nearly level, well-drained sandy loam and loam on terraces.
- Oswald-Gridley-Subaco: Moderately deep, level to nearly level, poorly drained and moderately well-drained clay and clay loam in basins and on basin rims.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.
- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.

Identification of the limitations on SMWC agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the Company and/or individual farmers within the Company.

Agricultural

The two major crops grown within the Company's service area are tomatoes (grown in rotation with wheat, safflower, and beans) and rice (sometimes grown in rotation with wheat, safflower, beans, and melons, or grown 7 or 8 years consecutively without rotation).

Rice is the predominant crop grown within SMWC's service area, accounting for approximately 35 to 40 percent of the Company's irrigated acreage on an annual basis. As is the case with most of the other districts, water requirements are typically highest during the summer months (June, July, and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice and other crops are greatest early in the growing season during dry years associated with irrigating previously dry fields. The vast majority of irrigation water requirements are met through the contract surface water supply, although drainwater is used depending on availability and quality.

Annual cropping patterns have changed a great deal over the last few decades, as rice acreage has declined substantially. The prevalence of relatively rich, well-drained soils allows for a diversity of crops within the Company boundary. Tomatoes have been the primary crop that has supplanted former rice-growing lands, due to economically driven individual grower decisions. However, the recent closure of two tomato canneries in the area may lead to a reduction in tomato production in the near future. Therefore, associated water requirement needs and associated diversions are driven by changes in cropping patterns, as well as water-year type.

Table 9 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 9
SMWC Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Rice	17,400 (+/- 10%)[c]	17,400(+/- 25%)[c]
Tomatoes	12,200 (+/- 10%)[c]	12,200 (+/- 20%)[c]
Grain	8,100 (+/- 15%)[c]	8,000 (+/- 15%)[c]
Dry Beans	5,500 (+/- 15%)[c]	4,900 (+/- 15%)[c]
All Other Crops	8,900 (+/- 15%)[c]	8,500 (+/- 25%)[c]
Total Irrigated Acreage	**52,100 (+/- 5%)[c,d]**	**51,000 (+/- 5%)[c,d]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Central District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Central District.

[c] Percentages obtained from SMWC.

[d] Includes 5,500 double-cropped acres for 1995, and 4,900 double-cropped acres for 2020.

Figure 10 summarizes irrigated acreage by crop, on-field requirements, and TDRs.

In response to increasingly stringent limitations on burning, many of the Company's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 3,000 to 4,000 acres have been flooded in the past, a trend that is expected to continue or increase assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. Flood-related restrictions currently specified by RD 1500 limit the total acreage potentially available for rice decomposition flooding to 5,000 acres. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to change, but the total water requirements for the Company remain relatively the same as current conditions.

Municipal and Industrial

SMWC overlies the agricultural and residential Town of Robbins, but does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the Company service area is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by approximately 1,900 ac-ft compared to 1995 estimated levels (DWR, Central District). All future M&I requirements are assumed to be met by groundwater supplies. In the future, SMWC may provide M&I water to meet growing future M&I requirements.

Environmental

In 1990, approximately 250 acres of riparian vegetation were estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. Other endangered species that occur within the service area include the western yellow-billed cuckoo, Swainson’s hawk, bank swallow, wood duck, western pond turtle, California tiger salamander, California red-legged frog, valley elderberry longhorn beetle, and the California hibiscus. Agricultural development has favored other species, notably waterfowl and ring-necked pheasants. Drainage ditches support blue and channel catfish, carp, crayfish, and bullfrogs.

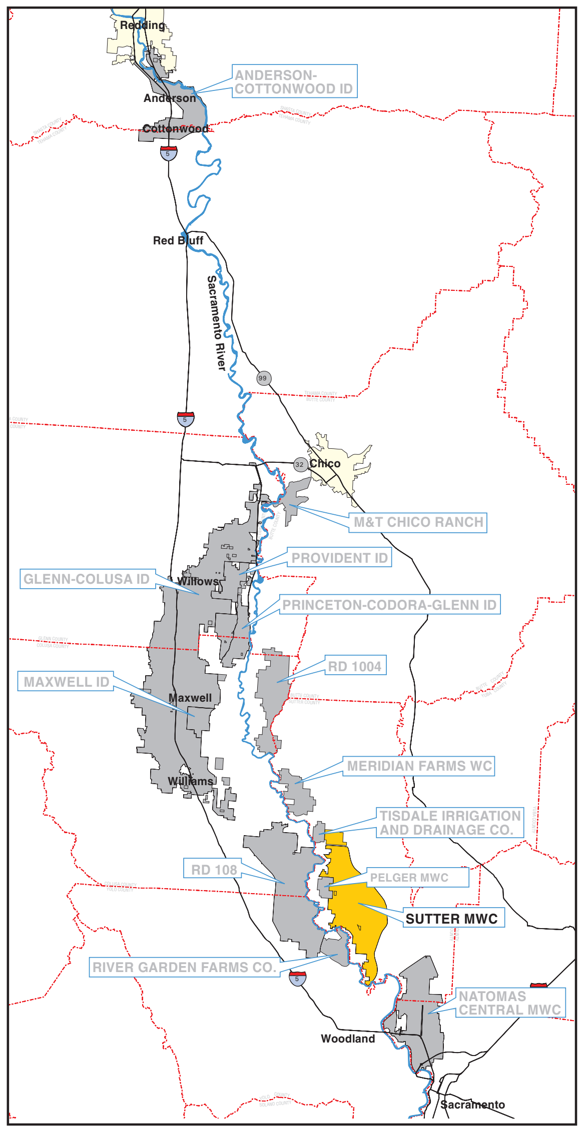
Up to 4,000 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. As previously described, the Company has set a total Companywide limit at 5,000 acres due to winter flooding concerns. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. No formally managed designated environmental or wetlands areas are within the Company.

Sutter Mutual Water Company

Manager: Max S. Sakato • P.O. Box 128 • Robbins, CA 95676 • (530) 738-4423

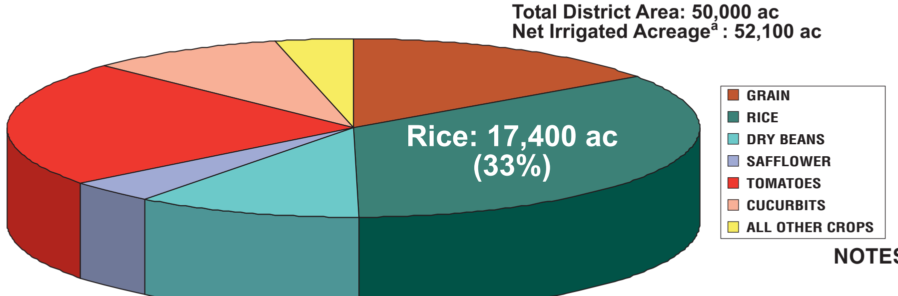
Settlement Contract:	**267,900 af[c]**
Base Supply:	**172,900 af[c]**
Project Supply:	**95,000 af[c]**
Proposed Renewal Contract:	226,000 af
Proposed Base Supply:	169,500 af
Proposed Project Supply:	56,500 af

Location Map



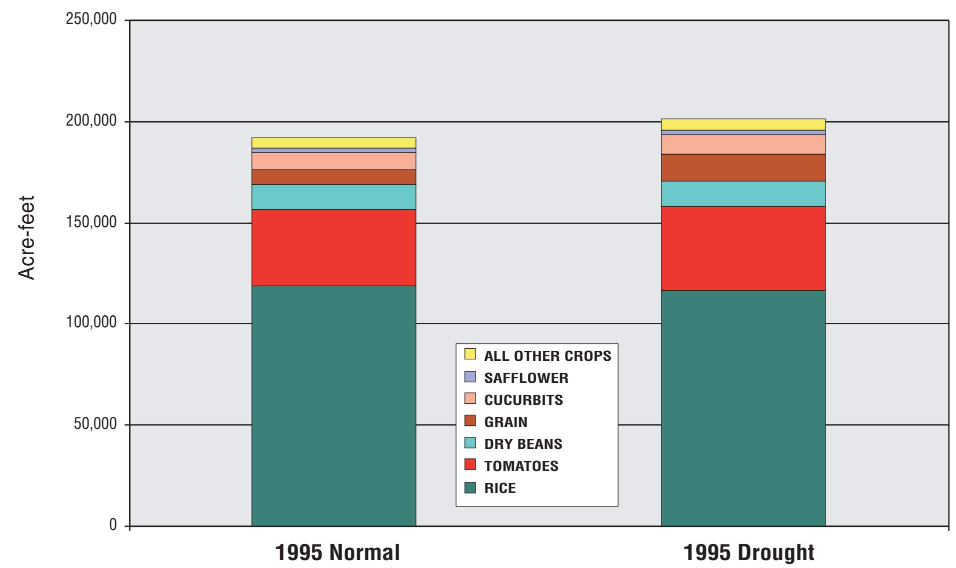
Irrigated Acreage by Crop

Total District Area: 50,000 ac
Net Irrigated Acreage[a] : 52,100 ac

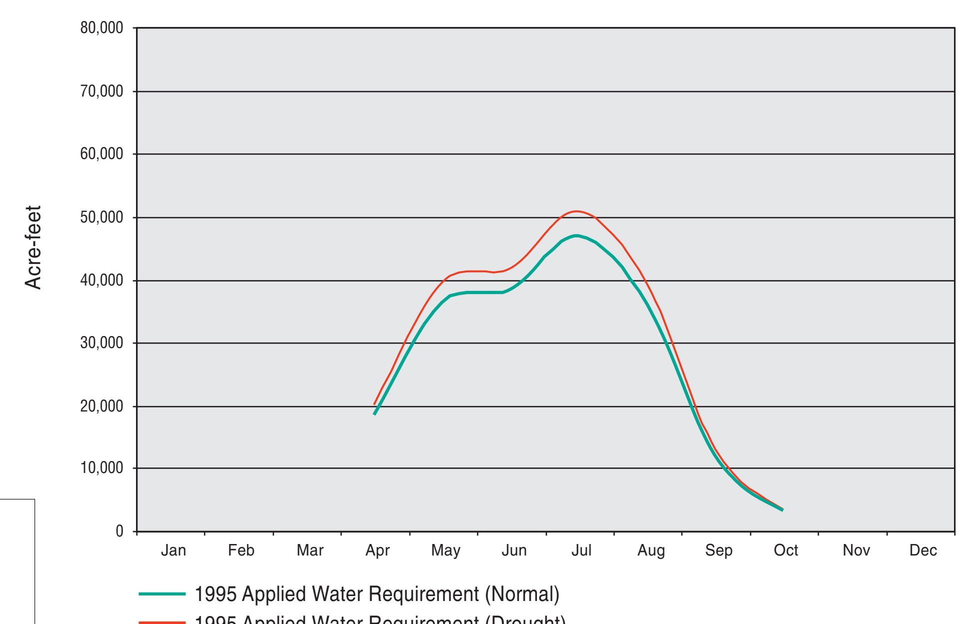


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

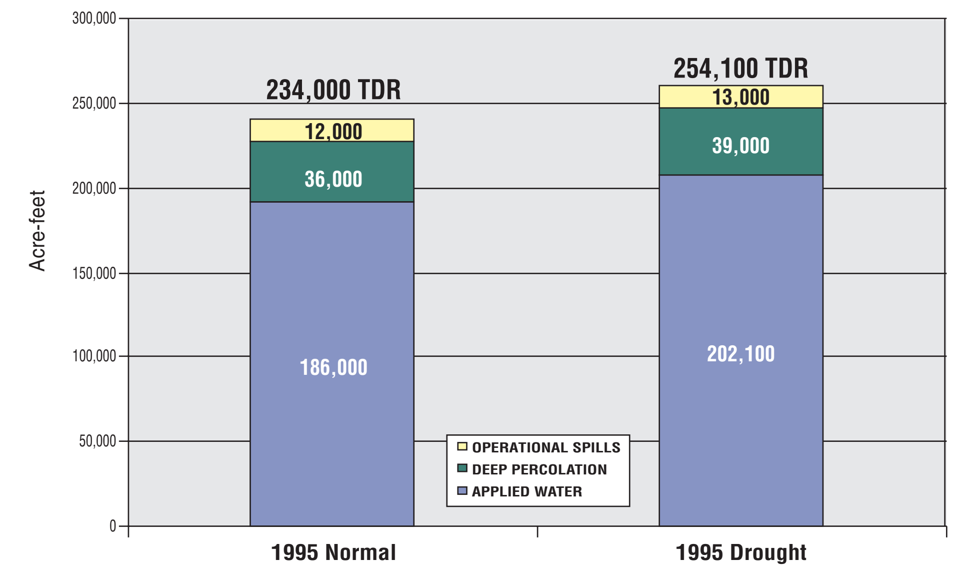


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

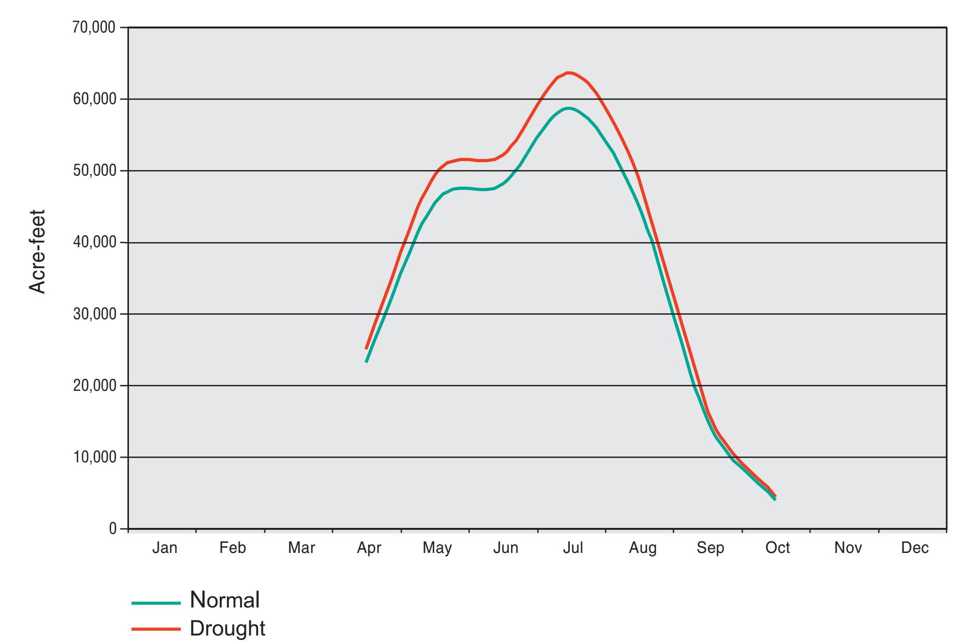


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 15% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates. Includes 5,500 double-cropped acres for 1995.
[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.
[c] Scheduled to expire in 2006.

FIGURE 10
SUTTER MUTUAL WATER COMPANY
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

W062004006RDD_20_TM 2 (10/4/04)

Pelger Mutual Water Company

Formation and Right

Pelger Mutual Water Company (PMWC or Company) was formed on March 11, 1965, under the state corporate laws and codes. The Company entered into a negotiated agreement with Reclamation in 1965, quantifying the amount of water PMWC could divert from the Sacramento River. The resulting negotiated agreement recognized PMWC's annual entitlement of a Base Supply of 7,110 ac-ft/yr of flows from the Sacramento River and also provided for a 1,750 ac-ft allocation of Project Water resulting, in a total contract entitlement of 8,860 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3. In addition to the contract water, PMWC has entitlements to pump water during the nonirrigation season for wetlands and rice straw decomposition. There are approximately three privately owned wells and no Company-owned wells within the Company's boundaries. These wells are used in conjunction with the river pumps and drainwater recycling pump to meet irrigation needs. Rice, tomatoes, and corn are the predominant crops grown within the Company, in addition to rotation crops such as wheat and safflower that are rotated on rice and tomato fields. Rotation crops are not typically irrigated, except for a brief pre-irrigation immediately following planting. PMWC's primary water supply facility is the Pelger Pump Station located on the Sacramento River. The Company also relies heavily on drainwater for a secondary supply, with diversions from the RD 1500 Drain just east of the Company service area.

Service Area and Distribution System

PMWC is located approximately 45 miles northwest of Sacramento and is bordered by SMWC on three sides. The Company encompasses approximately 2,900 acres and serves 10 landowners. Water deliveries are coordinated with SMWC and drain usage with RD 1500. RD 1500 has sole authority and control of flood control matters. While portions of neighboring SMWC have low-quality groundwater as a result of connate water upwelling, PMWC has usable groundwater resources within its boundaries and uses groundwater as a normal part of its resource mix. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These landowners, called "rimlanders," are not within Company boundaries, but contribute drainwater that may be reused by Company farmers.

PMWC uses an arranged schedule to deliver irrigation water to Company customers. The Company's distribution and conveyance system includes approximately 10 miles of canals and laterals. Seepage from the canals and laterals is approximately 10 percent. PMWC has a network of unlined drainage ditches and drain pump stations for conveying irrigation return flows. The drains and pumps are also an integral part of the water supply and distribution system for capturing and reusing drainwater. Area drains generally empty into the RD 1500 Drain to the east.

The Company actively manages three main water sources to meet its needs: river diversions, drain recycling, and groundwater pumping. Since 1990, the majority of irrigation water requirements have been meet by drainwater use (approximately 50 to 75 percent depending on year), with the remainder being met by Sacramento River diversions (15 to 50 percent) and groundwater (0 to 25 percent). The flexibility to supply water from these various sources is a function of the infrastructure in the Company and the relatively small acreage served.

Topography and Soils

The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter County.

- Oswald-Gridley-Subaco: Moderately deep, level to nearly level, poorly drained and moderately well-drained clay and clay loam in basins and on basin rims.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.

Identification of the limitations on PMWC agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the Company and/or individual farmers in the Company.

Agricultural

As noted above, PMWC is a relatively small company serving just 10 landowners. However, due to climate and soils, the Company operates similarly to larger districts in terms of cropping patterns and cultural practices. Rice typically accounts for less than half of the Company's irrigated acreage on an annual basis; other key crops include tomatoes and corn (DWR, Northern District). As is the case with most of the other districts, water requirements are typically highest during the summer months (July and August) due to the requirements of the crops grown within the PMWC boundary and the area's hot, dry climate.

Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. Irrigation water requirements are met through the contract surface water supplies, drain recycling, and groundwater. There is high variability in crop mix from year to year. Associated water requirement needs and associated diversions have therefore been a function of water-year type, climate, and changes in crop mix.

Table 10 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 10
PMWC Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a]	2020[b]
Corn	700 (+/- 10-25%)[c]	700(+/- 10-25%)[c]
Rice	600 (+/- 10-25%)[c]	600 (+/- 10-25%)[bc]
Tomatoes	600 (+/- 10-25%)[c]	600 (+/- 10-25%)[c]
All Other Crops	1,000(+/- 10-25%)[c]	1,000 (+/- 10-25%)[c]
Total Irrigated Acreage	**2,900(+/- 10%)[c,d]**	**2,900 (+/- 10%)[c,d]**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Northern District.

[b] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Northern District.

[c] Percentages obtained from PMWC.

[d] Includes 100 double-cropped acres for 2020.

Figure 11 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, some of the Company's rice-growing landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 1,000 acres have been flooded in the past, a trend that is expected to continue and increase assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. The Company currently has an agreement with the U.S. Fish and Wildlife Service, which encourages winter straw decomposition flooding practices. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Future irrigation season cropping patterns and associated water requirements are anticipated to vary widely, as shown by the historical data.

Municipal and Industrial

PMWC is near the agricultural and residential Town of Robbins, but does not provide water service for either municipal or industrial use. M&I water demand within the vicinity of the Company is anticipated to increase only slightly, with additional annual water requirements in the year 2020 expected to increase by approximately 1,900 ac-ft compared to 1995 estimated levels (DWR, Central District). All of this water (in addition to current demands) is assumed to be groundwater. Although M&I requirements are not currently being served, the Company does not preclude the possibility of serving such needs in the future. In the future, PMWC may provide M&I water, but current estimates of future M&I requirements are minimal.

Environmental

Approximately 60 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake. Other endangered species that occur within the service area include the western yellow-billed cuckoo, Swainson's hawk, bank swallow, wood duck, western pond turtle, California tiger salamander, California red-legged frog, valley elderberry longhorn beetle, and the California hibiscus. Agricultural development has favored other species, notably waterfowl and ring-necked pheasants. Ditches support blue and channel catfish, carp, crayfish, and bullfrogs; and the ditches are easily accessible to the public for fishing.

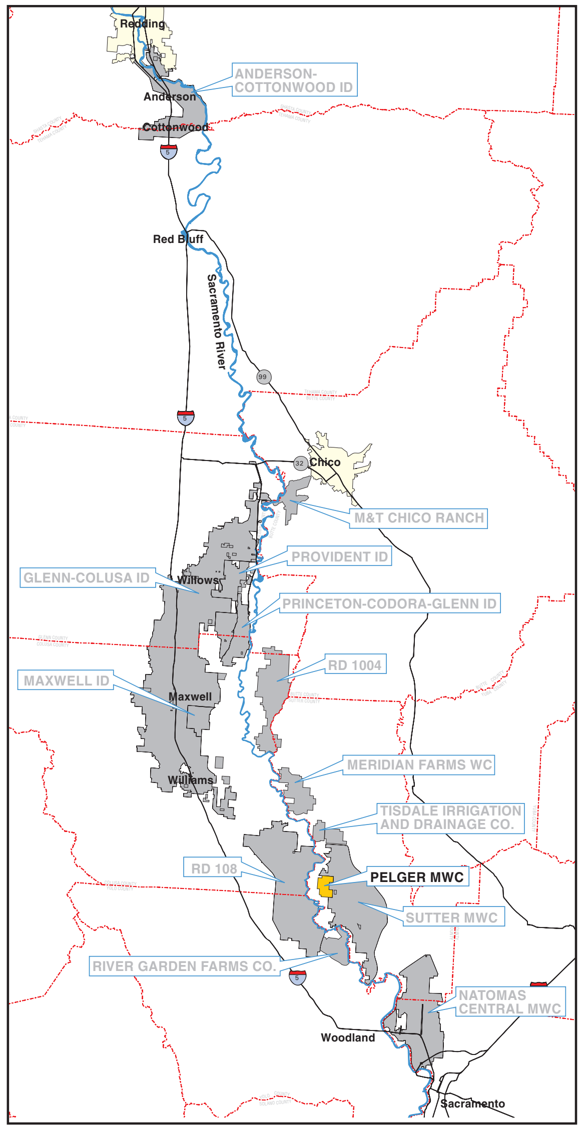
Up to 1,000 acres of rice stubble have been flooded in the past, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. As described above, the Company currently has an agreement with the U.S. Fish and Wildlife Service to provide winter water for waterfowl. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. Additionally, the Company serves approximately 1,000 acres of privately owned duck clubs; however, no other formally managed environmental or wetlands areas are within the Company.

Pelger Mutual Water Company

Manager: Scott C. Tucker • P.O. Box 488 • Knights Landing, CA 95645 • (530) 735-9455

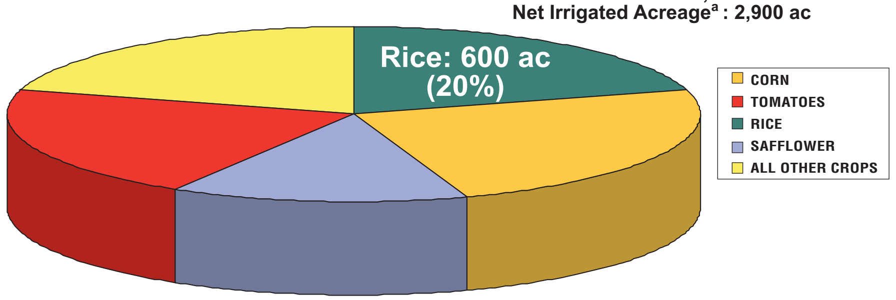
Settlement Contract:	8,860 af
Base Supply:	7,110 af
Project Supply:	1,750 af

Location Map



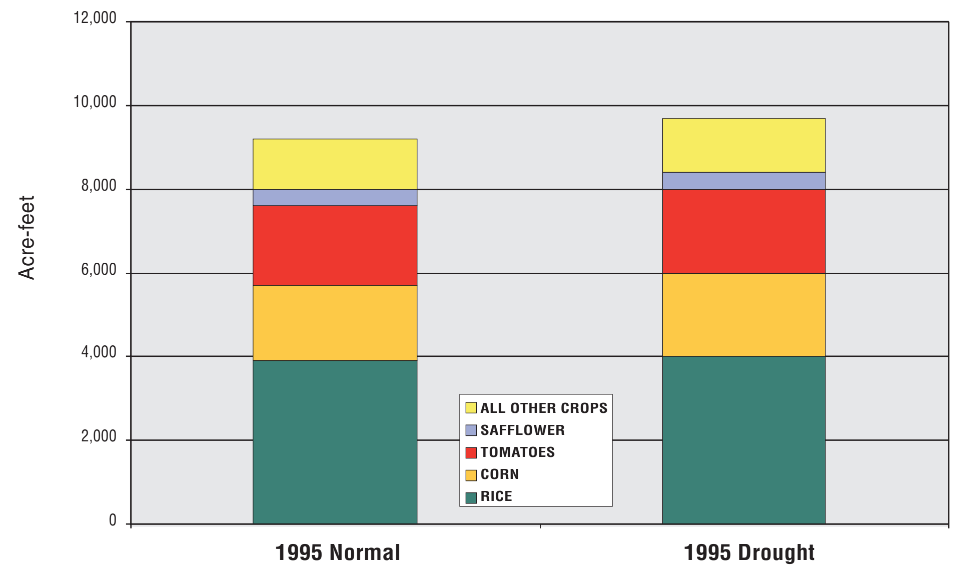
Irrigated Acreage by Crop

Total District Area: 2,900 ac
Net Irrigated Acreage[a] : 2,900 ac

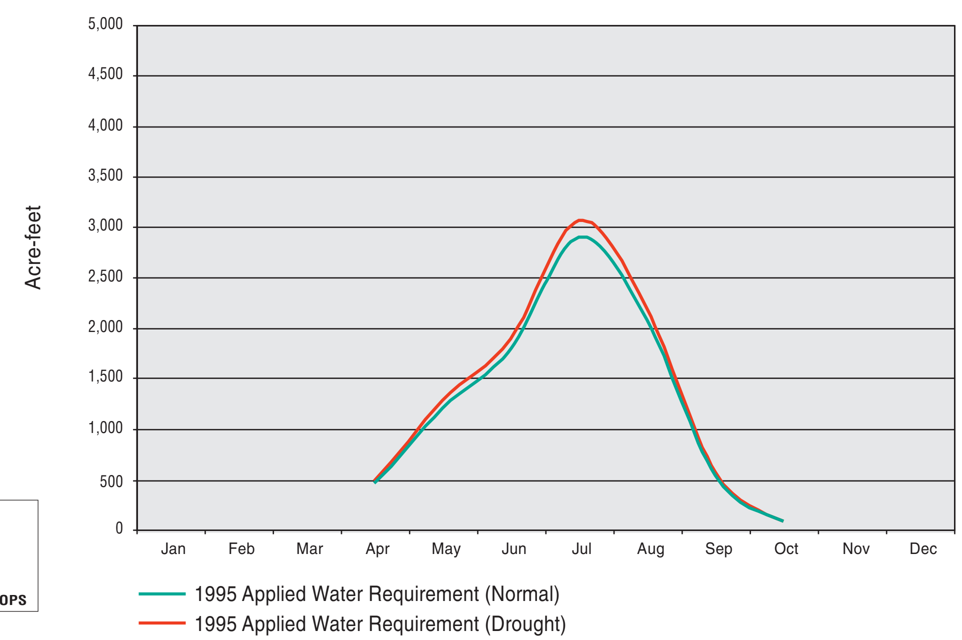


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

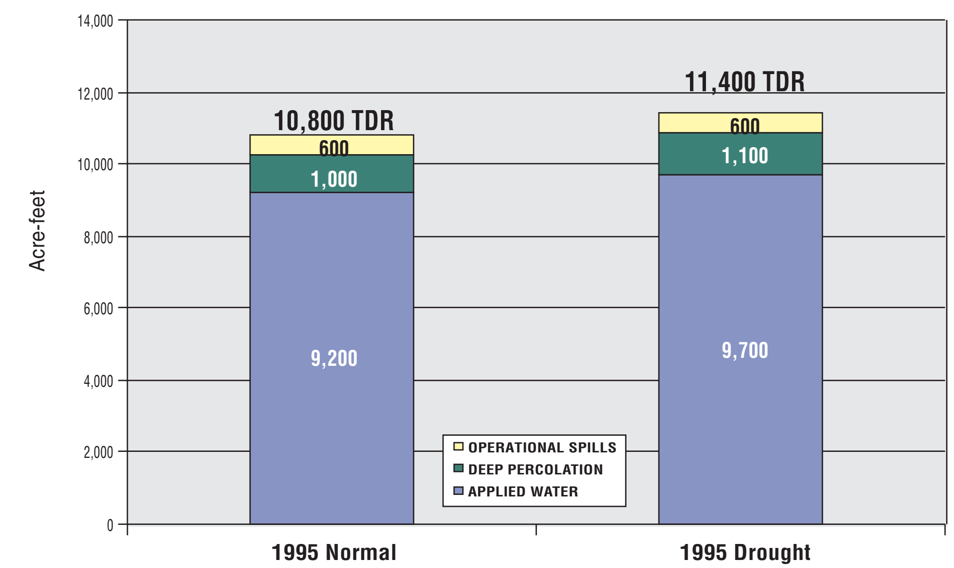


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

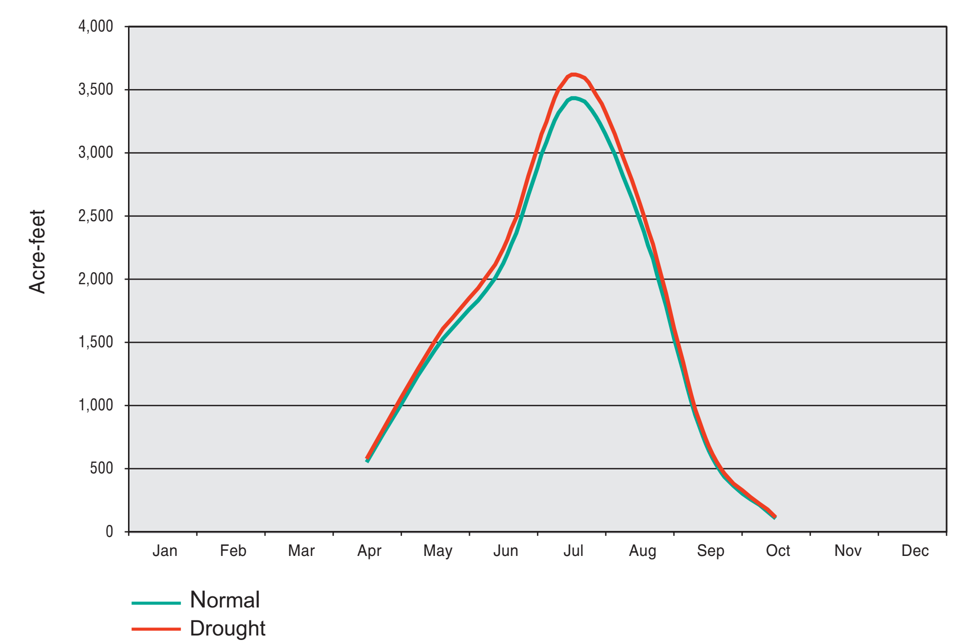


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



NOTES: [a] Basis for net irrigated acreage is DWR 1995 estimates.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 11
PELGER MUTUAL WATER COMPANY
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

American Sub-basin

- **Natomas Central Mutual Water Company**

Natomas Central Mutual Water Company

Formation and Right

Natomas Central Mutual Water Company (NCMWC or Company) was organized under the California Irrigation District Act of 1897. The Company entered into a negotiated agreement with Reclamation in 1964, quantifying the amount of water NCMWC would divert from the Sacramento River. The resulting negotiated agreement recognized NCMWC's annual entitlement to a Base Supply of 98,200 ac-ft/yr of flows from the Sacramento River and also provided for a 22,000 ac-ft allocation of Project Water, resulting in a total contract entitlement of 120,200 ac-ft/yr. The schedule of monthly diversions of the Contract Total, Base Supply, and Project Water are identified in Exhibit A to the Settlement Contract, and the recently negotiated Exhibit A's for each of the districts are included in Appendix A to TM 3. In addition to the contract water, NCMWC has entitlements to divert Sacramento River water during the nonirrigation season for wetlands and rice straw decomposition. There are approximately 61 privately owned wells and two Company-owned wells within the Company's boundaries. These wells are used in conjunction with the river pumps and drainwater recycling pump to meet irrigation needs on an as-needed basis. Rice is the predominant crop grown within the Company boundaries, in addition to sugar beets and grain.

Service Area and Distribution System

NCMWC is located on the east side of the Sacramento River between the towns of Knights Landing and Sacramento in the Counties of Sutter and Sacramento within the southern portion of the American Basin. NCMWC's service area encompasses approximately 55,000 acres, which includes approximately 36,000 acres that are typically irrigated. The Company serves approximately 238 landowners. The Company's service area includes the Sacramento Municipal Airport and several residential developments, which are proposed in response to continued growth within and adjacent to the Sacramento area. NCMWC has two main pump stations located on the Sacramento River: Prichard Lake Pumping Plant and Elkhorn Pumping Plant. The Company also diverts water from the Natomas Cross Channel, which is located along the northern boundary of the Company. Diversion waters from the Cross Channel subsequently flow from north to south, and water diverted from the Sacramento River flows generally flow from west to east or south.

NCMWC uses an arranged schedule to deliver irrigation water to Company customers. The Company's distribution and conveyance system includes approximately 260 miles of canals and laterals. Seepage from these canals and laterals is approximately 10 percent. NCMWC is drained by four main drainage canals: Natomas East Main Drainage Canal, North Drainage Canal, East Drainage Canal, and the West Drainage Canal. The Natomas East Main Drainage Canal drains directly into the Sacramento River, just north of its confluence with the American River. The West Drainage Canal and the East Drainage Canal join drain to the Sacramento River in the southern portion of the Company via the RD 1000 Pumping Plant.

The Company completed the installation of a recirculation system in 1986, the purpose being to increase water quality for the City of Sacramento and to increase overall efficiency within the Company boundaries. The recirculation system includes 30 pumping stations at various locations that recapture water for reuse either directly into fields or back into the main irrigation canals.

Topography and Soils

The Company's topography generally consists of nearly level to gently sloping terrain. Because the Company is relatively flat, the impact of the area's terrain on Company water management practices is negligible.

The soil associations that are found within the Company are identified below. Complete descriptions of the soil associations and the corresponding acreage of each association in the Company are provided in the NRCS Soil Surveys for Sutter and Sacramento Counties.

- San Joaquin-Cometa: Moderately deep and very deep, level to nearly level, well-drained sandy loam and loam on terraces.
- Clear Lake-Capay: Deep and very deep, level to nearly level, poorly drained and moderately well-drained clay and silty clay in basins and on basin rims.
- Shanghai-Nueva-Columbia: Very deep, level to nearly level, somewhat poorly drained silt loam, loam, and fine sandy loam on floodplains.
- Sailboat-Scribner-Cosumnes: Somewhat poorly drained and poorly drained silt to clay loam with a seasonal high water table and are protected by levees.
- Egbert-Valpac: Somewhat poorly drained and poorly drained silty clay loam with a high water table throughout the year or during part of the year and are protected by levees.
- Columbia-Cosumnes: Sandy loam to silt loam, somewhat poorly drained soils that are subject to flooding or are protected by levees.
- Clear Lake: Somewhat poorly drained clay that has a seasonal high water table, is protected by levees, and is very deep or deep over a cemented hardpan.
- San Joaquin: Moderately well-drained loam that is moderately deep over a cemented hardpan.

Identification of the limitations on NCMWC agriculture resulting from soil problems is not applicable to the BWMP. Specific data regarding soil problems and related impacts to agriculture are available through the Company and/or individual farmers in the Company.

Agricultural

Rice is the overwhelmingly predominant crop grown within NCMWC's service area. Other crops include tomatoes and sugar beets, in addition to rotation crops such as wheat and safflower, which are rotated with rice and tomatoes. Rice typically accounts for approximately 60 percent of the Company's irrigated acreage on an annual basis. Agriculture in NCMWC is under increasing pressure to convert to urbanized, residential use in the face of growth in the greater Sacramento region. Additionally, some of the irrigated acreage for urban developments, such as the airport, use Company water for ornamental landscaping.

As is the case with most of the other water providers, water requirements are typically highest during the summer months (July and August) due to the requirements of rice and the area's hot, dry climate. Cultural practice water needs for rice are greatest early in the growing season associated with the flooding up of previously dry rice fields, as well as to meet the needs of other crops. The vast majority of irrigation water requirements are met through the contract surface water supply, although groundwater is used in drought years on an individual grower basis, as well as per agreements with the Company. Annual cropping patterns have remained fairly constant over the last few decades, other than in response to farm programs in the early 1980s. Associated water requirement needs and associated diversions have therefore been more a function of water-year type and climate than changes in cropping.

Table 11 shows current (1995 normalized estimates) irrigated acreage estimates for the primary crops grown within the Company service area, as well as projections for 2020. The variation around these estimates (+/- percentage figures) was provided by the Company to account for typical variations in particular crop acreage (primarily due to year type), as well as anticipated future variation.

TABLE 11
NCMWC Irrigated Acreage – 1995 and 2020 Estimates

Crop	1995[a, b]	2020[c]
Rice	18,000	13,700
Sugar Beets	3,700	1,800
Corn	1,000	700
Tomatoes	600	500
All Other Crops	600	4,600
Total Irrigated Acreage	**23,900** [b]	**21,300**

[a] Figures are estimates derived from field data that have been normalized (data have been modified to simulate a condition where hydrology and climate are assumed to be normal, i.e., drought or wet condition assumed not to occur). Source: DWR, Central District.

[b] Acreages are based on NCMWC's actual deliveries; land use is changing. See Appendix B for further information.

[c] Figures are future projections that incorporate current and historical trends, as well as anticipated local and regional development and economic trends in the year 2020. Source: DWR, Central District.

Figure 12 summarizes irrigated acreage by crop, on-field water requirements, and TDRs.

In response to increasingly stringent limitations on burning, some of the Company's rice-growing landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 5,780 acres were flooded in 1999, a trend that is expected to continue or increase, assuming other options (including the sale of stubble for ethanol production) are not determined to be more economically feasible. This practice provides additional winter habitat for waterfowl above that which has been available within the Sacramento Valley since the development of agriculture.

Municipal and Industrial

As noted above, NCMWC has been experiencing increased growth pressure from the Sacramento area. The Company does not currently provide treated water for M&I, although it does provide water for landscaping. The Company's Board of Directors is currently reviewing this practice.

M&I water demand within the vicinity of the Company is anticipated to increase substantially, with additional annual water requirements in the year 2020 expected to increase by 80,000 ac-ft (an increase of approximately 40 percent) compared to 1995 estimated levels (DWR, Central District). The majority of this water (in addition to current demands) is assumed to be groundwater. Although M&I demands are not currently being served, the Company does not preclude the possibility of serving such needs in the future.

Environmental

Company lands are currently included in the Natomas Basin Habitat Conservation Plan that has been prepared to address long-term habitat needs for the giant garter snake, the American peregrine falcon, the valley elderberry longhorn beetle, and multiple other state- and federal-listed or threatened species. The preparation of the Natomas Basin Habitat Conservation Plan underscores the continuing resource agency concern with the continued urban development of lands within the NCMWC service area, which currently provide valuable habitat for a number of sensitive species. Adoption and implementation of this habitat conservation plan has placed additional constraints on both agricultural and M&I water use, including mandatory deliveries of water in the winter and cropping requirements. However, implementation of the Natomas Basin Habitat Conservation Plan is expected to limit the amount of additional Company lands that could be converted to urban use.

Approximately 635 acres of riparian vegetation are estimated to be incidentally supplied by irrigation, including vegetation directly adjacent to delivery laterals or influenced by leakage from the delivery system. Such vegetation includes habitat used by the federally listed giant garter snake and other species that use such habitat as discussed above.

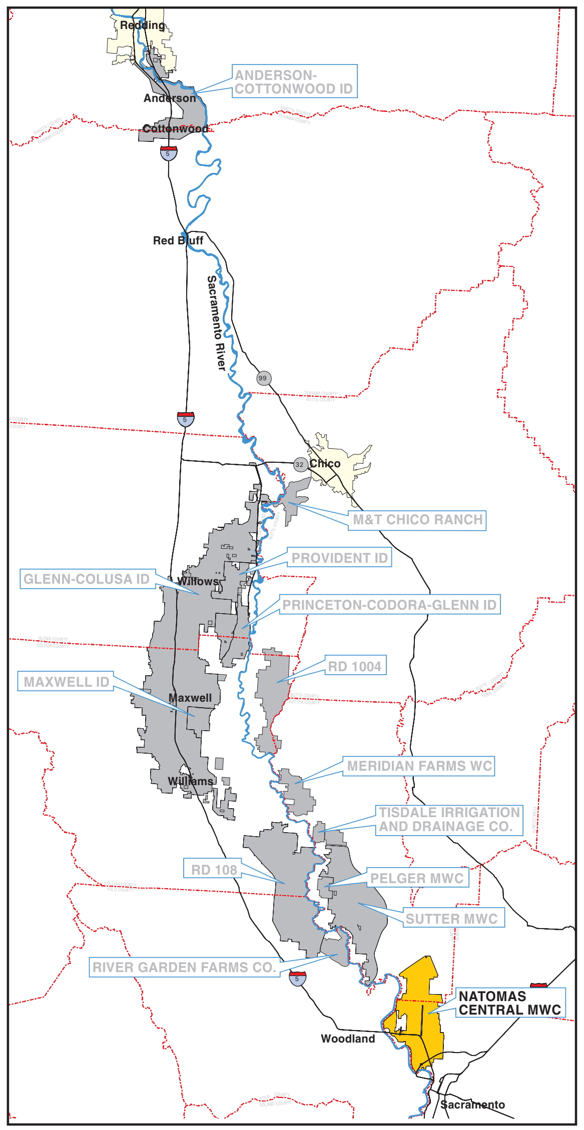
Up to 5,380 acres of rice stubble were flooded in 1999, with associated winter habitat benefits to migratory waterfowl that use the area as part of the Pacific Flyway. The flooding of rice fields in the spring and summer provides wetlands habitat during these periods for waterfowl and terrestrial species. Rice fields that are not flooded also provide habitat for waterfowl and upland birds as resting areas. Additionally, the Company serves approximately 16,380 acres of privately owned duck clubs within the Company. Of these lands, the Natomas Basin Conservancy manages approximately 1,031 acres of environmental or wetlands areas within the Company.

Natomas Central Mutual Water Company

General Manager: Peter Hughes • 2601 West Elkhorn Blvd. • Rio Linda, CA 95673 • (916) 419-5936

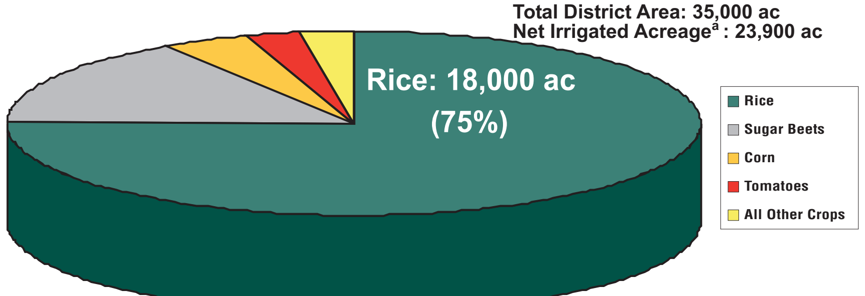
Settlement Contract:	120,200 af
Base Supply:	98,200 af
Project Supply:	22,000 af

Location Map



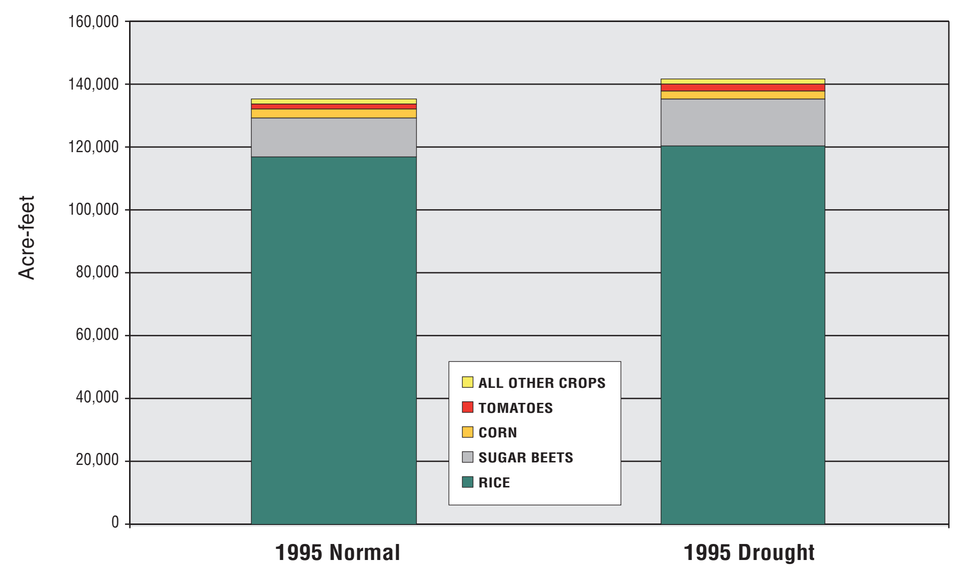
Irrigated Acreage by Crop

Total District Area: 35,000 ac
Net Irrigated Acreage[a] : 23,900 ac

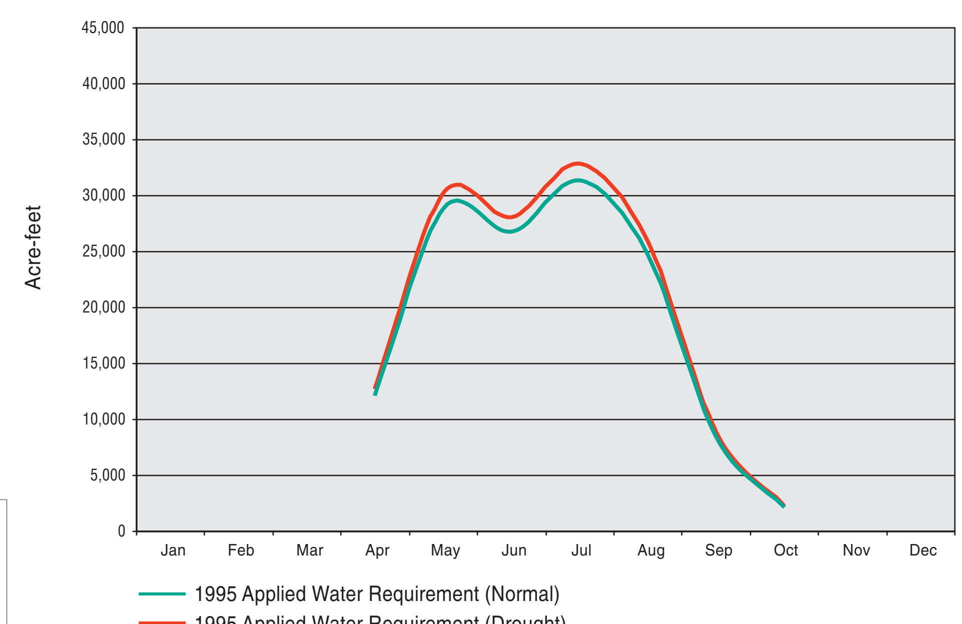


On-field Water Requirements

Annual Applied On-field Water Requirement by Crop[b]
(Normal and Drought)

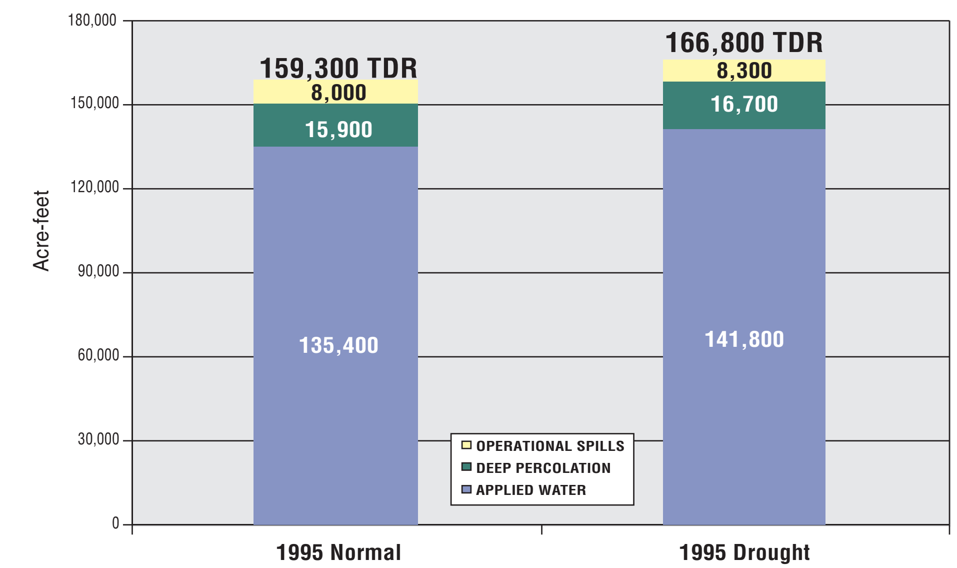


Monthly Applied On-field Water Requirement[b]
(Normal and Drought)

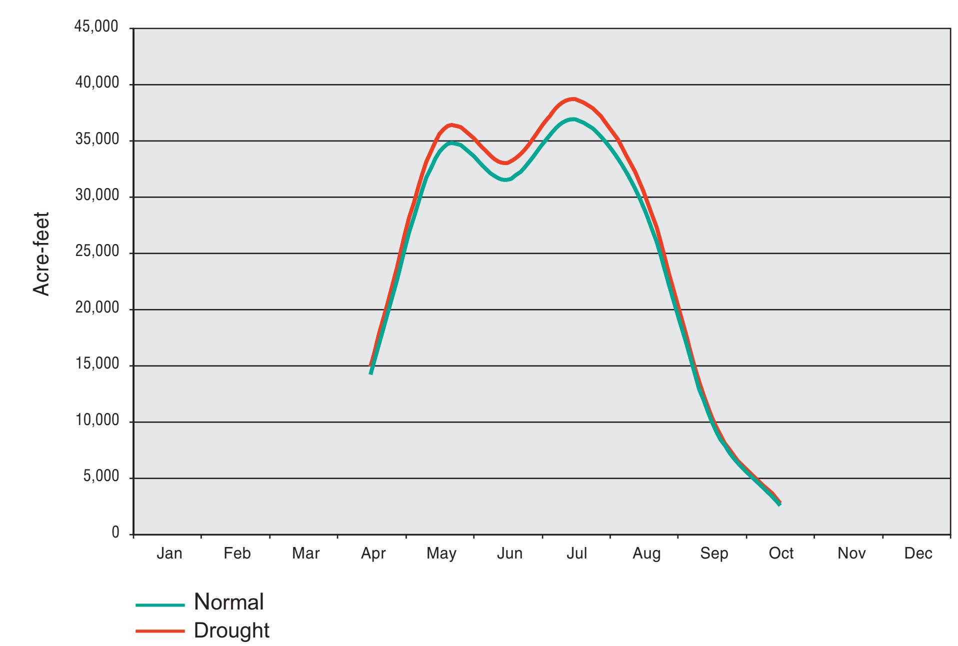


District Water Requirements

Annual Total District Water Requirement
(Includes 5% Operational Spills and 10% Deep Percolation Estimates)



Monthly Total District Water Requirement
(Includes 10% Operational Spills and 10% Deep Percolation Estimates)



NOTES: [a] Natomas' actual deliveries are the basis for revised acreages. Potential acreage within USBR contract service is approximately 35,000 acres.

[b] Basis for monthly applied on-field water requirement is DWR 1995 normalized estimates.

FIGURE 12
NATOMAS CENTRAL MUTUAL WATER COMPANY
TM 2 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

References

California Department of Water Resources. 1998. The California Water Plan Update – Bulletin 160-98, Volume 1. November.

CH2M HILL. 1997. *Shasta County Water Resources Management Plan Phase I Report: Current and Future Water Needs.* October.

U.S. Department of Agriculture/Natural Resources Conservation Service. 1996. RD 1500 Resource Study.

Appendix A
Calculation of Water Requirements Memorandum

MBK ENGINEERS

Water Resources • Flood Control • Water Rights

MEMORANDUM

Calculation of Water Requirements

The purpose of this memorandum is to describe procedures for calculating agricultural water requirements. Numerous factors must be considered when estimating water requirements. Definition of the terms describing these factors must be clear and agreed upon to ensure the appropriate water requirement is estimated and minimize confusion. Terminology and definitions currently vary depending on calculation method and geographic area under consideration. Accordingly, this memorandum presents definitions used in the preparation of the Sacramento River Basin-Wide Water Management Plan (BWMP) and addresses methods currently used by the Bureau of Reclamation (USBR Method) and the Department of Water Resources (DWR Method) for estimating water diversion requirements, as well as the geographic area under consideration using each method.

Agricultural water requirement is the amount of water that must be physically diverted to satisfy crop needs. Water supplies available for these diversions can be in the form of ground water, stream, or irrigation return flow diversion. Both stream diversion and diversion of return flow can be in the form of a water delivery or diversion under a water right. Water delivery is defined as the transfer of ownership of water from one entity to another. A common delivery (transfer of ownership) is from the USBR to water districts. Districts in the Sacramento Valley typically divert their delivery from the Sacramento River. Farms within water districts divert their delivered water from water district laterals and canals. When the only source of water available to a district or field is from a surface water delivery then diversions are equal to deliveries. This memorandum uses the term water diversion to represent the amount of water that must be diverted, from all sources, to satisfy agricultural water requirements.

One of the most basic principles in hydrologic analysis is mass balance. A mass balance is performed by accounting for all mass (water) entering an area, leaving an area, and stored in an area. Mass balance is achieved mathematically by ensuring the amount of water entering an area equals the amount leaving the area plus storage change within the area. The area for which a mass balance is performed is referred to as a control volume. The control volume is three-dimensional and its boundary represents the location at which water entering and leaving the area is measured. Figure 1 displays the hydrologic accounting for a control volume or geographic area (Figure 1 at the back of this technical memorandum).

When determining water diversion requirements a hydrologic accounting is performed. Water entering, leaving, and stored within the boundary of an area must be accounted. When determining the water needs for a farm, the farm boundary becomes the boundary for the control volume, or location for water measurement. Water entering the area can be from precipitation, surface diversion, ground water diversion, or diversion of return flows. Water may exit through crop evapotranspiration (ET), loss, runoff, or deep percolation. Deep percolation can be realized as increased ground water storage or as subsurface return flow. Runoff that returns to a drain or stream system is immediately available for reuse or to satisfy other downstream water needs.

WATER DIVERSION REQUIREMENT

Water diversion requirements can be determined for fields, water districts, subbasins, basin, and entire drainage areas. As the geographic area increases, from farms to water districts to subbasins, the factors influencing selection of diversion sources changes. The amount of water reused, or re-diverted, increases as this size of the geographic area under consideration increases. Reuse of water is the diversion of irrigation return flow from upstream farms or water districts by users downstream or the pump-back of tail water to the area that generated the tail water.

In general this memorandum focuses on three primary levels of water diversion (applied water) requirement, which are more fully described and explained below:

Applied Water Requirement: the quantity of irrigation water required to be diverted to meet the needs of a given crop including crop ET, cultural practice water, leaching requirement, and losses.

District Water Diversion Requirement: the quantity of irrigation water that must be diverted into a water district boundary to satisfy all water requirements including FWDR and district loss. Although diversion of return flows within a district may not cross a district boundary, it can be considered a diversion source for a water district.

Subbasin Water Diversion Requirement: the quantity of irrigation water that must be diverted into a subbasin boundary to satisfy all water requirements including FWDR and subbasin loss.

Applied Water Requirement

The smallest geographic area, or boundary, used in determining water diversion requirements is a field. Applied water requirement, previously defined, also referred to as field water diversion requirement, is the sum of all beneficial uses including, but not limited to, evapotranspiration, leaching requirements, cultural practices (climate control and pre-irrigation) plus non-recoverable losses.

Applied water requirements represent the total amount of water that must be diverted to a field, regardless of source. The mass balance approached is applied at the field level for determining water requirements and return flow is assumed to leave the field, regardless if it is re-diverted back onto the field, when determining applied water requirement.

Applied water requirements can be estimated using the USBR or DWR method. These two methods provide similar results, but rely on different definitions of efficiency. Applied water requirements at the field level can be calculated using the following equation (Burt 1995):

$$\text{Applied Water Requirement}_{\text{Burt}} = \frac{ET - EP}{\frac{EF_{Burt}}{100} \times (1 - LR)}$$

The USBR method uses this equation with an additional term for cultural practices. Applied water requirement using the USBR method is calculated using the following equation:

$$\text{Applied Water Requirement}_{USBR} = \frac{ET - EP}{\frac{EF_{Burt}}{100} \times (1 - LR)} + \frac{CP}{\frac{EF_{Burt}}{100}}$$

Unlike the USBR method, the DWR method calculates applied water requirements assuming leaching requirement and cultural practice water is included in the efficiency assumption using the following equation:

$$\text{Applied Water Requirement}_{DWR} = \frac{ET - EP}{\frac{EF_{DWR}}{100}} = \frac{ETAW}{\frac{EF_{DWR}}{100}}$$

ET = Evapotranspiration
The amount of water used by crops through transpiration and evaporation

EP = Effective Precipitation
The portion of rainfall that contributes to satisfying ET, LR, and CP. Note: EP does not satisfy CP in the USBR equation.

CP = Cultural Practices
Crop-specific additional water requirements for seed germination, climate control, crop yield, weed control, and other needs

LR = Leaching Requirement
Leaching requirement is the fraction of applied water required, above ET needs, to maintain acceptable salinity levels in the soil.

$$LR = \frac{EC_W}{(5 \times EC_E) - EC_W}$$

ECw = electrical conductivity of applied water
ECe = salinity threshold limit of crop

EF = Field Irrigation Efficiency
(See below for definition)

Field Irrigation Efficiency

As discussed above, the key difference between the USBR and DWR methods of determining applied water requirements is different definitions of irrigation efficiency. Using the USBR method, irrigation efficiency is the percentage of irrigation water beneficially used, or the ratio of water beneficially used, to the total applied (Burt 1995):

$$\text{Field Irrigation Efficiency}_{USBR,Burt} = \frac{\textit{Irrigation water beneficially used}}{\textit{Applied water requirement}} \times 100$$

$$= \frac{ETAW + LR + CP}{Applied\ Water} \times 100$$

A majority of applied water satisfies crop ET, however there are several other possible destinations of applied water. These destinations may include non-recoverable loss, deep percolation, or runoff. Figure 1 displays this hydrologic accounting. Beneficial uses include ET, LR, and CP while non-beneficial uses, or non-recoverable loss, may include weed ET, evaporation from wet soil or foliage, ditch loss, and spray loss. In some areas, such losses can benefit riparian vegetation and associated habitat.

The DWR Method incorporates CP and LR into irrigation efficiency. Irrigation efficiency using the DWR Method is calculated as the fraction of applied water that is used to satisfy beneficial consumptive use needs of the crops. ETAW is considered beneficial consumptive use, therefore the DWR Method expresses efficiency as follows:

$$\text{Field Irrigation Efficiency}_{DWR} = \frac{ETAW}{\textit{Applied water}} \times 100$$

In the DWR definition any applied water that is not satisfying ETAW will lower the calculated efficiency and increase the applied water requirement. The two methods, USBR and DWR, differ by the explicit identification of LR and CP in the USBR Method. The DWR Method handles LR and CP implicit in the efficiency estimates. Although both methods may develop similar water use requirements, the DWR definition of efficiency will result in lower calculated efficiencies for the same field under the same conditions than the USBR method.

Both the DWR and USBR methods for determining applied water requirements utilize assumed irrigation efficiencies. These efficiencies are applied to all crops of the same type within a water district, no attempt is made to address irrigation efficiency for specific farms. Due to the many factors that influence efficiency, various fields with the same crop type can have different irrigation efficiencies. Among the factors influencing efficiency are distribution uniformity, irrigation methods, soil type, irrigation scheduling, leaching, cultural practice, districtwide internal irrigation water reuse, districtwide internal irrigation water reuse, and crop type.

Distribution Uniformity

Distribution Uniformity (DU) is a measure of how evenly water is applied to crops throughout a field and is expressed as the ratio of the minimum depth water is infiltrated in a field to the average depth of infiltration. The ratio is expressed using the following equation (Kruse, 1978):

$$DU = \frac{\text{Minimum depth infiltrated}}{\text{Average depth infiltrated}} \times 100$$

The "Minimum depth infiltrated" represents the average depth infiltrated in the region of the field receiving the lowest 25% of the water (Burt, 1995).

DU is perhaps the major factor in determining irrigation efficiency. For each method of irrigation and each type of crop some portions of a field will receive more water than others. Water is applied to fields to provide enough water to satisfy ET, LR, and CP at the driest (highest elevation or permeability) point of the field, therefore the wettest (lowest elevation or permeability) parts of fields will receive more water than is required. Over-application to the wettest (lowest) parts of fields results in greater return flows. The lower the DU the greater the field water diversion must be. Lower DU in a fully irrigated field results in lower irrigation efficiency with greater return flow and seepage loss.

Irrigation methods
Various irrigation methods result in evaporation losses ranging from 0% to 6% of applied water (Burt, 1995). Although spray and evaporation losses make up a minor portion of applied water, any increase in loss results in a decrease in irrigation efficiency.

Soil Type
Soil type can influence seepage losses and deep percolation. Sandy type soils have a higher permeability than clay type soils, therefore sandy soils are prone to excessive deep percolation and clay soils are prone to excessive runoff.

Scheduling
Scheduling generally refers to when and how much water is applied to satisfy crop requirements. Water applied when soil moisture is already high enough to maintain crops will lead to increased seepage and runoff. Water applied in excess of soil capacity in the potential root zone will also lead to increased seepage and runoff. If soil moisture drops too low or not enough water is applied, crop yields can decrease. Improper scheduling can lead to decreases in calculated irrigation efficiency and lower crop yields.

Leaching
Leaching requirements vary depending on crop type and irrigation water quality. This only affects calculated efficiency using the DWR Method because the USBR method explicitly addresses LR. Some crops are more tolerant of higher salinity levels than others. Crops with a lower tolerance to salinity require higher applied water requirements to remove salts, which result in a lower calculated efficiency using the DWR method.

Cultural Practice Water
Various crop types require water in addition to that needed to satisfy ET and LR. This additional water need, while not directly used by the crop, is necessary to maintain crop yield and therefore is considered a beneficial use. Examples of CP include seed germination, climate control, weed control, rice straw decomposition, and others. This requirement can have a large effect on the applied water, therefore affect the calculated efficiency of various crops using the DWR Method. Cultural practice water is a particularly significant component of irrigation water requirements in the Sacramento Valley, given the prevalence of rice. As such, the difference in irrigation efficiency between the USBR and DWR methods is significantly influenced by CP.

District Water Diversion Requirement
District water diversion requirements represent the total amount of water that must be diverted into a water district. Just as all water entering, leaving, or stored in a field must be accounted for to achieve mass balance and to determine field water requirements, all water crossing an irrigation district boundary must be accounted for to determine district water diversion requirements. Diversions, ET, loss, and return flow now represent the

flow entering or leaving the district boundary. Losses at the district level include the district distribution system losses in addition to field losses for the entire water district.

Water districts serve water to numerous fields and farms throughout their distribution systems. Return flow from one farm in a district may be available for use or reuse by another farm downstream, therefore internal use of return flow must also be considered. In the mass balance for a water district return flow is considered to leave the water district, however reuse within a water district boundary is considered a source of water which can be used to satisfy applied water requirements. The amount of reuse within a water district is discretionary. Water districts can pump-back return flow into their water distribution system or operate to alter internal reuse. The prevalence of water reuse within a majority of the districts in the Sacramento Valley results in surface and ground water diversions for a district being less than the sum of all the applied water requirements within the district.

Water delivered to meet the applied water requirement within a district includes diversion of return flows from upstream farms within the district and pump-back of return flows. Return flows can be diverted many times within an irrigation district boundary. This reuse of water within a district influences the district's stream and/or ground water diversion requirement. Return flow from fields within a district are generally due to low application efficiency and other factors previously described however, a portion of CP and LR may also contribute to field return flow. For example, flow-through water for rice is a portion of rice CP that results in field runoff and return flow. However, CP for rice seed germination results in little or no runoff or return flow.

Applied water requirement for a water district includes three components; direct surface diversion, ground water pumping, and reuse. When calculating district efficiency only diversions crossing the district boundary, direct surface diversion and ground water pumping, are considered. Because water reused within a district does not cross the district boundary it is not considered part of the districts diversions. Too much reuse within a water district can lead to increase salinity and other water quality problems, which can lead to decreased crop yields. There are limits to the amount of reuse that can occur without adversely impacting water quality and crop yield. District water diversion requirement includes all water entering the district boundary and is expressed as follows:

$$\text{Diversion}_{\text{district}} = \frac{\text{ETAW}_{\text{fields}}}{\text{Efficiency}_{\text{district}}}$$

$$\text{Diversion}_{\text{district}} = \sum \text{Field Diversions} - \text{Internal Diversion of Return Flow} + \text{Losses}$$
$$= \text{Stream Diversion}_{\text{district}} + \text{Ground Water Pumping}_{\text{district}}$$

Water district efficiency can be expressed as follows:

$$\text{Efficiency}_{\text{district}} = \frac{\text{Diversion}_{\text{district}} - \text{Return Flow}_{\text{district}} - \text{Loss}}{\text{Diversion}_{\text{district}}} = \frac{\text{ETAW}}{\text{Diversion}_{\text{district}}}$$

USBR has explicitly included water district conveyance loss into the equation below by subtracting the amount out of the total losses incurred by the district. This is only true when the conveyance loss contributes to ground water recharge and does not significantly degrade in quality. The following equation is the USBR calculation of water district efficiency:

$$Efficiency_{district} = \frac{Diversion_{district} - Return\ Flow_{district} - Field\ Losses + Conveyance\ loss_{district}}{Diversion_{district}}$$

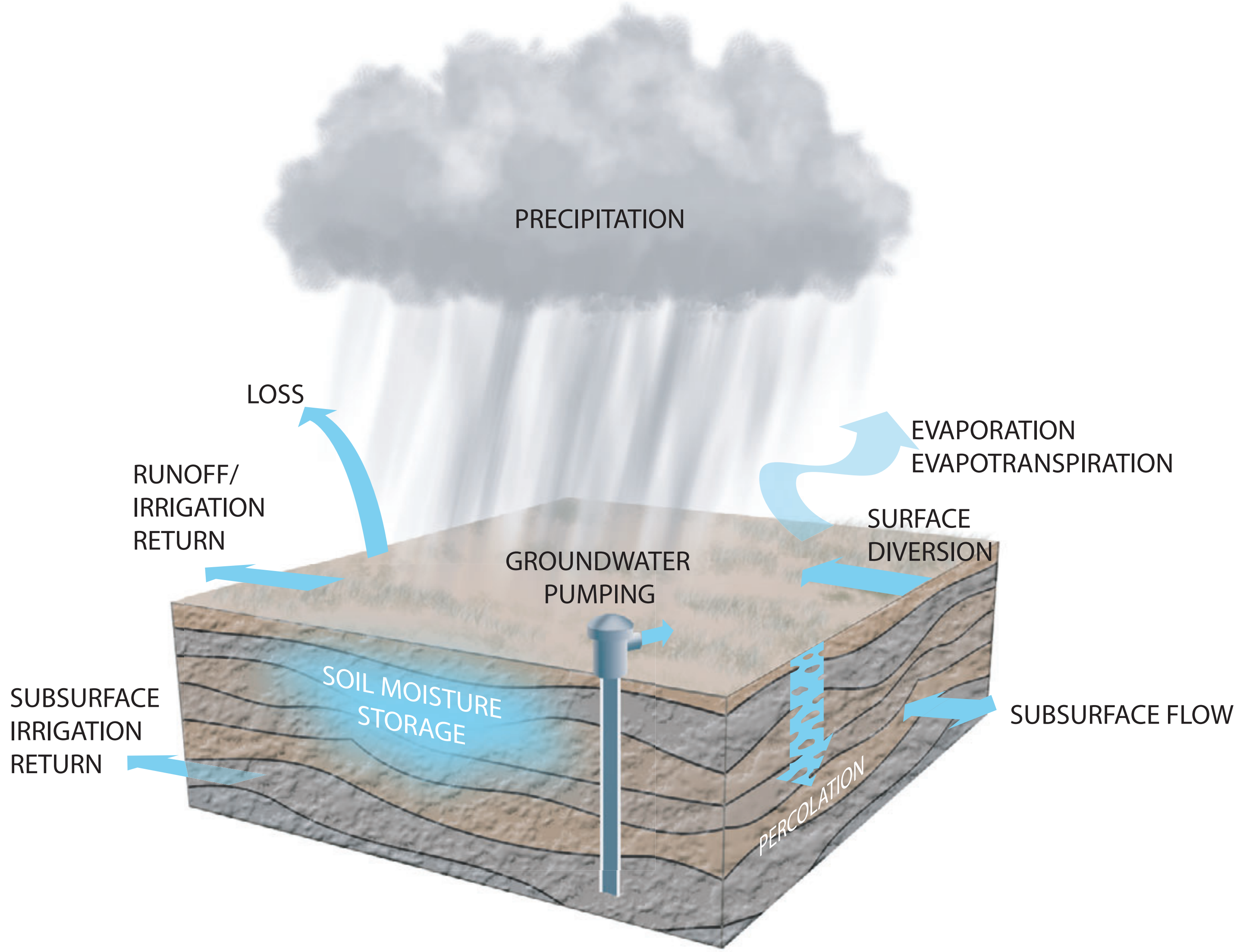
Subbasin Water Diversion Requirement

To determine water use at a subbasin level the hydrologic accounting presented in Figure 1 is performed for the entire subbasin. The subbasin boundary becomes the location where the accounting takes place. Subbasins often contain several irrigation districts, and in many cases downstream districts divert return flow from upstream districts. Additionally, some subbasins include M&I as well as environmental uses and associated demands. Just as surface diversion requirements and groundwater use within a district are typically less than the sum of all the field water requirements within the district given the high degree of water reuse within the Sacramento Valley, surface diversion requirements and groundwater use for a subbasin are generally less than the sum of the water requirements for the districts contained within a subbasin.

Subbasin diversions and return flows are measured at the subbasin boundary. Equations used to describe water district diversion and efficiency can be applied to a subbasin by using subbasin diversion and ETAW for the entire subbasin. The efficiency for a subbasin will generally be higher than for individual water districts within the subbasin because of increased use of return flows between districts.

Expanding the geographic area under consideration from the subbasin level to an entire basin, such as the Sacramento River Basin, use of return flow again increases. As the geographic area and reuse of return flow increased, the efficiency increases. Therefore, the efficiency of a basin will generally be higher than subbasins contained within a basin.

When considering an entire water system, such as the Sacramento – San Joaquin River Delta, efficiency can increase above the basin level. When the Delta is in balanced conditions, all water entering the Delta is beneficially used. If all water in the system, with the exception of non-recoverable loss, is beneficially used then efficiency can be considered to be very high.



W062004006RDD_01_TM 2_APP A (7/16/04)

FIGURE 1
HYDROLOGIC ACCOUNTING

Appendix B
Revised Natomas Water Use Data

file: Sac Grp BWMP

MBK ENGINEERS

Water Resources • Flood Control • Water Rights

MEMORANDUM

DATE: November 3, 2000

TO: Mark Oliver

FROM: Tom Hickmann and Marc Van Camp

SUBJECT: Discrepancies with Natomas Water Use Data

The purpose of this memorandum is to reconcile the discrepancies between water demands identified in Technical Memorandum 2 (TM 2), in excess of 200,000 AF, and actual Sacramento River diversions and other available sources to the Natomas Central Mutual Water Company (Natomas). To help resolve this issue, MBK Engineers and Natomas' Special Projects Manager, Tom Barandas, met with Department of Water Resources (DWR) Staff regarding the mapping of the land use data.

Our understanding is that the land use identified in the technical memorandums is estimated land use for the years 1995 and 2020 based on actual land use photographs taken in 1984. The land use numbers identified for Natomas in TM 2 are estimated to be approximately 34,000 acres of irrigated lands in 1995. Although Natomas includes approximately 36,000 acres, Natomas served water to approximately 24,000 acres in 1995 which is 10,000 acres less than used in TM 2. The total acreage identified by DWR compares well with the known acreage within Natomas; however, in any given year Natomas only supplies surface water to 20,000 to 25,000 acres. The remaining acreage is either fallowed or dry cropped by the landowner, irrigated with well water or irrigated through the subsurface groundwater which in some areas of Natomas is sufficiently high to reach the root zone of the crops. TM 2 and the data provided by DWR assumes all lands within Natomas are irrigated with a surface water supply from Natomas.

Attached is a copy of the applied water table from TM 2 for Natomas on which we have inserted the actual irrigated acreage which Natomas supplied surface water. You will find a difference of 10,200 acres, and 30,700 AF of applied water less from the values identified in TM 2. Approximately one-half of the acreage (5,300 acres) is grain and safflower. These crops can be grown in many areas of Natomas without applying surface water. Other discrepancies in the acreages are likely due to projections from 1984 aerial photographs.

The majority of the basin in which Natomas is included has a groundwater depth of 10 feet or less. We believe this high ground water table may reduce Natomas' need for surface water diversions to flood up early in the season. This high ground water may also intercept drains which provides an unmeasured amount of water to meet applied water needs. In addition, field and row crops are likely

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meeting portions, if not all, of the crop water needs from the high ground water table. In many cases, within Natomas, various wheat and barley crops can be grown with no surface water supply needed after germination due to the high water table. DWR's land use and TM 2, however, would estimate the applied water ET of these crops higher than what is actually occurring. We believe that this, combined with the other factors stated above, could explain the discrepancy between actual historical water use versus the estimated water use identified in the technical memorandums.

In order to ground truth the method for estimating applied water used for the Basin-Wide Water Management Plan we have evaluated the applied water quantity contained in the attached table with actual 1995 diversions by Natomas. During 1995, USBR records show Natomas diverted 70,911 AF. Precipitation during March through June of 1995 was a total of 10.83 inches. Assuming 50 to 100 percent of this precipitation is available to the approximate 23,900 irrigated acres, this would account for a range of approximately 10,800 AF to 21,600 AF of applied water requirements being met with precipitation. In addition, 50 percent of the precipitation on the approximately remaining 31,000 acres within the basin would also contribute approximately 14,000 AF of the applied water requirements within Natomas. It is our under-standing Natomas has decreased diversions by approximately 30,000 AF since the completion of its reuse system. This represents an increase of 30,000 AF of reuse from some value (say 15,000 AF) prior to the completion of its reuse system. Summing diversions, precipitation and estimated reuse arrives at a total applied water of 139,800 AF to 150,600 AF. This compares well with the 135,400 AF of applied water identified in the attached table. We believe this provides adequate support for the method used in determining applied water needs in TM 2.

In our discussions with DWR staff, we believed the best way to deal with this issue was not in the mapping, but to footnote Natomas' land use data in the Technical Memorandums with language that identified the acreage discrepancy. To our knowledge, the purpose of this was to resolve the land use numbers identified in the technical memorandums. We suggest using the acreages and quantities contained in the attached table and include the footnote as indicated on the table.

Marc Van Camp Tom Hickmann

TH/mv
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cc: Pete Hughes, Natomas
Tom Barandas, Natomas
Ed Morris, DWR

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use for 1995

DAU Name: [illegible] — Natomas Mutual Water Company — PSA: Central Basin West

Sacramento and Sutter Counties — HR: Sacramento River

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre) Surface	Ground	Net Irrigated Acreage* (1000's of acres) Surface	Ground	Total	ET of Applied Water (1000's of acre-feet) Surface	Ground	Total	Applied Water (1000's of acre-feet) Surface	Ground	Total
GRAIN	0.6	66% 0.9		0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.4	52% 6.5		18.0		18.0	61.2		61.2	117.0		117.0
COTTON												
SUGAR BEETS	2.3	68% 3.4		3.7		3.7	8.6		8.6	12.7		12.7
CORN	1.8	69% 2.6		1.0		1.0	1.8		1.8	2.6		2.6
DRY BEANS												
SAFFLOWER	0.7	78% 0.9										
OTHER FIELD	1.5	68% 2.2		0.2		0.2	0.2		0.2	0.3		0.3
ALFALFA	3.0	68% 4.4		0.0		0.0	0.1		0.1	0.2		0.2
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	62% 5.3		0.1		0.1	0.2		0.2	0.3		0.3
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	68% 3.1		0.6		0.6	1.3		1.3	1.8		1.8
POTATOES												
CUCURBITS	1.2	67% 1.8		0.1		0.1	0.1		0.1	0.2		0.2
OTHER TRUCK				0.1		0.1						
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	69% 3.6		0.1		0.1	0.1		0.1	0.2		0.2
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				23.9		23.9	73.7		73.7	135.4		135.4
Double Crop Acreage												
Total Irrigated Land Area				23.9		23.9						

*Net irrigated acreage is equal to 95 percent of the gross acreage.

Note: Acreages are based on Natomas' actual deliveries. Potential acreage within USBR contract service area is approximately 35,000 acres.

Miscellaneous Land Use Information (1,000 of Acres)			
Seasonal Marsh		Idle	2,075.0
Permanent Marsh		Farmsteads	
Rice Fallow	2,304.0	Dairies	

Appendix C
District-specific Land and Water Use Tables (1995 and 2020 – Normal and Drought Conditions)

ANDERSON-COTTONWOOD IRRIGATION DISTRICT (ACID)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Anderson-Cottonwood Irrigation District

NORMAL YEAR

DAU #/Name: 141/Redding West (SHA)
143/Redding East (SHA)
141/Redding West (TEH)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70%	0.7	85%	0.6	0.5		0.5	0.4		0.4	0.4		0.4
RICE														
COTTON														
SUGAR BEETS														
CORN														
DRY BEANS	1.8	70%	2.6	80%	2.3	0.1		0.1	0.2		0.2	0.3		0.3
SAFFLOWER														
OTHER FIELD	1.9	65%	2.9	70%	2.7	0.1		0.1	0.2		0.2	0.3		0.3
ALFALFA	3.2	70%	4.6	75%	4.3	0.2	0.2	0.4	0.6	0.6	1.2	0.9	0.9	1.8
ALFALFA - X														
CLOVER SEED														
PASTURE	3.3	65%	5.1	75%	4.4	10.5		10.5	34.6		34.6	53.5		53.5
PASTURE - X	2.5	80%	3.1	85%	2.9	0.1		0.1	0.3		0.3	0.3		0.3
MEADOW PASTURE														
TOMATOES														
POTATOES														
CUCURBITS														
OTHER TRUCK	1.2	70%	1.7	75%	1.6	0.2	0.2	0.4	0.2	0.2	0.4	0.4	0.3	0.7
ALMONDS + PIST.	2.7	75%	3.6	80%	3.4	0.2		0.2	0.6		0.6	0.8		0.8
OTHER DECIDUOUS	2.7	70%	3.9	75%	3.6	1.0	0.6	1.6	2.7	1.6	4.3	3.9	2.2	6.1
KIWI														
CITRUS - OLIVES														
GRAPES														
EUCALYPTUS														
Totals						12.9	1.0	13.9	39.8	2.4	42.2	60.8	3.4	64.2
Double Crop Acreage														
Total Irrigated Land Area						12.9	1.0	13.9						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Anderson-Cottonwood Irrigation District

NORMAL YEAR

DAU #/Name: 141/Redding West (SHA)
143/Redding East (SHA)
141/Redding West (TEH)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70% 0.7	85% 0.6	0.5		0.5	0.4		0.4	0.4		0.4
RICE												
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS	1.8	70% 2.6	80% 2.3	0.1		0.1	0.2		0.2	0.3		0.3
SAFFLOWER												
OTHER FIELD	1.9	65% 2.9	70% 2.7	0.1		0.1	0.2		0.2	0.3		0.3
ALFALFA	3.2	70% 4.6	75% 4.3	0.1	0.1	0.2	0.3	0.3	0.6	0.5	0.4	0.9
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	65% 5.1	75% 4.4	9.9		9.9	32.6		32.6	50.4		50.4
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK	1.2	70% 1.7	75% 1.6	0.3	0.2	0.5	0.3	0.2	0.5	0.5	0.3	0.8
ALMONDS + PIST.	2.7	75% 3.6	80% 3.4	0.2		0.2	0.6		0.6	0.8		0.8
OTHER DECIDUOUS	2.7	70% 3.9	75% 3.6	1.0	0.6	1.6	2.7	1.6	4.3	3.9	2.2	6.1
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				**12.2**	**0.9**	**13.1**	**37.3**	**2.1**	**39.4**	**57.1**	**2.9**	**60.0**
Double Crop Acreage												
Total Irrigated Land Area				**12.2**	**0.9**	**13.1**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Anderson-Cottonwood Irrigation District

DROUGHT YEAR

DAU #/Name: 141/Redding West (SHA)
143/Redding East (SHA)
141/Redding West (TEH)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.5		0.5	0.5		0.5	0.6		0.6
RICE												
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS	1.9	70% 2.7	80% 2.4	0.1		0.1	0.2		0.2	0.3		0.3
SAFFLOWER												
OTHER FIELD	2.0	65% 3.1	70% 2.9	0.1		0.1	0.2		0.2	0.3		0.3
ALFALFA	4.0	70% 5.7	75% 5.3	0.2	0.2	0.4	0.8	0.8	1.6	1.1	1.1	2.2
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	10.5		10.5	43.0		43.0	66.1		66.1
PASTURE - X	3.4	85% 4.0	90% 3.8	0.1		0.1	0.3		0.3	0.4		0.4
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK	1.3	70% 1.9	75% 1.7	0.2	0.2	0.4	0.2	0.3	0.5	0.4	0.3	0.7
ALMONDS + PISTACHIOS	3.0	75% 4.0	80% 3.8	0.2		0.2	0.6		0.6	0.8		0.8
OTHER DECIDUOUS	3.0	70% 4.3	75% 4.0	1.0	0.6	1.6	3.0	1.8	4.8	4.3	2.4	6.7
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				12.9	1.0	13.9	48.8	2.9	51.7	74.3	3.8	78.1
Double Crop Acreage												
Total Irrigated Land Area				12.9	1.0	13.9						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Anderson-Cottonwood Irrigation District

DROUGHT YEAR

DAU #/Name: 141/Redding West (SHA)
143/Redding East (SHA)
141/Redding West (TEH)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.5		0.5	0.5		0.5	0.6		0.6
RICE												
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS	1.9	70% 2.7	80% 2.4	0.1		0.1	0.2		0.2	0.3		0.3
SAFFLOWER												
OTHER FIELD	2.0	65% 3.1	70% 2.9	0.1		0.1	0.2		0.2	0.3		0.3
ALFALFA	4.0	70% 5.7	75% 5.3	0.1	0.1	0.2	0.4	0.4	0.8	0.6	0.5	1.1
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	9.9		9.9	40.5		40.5	62.3		62.3
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK	1.3	70% 1.9	75% 1.7	0.3	0.2	0.5	0.4	0.3	0.7	0.6	0.3	0.9
ALMONDS + PISTACHIOS	3.0	75% 4.0	80% 3.8	0.2		0.2	0.6		0.6	0.8		0.8
OTHER DECIDUOUS	3.0	70% 4.3	75% 4.0	1.0	0.6	1.6	3.0	1.8	4.8	4.3	2.4	6.7
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				12.2	0.9	13.1	45.8	2.5	48.3	69.8	3.2	73.0
Double Crop Acreage												
Total Irrigated Land Area				12.2	0.9	13.1						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

GLENN-COLUSA IRRIGATION DISTRICT (GCID)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Glenn-Colusa IrrigationDistrict

NORMAL YEAR

DAU #/Name: 142/Red Bluff-Orland (GLE)
163/Willows-Arbuckle (COL)
163/Willows-Arbuckle (GLE)
164/Glenn-Knights Landing (GLE)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70%	0.7	85%	0.6	5.2	0.3	5.5	2.8	0.2	3.0	3.7	0.2	3.9
RICE	3.3	60-63%	5.2-5.5	67-68%	4.9	99.1	0.2	99.3	327.1	0.7	327.8	515.5	1.0	516.5
COTTON	2.9	70%	4.1	75%	3.9	1.0		1.0	2.9		2.9	4.1		4.1
SUGAR BEETS	2.7	65%	4.2	75%	3.6	1.9	0.1	2.0	5.1	0.3	5.4	8.0	0.4	8.4
CORN	2.3	65%	3.5	70%	3.3	2.0	0.2	2.2	4.6	0.5	5.1	7.1	0.7	7.8
DRY BEANS	1.8	70%	2.6	80%	2.3	0.7	0.1	0.8	1.3	0.2	1.5	1.8	0.2	2.0
SAFFLOWER	0.4	90%	0.4	90%	0.4	0.2		0.2	0.1		0.1	0.1		0.1
OTHER FIELD	1.9	65%	2.9	70%	2.7	0.2	0.1	0.3	0.4	0.2	0.6	0.6	0.3	0.9
ALFALFA	3.2	70%	4.6	75%	4.3	4.0	0.3	4.3	12.8	0.9	13.7	18.5	1.3	19.8
ALFALFA - X														
CLOVER SEED	2.4	70%	3.4	75%	3.2	0.3	0.1	0.4	0.7	0.2	0.9	1.0	0.3	1.3
PASTURE	3.3	65%	5.1	75%	4.4	4.1		4.1	13.5		13.5	20.9		20.9
PASTURE - X														
MEADOW PASTURE														
TOMATOES	2.1	70%	3.0	75%	2.8	3.6	0.2	3.8	7.6	0.4	8.0	10.8	0.6	11.4
POTATOES														
CUCURBITS	1.4	75%	1.9	80%	1.8	3.1	0.4	3.5	4.3	0.6	4.9	5.9	0.7	6.6
OTHER TRUCK	1.2	70%	1.7	75%	1.6	0.2		0.2	0.2		0.2	0.3		0.3
ALMONDS + PIST.	2.7	75%	3.6	80%	3.4	1.3		1.3	3.5		3.5	4.7		4.7
OTHER DECIDUOUS	2.7	70%	3.9	75%	3.6	1.2		1.2	3.3		3.3	4.7		4.7
KIWI														
CITRUS - OLIVES														
GRAPES	2.0	75%		80%		0.1		0.1	0.2		0.2	0.3		0.3
EUCALYPTUS														
Totals						128.2	2.0	130.2	390.4	4.2	394.6	608.0	5.7	613.7
Double Crop Acreage						0.1	0.1	0.2						
Total Irrigated Land Area						128.1	1.9	130.0						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Glenn-Colusa IrrigationDistrict

NORMAL YEAR

DAU #/Name: 142/Red Bluff-Orland (GLE)
163/Willows-Arbuckle (COL)
163/Willows-Arbuckle (GLE)
164/Glenn-Knights Landing (GLE)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70%	0.7	85%	0.6	4.7	0.3	5.0	2.5	0.2	2.7	3.3	0.2	3.5
RICE	3.3	62-63%	5.2-5.3	69%	4.8	98.9	0.2	99.1	326.4	0.7	327.1	514.3	1.0	515.3
COTTON	2.9	70%	4.1	75%	3.9	3.5		3.5	10.2		10.2	14.4		14.4
SUGAR BEETS	2.7	65%	4.2	75%	3.6	1.6	0.1	1.7	4.3	0.3	4.6	6.8	0.4	7.2
CORN	2.3	65%	3.5	70%	3.3	2.6	0.2	2.8	6.0	0.5	6.5	9.2	0.7	9.9
DRY BEANS	1.8	70%	2.6	80%	2.3	0.7	0.1	0.8	1.3	0.2	1.5	1.8	0.2	2.0
SAFFLOWER	0.4	90%	0.4	90%	0.4	0.2		0.2	0.1		0.1	0.1		0.1
OTHER FIELD	1.9	65%	2.9	70%	2.7	0.7	0.1	0.8	1.3	0.2	1.5	2.0	0.3	2.3
ALFALFA	3.2	70%	4.6	75%	4.3	4.2	0.3	4.5	13.4	0.9	14.3	19.4	1.3	20.7
ALFALFA - X														
CLOVER SEED	2.4	70%	3.4	75%	3.2	0.3	0.1	0.4	0.7	0.2	0.9	1.0	0.3	1.3
PASTURE	3.3	65%	5.1	75%	4.4	3.3		3.3	10.9		10.9	16.9		16.9
PASTURE - X														
MEADOW PASTURE														
TOMATOES	2.1	70%	3.0	75%	2.8	6.2	0.2	6.4	13.0	0.4	13.4	18.6	0.6	19.2
POTATOES														
CUCURBITS	1.4	75%	1.9	80%	1.8	3.8	0.4	4.2	5.3	0.6	5.9	7.2	0.7	7.9
OTHER TRUCK	1.2	70%	1.7	75%	1.6	1.3		1.3	1.6		1.6	2.3		2.3
ALMONDS + PIST.	2.7	75%	3.6	80%	3.4	1.3		1.3	3.5		3.5	4.7		4.7
OTHER DECIDUOUS	2.7	70%	3.9	75%	3.6	1.2	0.2	1.4	3.3	0.5	3.8	4.7	0.7	5.4
KIWI														
CITRUS - OLIVES														
GRAPES	2.0	75%	2.7	80%	2.5	0.1		0.1	0.2		0.2	0.3		0.3
EUCALYPTUS														
Totals						**134.6**	**2.2**	**136.8**	**404.0**	**4.7**	**408.7**	**627.0**	**6.4**	**633.4**
Double Crop Acreage						**3.5**	**0.2**	**3.7**						
Total Irrigated Land Area						**131.1**	**2.0**	**133.1**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Glenn-Colusa IrrigationDistrict

DROUGHT YEAR

DAU #/Name: 142/Red Bluff-Orland (GLE)
163/Willows-Arbuckle (COL)
163/Willows-Arbuckle (GLE)
164/Glenn-Knights Landing (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	5.2	0.3	5.5	4.7	0.3	5.0	6.7	0.3	7.0
RICE	3.6	62-63% 5.7-5.8	69% 5.2	99.1	0.2	99.3	356.8	0.7	357.5	564.9	1.0	565.9
COTTON	3.2	70% 4.6	75% 4.3	1.0		1.0	3.2		3.2	4.6		4.6
SUGAR BEETS	3.2	65% 4.9	75% 4.3	1.9	0.1	2.0	6.1	0.3	6.4	9.3	0.4	9.7
CORN	2.3	65% 3.5	70% 3.3	2.0	0.2	2.2	4.6	0.5	5.1	7.1	0.7	7.8
DRY BEANS	1.9	70% 2.7	80% 2.4	0.7	0.1	0.8	1.4	0.2	1.6	1.9	0.2	2.1
SAFFLOWER	0.5	90% 0.6	90% 0.6	0.2		0.2	0.1		0.1	0.1		0.1
OTHER FIELD	2.0	65% 3.1	70% 2.9	0.2	0.1	0.3	0.4	0.2	0.6	0.6	0.3	0.9
ALFALFA	4.0	70% 5.7	75% 5.3	4.0	0.3	4.3	16.0	1.2	17.2	22.9	1.6	24.5
ALFALFA - X												
CLOVER SEED				0.3	0.1	0.4	0.9	0.3	1.2	1.3	0.4	1.7
PASTURE	4.1	65% 6.3	75% 5.5	4.1		4.1	16.8		16.8	25.8		25.8
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.2	70% 3.1	75% 2.9	3.6	0.2	3.8	7.9	0.4	8.3	11.2	0.6	11.8
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	3.1	0.4	3.5	4.3	0.6	4.9	5.9	0.7	6.6
OTHER TRUCK	1.3	70% 1.9	75% 1.7	0.2		0.2	0.3		0.3	0.4		0.4
ALMONDS + PISTACHIOS	3.0	75% 4.0	80% 3.8	1.3		1.3	3.9		3.9	5.2		5.2
OTHER DECIDUOUS	3.0	70% 4.3	75% 4.0	1.2		1.2	3.6		3.6	5.2		5.2
KIWI												
CITRUS - OLIVES												
GRAPES	2.0	75% 2.7	80% 2.5	0.1		0.1	0.2		0.2	0.3		0.3
EUCALYPTUS												
Totals				128.2	2.0	130.2	431.2	4.7	435.9	673.4	6.2	679.6
Double Crop Acreage												
Total Irrigated Land Area				128.2	2.0	130.2						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Glenn-Colusa IrrigationDistrict

DROUGHT YEAR

DAU #/Name: 142/Red Bluff-Orland (GLE)
163/Willows-Arbuckle (COL)
163/Willows-Arbuckle (GLE)
164/Glenn-Knights Landing (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	4.7	0.3	5.0	4.2	0.3	4.5	6.1	0.3	6.4
RICE	3.6	63% 5.7	69% 5.2	98.9	0.2	99.1	356.1	0.7	356.8	563.7	1.0	564.7
COTTON	3.2	70% 4.6	75% 4.3	3.5		3.5	11.2		11.2	16.1		16.1
SUGAR BEETS	3.2	65% 4.9	75% 4.3	1.6	0.1	1.7	5.2	0.3	5.5	7.9	0.4	8.3
CORN	2.3	65% 3.5	70% 3.3	2.6	0.2	2.8	6.0	0.5	6.5	9.2	0.7	9.9
DRY BEANS	1.9	70% 2.7	80% 2.4	0.7	0.1	0.8	1.4	0.2	1.6	1.9	0.2	2.1
SAFFLOWER	0.5	90% 0.6	90% 0.6	0.2		0.2	0.1		0.1	0.1		0.1
OTHER FIELD	2.0	65% 3.1	70% 2.9	0.7	0.1	0.8	1.4	0.2	1.6	2.2	0.3	2.5
ALFALFA	4.0	70% 5.7	75% 5.3	4.2	0.3	4.5	16.8	1.2	18.0	24.0	1.6	25.6
ALFALFA - X												
CLOVER SEED	3.1	70% 4.4	75% 4.1	0.3	0.1	0.4	0.9	0.3	1.2	1.3	0.4	1.7
PASTURE	4.1	65% 6.3	75% 5.5	3.3		3.3	13.6		13.6	20.8		20.8
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.2	70% 3.1	75% 2.9	6.2	0.2	6.4	13.6	0.4	14.0	19.2	0.6	19.8
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	3.8	0.4	4.2	5.3	0.6	5.9	7.2	0.7	7.9
OTHER TRUCK	1.3	70% 1.9	75% 1.7	1.3		1.3	1.7		1.7	2.5		2.5
ALMONDS + PISTACHIOS	3.0	75% 4.0	80% 3.8	1.3		1.3	3.9		3.9	5.2		5.2
OTHER DECIDUOUS	3.0	70% 4.3	75% 4.0	1.2	0.2	1.4	3.6	0.6	4.2	5.2	0.8	6.0
KIWI												
CITRUS - OLIVES												
GRAPES	2.0	75% 2.7	80% 2.5	0.1		0.1	0.2		0.2	0.3		0.3
EUCALYPTUS												
Totals				**134.6**	**2.2**	**136.8**	**445.2**	**5.3**	**450.5**	**692.9**	**7.0**	**699.9**
Double Crop Acreage												
Total Irrigated Land Area				**134.6**	**2.2**	**136.8**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

PROVIDENT IRRIGATION DISTRICT (PID)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Provident Irrigation District

NORMAL YEAR

DAU #/Name: 163/Willows-Arbuckle (COL)
163/Willows-Arbuckle (GLE)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70% 0.7	85% 0.6	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.3	63% 5.2	68% 4.9	14.6		14.6	48.2		48.2	75.9		75.9
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	65% 5.1	75% 4.4	0.1		0.1	0.3		0.3	0.5		0.5
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				14.8		14.8	48.6		48.6	76.5		76.5
Double Crop Acreage												
Total Irrigated Land Area				14.8		14.8						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Provident Irrigation District

NORMAL YEAR

DAU #/Name: 163/Willows-Arbuckle (COL)
163/Willows-Arbuckle (GLE)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70% 0.7	85% 0.6	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.3	63% 5.2	69% 4.8	14.6		14.6	48.2		48.2	75.9		75.9
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA	3.2	70% 4.6	75% 4.3	0.2		0.2	0.6		0.6	0.9		0.9
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	65% 5.1	75% 4.4	0.1		0.1	0.3		0.3	0.5		0.5
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				15.0		15.0	49.2		49.2	77.4		77.4
Double Crop Acreage												
Total Irrigated Land Area				15.0		15.0						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Provident Irrigation District

DROUGHT YEAR

DAU #/Name: 163 Willows-Arbuckle (COL)
163 Willows-Arbuckle (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.6	63% 5.7	69% 5.2	14.6		14.6	52.5		52.5	83.2		83.2
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	0.1		0.1	0.4		0.4	0.6		0.6
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PISTACHIOS												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				14.8		14.8	53.0		53.0	83.9		83.9
Double Crop Acreage												
Total Irrigated Land Area				14.8		14.8						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Provident Irrigation District

DROUGHT YEAR

DAU #/Name: 163 Willows-Arbuckle (COL)
163 Willows-Arbuckle (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.6	63% 5.7	69% 5.2	14.6		14.6	52.5		52.5	83.2		83.2
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA	4.0	70% 5.7	75% 5.3	0.2		0.2	0.8		0.8	1.1		1.1
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	0.1		0.1	0.4		0.4	0.6		0.6
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PISTACHIOS												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				15.0		15.0	53.8		53.8	85.0		85.0
Double Crop Acreage												
Total Irrigated Land Area				15.0		15.0						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

PRINCETON-CODORA-GLENN IRRIGATION DISTRICT (PCGID)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Princeton-Codora-Glenn Irrigation District

NORMAL YEAR

DAU #/Name: 163/Willows-Arbuckle (COL)
164/Glenn-Knights Landing (COL)
163/Willows-Arbuckle (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70% 0.7	85% 0.6	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
RICE	3.3	63% 5.2	68% 4.9	7.7		7.7	25.4		25.4	40.0		40.0
COTTON												
SUGAR BEETS	2.7	65% 4.2	75% 3.6		0.1	0.1		0.3	0.3		0.4	0.4
CORN	2.3	65% 3.5	70% 3.3		0.2	0.2		0.5	0.5		0.7	0.7
DRY BEANS	1.8	70% 2.6	80% 2.3		0.1	0.1		0.2	0.2		0.2	0.2
SAFFLOWER												
OTHER FIELD	1.9	65% 2.9	70% 2.7		0.1	0.1		0.2	0.2		0.3	0.3
ALFALFA	3.2	70% 4.6	75% 4.3	0.1	0.1	0.2	0.3	0.3	0.6	0.5	0.4	0.9
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	65% 5.1	75% 4.4	0.1	0.1	0.2	0.3	0.3	0.6	0.5	0.4	0.9
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	70% 3.0	75% 2.8		0.1	0.1		0.2	0.2		0.3	0.3
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	0.3		0.3	0.4		0.4	0.6		0.6
OTHER TRUCK												
ALMONDS + PISTACHIOS	2.7	75% 3.6	80% 3.4	0.1		0.1	0.3		0.3	0.4		0.4
OTHER DECIDUOUS	2.7	70% 3.9	75% 3.6	0.5	0.2	0.7	1.3	0.5	1.8	2.0	0.7	2.7
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				8.9	1.1	10.0	28.1	2.6	30.7	44.1	3.5	47.6
Double Crop Acreage					0.1	0.1						
Total Irrigated Land Area				8.9	1.0	9.9						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Princeton-Codora-Glenn Irrigation District

NORMAL YEAR

DAU #/Name: 163/Willows-Arbuckle (COL)
164/Glenn-Knights Landing (COL)
163/Willows-Arbuckle (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70%	0.7	85%	0.6	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
RICE	3.3	63%	5.2	69%	4.8	7.7		7.7	25.4		25.4	40.0		40.0
COTTON														
SUGAR BEETS	2.7	65%	4.2	75%	3.6	3.6	0.2	0.1		0.3	0.3		0.4	0.4
CORN	2.3	65%	3.5	70%	3.3	3.3	0.2	0.2		0.5	0.5		0.7	0.7
DRY BEANS	1.8	70%	2.6	80%	2.3		0.1	0.1		0.2	0.2		0.2	0.2
SAFFLOWER														
OTHER FIELD	1.9	65%	2.9	70%	2.7		0.1	0.1		0.2	0.2		0.3	0.3
ALFALFA	3.2	70%	4.6	75%	4.3	0.4	0.1	0.5	1.3	0.3	1.6	1.9	0.4	2.3
ALFALFA - X														
CLOVER SEED														
PASTURE	3.3	65%	5.1	75%	4.4	0.1	0.1	0.2	0.3	0.3	0.6	0.5	0.4	0.9
PASTURE - X														
MEADOW PASTURE														
TOMATOES	2.1	70%	3.0	75%	2.8		0.1	0.1		0.2	0.2		0.3	0.3
POTATOES														
CUCURBITS	1.4	75%	1.9	80%	1.8	0.3		0.3	0.4		0.4	0.6		0.6
OTHER TRUCK														
ALMONDS + PIST.	2.7	75%	3.6	80%	3.4	0.1		0.1	0.3		0.3	0.4		0.4
OTHER DECIDUOUS	2.7	70%	3.9	75%	3.6	0.5	0.2	0.7	1.3	0.5	1.8	2.0	0.7	2.7
KIWI														
CITRUS - OLIVES														
GRAPES														
EUCALYPTUS														
Totals						9.2	1.1	10.3	29.1	2.6	31.7	45.5	3.5	49.0
Double Crop Acreage							0.1	0.1						
Total Irrigated Land Area						9.2	1.0	10.2						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Princeton-Codora-Glenn Irrigation District

DROUGHT YEAR

DAU #/Name: 163/Willows-Arbuckle (COL)
164/Glenn-Knights Landing (COL)
163/Willows-Arbuckle (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
RICE	3.6	63% 5.7	69% 5.2	7.7		7.7	27.7		27.7	43.9		43.9
COTTON												
SUGAR BEETS	3.2	65% 4.9	75% 4.3		0.1	0.1		0.3	0.3		0.4	0.4
CORN	2.3	65% 3.5	70% 3.3		0.2	0.2		0.5	0.5		0.7	0.7
DRY BEANS	1.9	70% 2.7	80% 2.4		0.1	0.1		0.2	0.2		0.2	0.2
SAFFLOWER												
OTHER FIELD	2.0	65% 3.1	70% 2.9		0.1	0.1		0.2	0.2		0.3	0.3
ALFALFA	4.0	70% 5.7	75% 5.3	0.1	0.1	0.2	0.4	0.4	0.8	0.6	0.5	1.1
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	0.1	0.1	0.2	0.4	0.4	0.8	0.6	0.6	1.2
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.2	70% 3.1	75% 2.9		0.1	0.1		0.2	0.2		0.3	0.3
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	0.3		0.3	0.4		0.4	0.6		0.6
OTHER TRUCK												
ALMONDS + PISTACHIOS	3.0	75% 4.0	80% 3.8	0.1		0.1	0.3		0.3	0.4		0.4
OTHER DECIDUOUS	3.0	70% 4.3	75% 4.0	0.5	0.2	0.7	1.5	0.6	2.1	2.2	0.8	3.0
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				8.9	1.1	10.0	30.8	2.9	33.7	48.4	3.9	52.3
Double Crop Acreage					0.1	0.1						
Total Irrigated Land Area				8.9	1.0	9.9						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Princeton-Codora-Glenn Irrigation District

DROUGHT YEAR

DAU #/Name: 163/Willows-Arbuckle (COL)
164/Glenn-Knights Landing (COL)
163/Willows-Arbuckle (GLE)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
RICE	3.6	63% 5.7	69% 5.2	7.7		7.7	27.7		27.7	43.9		43.9
COTTON												
SUGAR BEETS	3.2	65% 4.9	75% 4.3		0.1	0.1		0.3	0.3		0.4	0.4
CORN	2.3	65% 3.5	70% 3.3		0.2	0.2		0.5	0.5		0.7	0.7
DRY BEANS	1.9	70% 2.7	80% 2.4		0.1	0.1		0.2	0.2		0.2	0.2
SAFFLOWER												
OTHER FIELD	2.0	65% 3.1	70% 2.9		0.1	0.1		0.2	0.2		0.3	0.3
ALFALFA	4.0	70% 5.7	75% 5.3	0.4	0.1	0.5	1.6	0.4	2.0	2.3	0.5	2.8
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	0.1	0.1	0.2	0.4	0.4	0.8	0.6	0.6	1.2
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.2	70% 3.1	75% 2.9		0.1	0.1		0.2	0.2		0.3	0.3
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	0.3		0.3	0.4		0.4	0.6		0.6
OTHER TRUCK												
ALMONDS + PISTACHIOS	3.0	75% 4.0	80% 3.8	0.1		0.1	0.3		0.3	0.4		0.4
OTHER DECIDUOUS	3.0	70% 4.3	75% 4.0	0.5	0.2	0.7	1.5	0.6	2.1	2.2	0.8	3.0
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				9.2	1.1	10.3	32.0	2.9	34.9	50.1	3.9	54.0
Double Crop Acreage					0.1	0.1						
Total Irrigated Land Area				9.2	1.0	10.2						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

MAXWELL IRRIGATION DISTRICT (MID)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Maxwell Irrigation District

NORMAL YEAR

DAU #/Name: 163/Willows-Arbuckle(COL)
164/Willows-Arbuckle (COL)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70% 0.7	85% 0.6	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.3	63% 5.2	68% 4.9	4.9		4.9	16.2		16.2	25.4		25.4
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				5.0		5.0	16.3		16.3	25.5		25.5
Double Crop Acreage												
Total Irrigated Land Area				5.0		5.0						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Maxwell Irrigation District

NORMAL YEAR

DAU #/Name: 163/Willows-Arbuckle(COL)
164/Willows-Arbuckle (COL)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5	70% 0.7	85% 0.6	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.3	63% 5.2	69% 4.8	4.9		4.9	16.2		16.2	25.4		25.4
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				5.0		5.0	16.3		16.3	25.5		25.5
Double Crop Acreage												
Total Irrigated Land Area				5.0		5.0						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

MID 2020 NORMAL TOTALS

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Maxwell Irrigation District

DROUGHT YEAR

DAU #/Name: 163/Willows-Arbuckle(COL)
164/Willows-Arbuckle (COL)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.6	63% 5.7	69% 5.2	4.9		4.9	17.6		17.6	27.9		27.9
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PISTACHIOS												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				5.0		5.0	17.7		17.7	28.0		28.0
Double Crop Acreage												
Total Irrigated Land Area				5.0		5.0						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Maxwell Irrigation District

DROUGHT YEAR

DAU #/Name: 163/Willows-Arbuckle(COL)
164/Willows-Arbuckle (COL)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9	70% 1.3	85% 1.1	0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.6	63% 5.7	69% 5.2	4.9		4.9	17.6		17.6	27.9		27.9
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS												
SAFFLOWER												
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES												
POTATOES												
CUCURBITS												
OTHER TRUCK												
ALMONDS + PISTACHIOS												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				5.0		5.0	17.7		17.7	28.0		28.0
Double Crop Acreage												
Total Irrigated Land Area				5.0		5.0						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

RECLAMATION DISTRICT 108 (RD 108)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Reclamation District 108

NORMAL YEAR

DAU #/Name: 164/Glenn-Knights Landing (COL)
164/Glenn-Knights Landing (YOL)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5-0.6	66%-70%	0.7-0.9	85%	0.6	8.1	0.1	8.2	4.3	0.1	4.4	6.2	0.1	6.3
RICE	3.3-3.4	52%-63&	5.2	68%	4.9	21.5		21.5	71.8		71.8	122.6		122.6
COTTON	2.9	70%	4.1	75%	3.9	0.5		0.5	1.5		1.5	2.1		2.1
SUGAR BEETS	2.7	65%	4.2	75%	3.6	0.4	0.2	0.6	1.1	0.5	1.6	1.7	0.7	2.4
CORN	1.8-2.3	65%-69%	3.5	70%	3.3	1.3		1.3	2.9		2.9	4.4		4.4
DRY BEANS	1.5-1.8	68%-70%	2.6	80%	2.3	1.5		1.5	2.7		2.7	3.8		3.8
SAFFLOWER	0.4-0.7	78%-90%	0.4	90%	0.4	5.4	0.1	5.5	3.0		3.0	3.5		3.5
OTHER FIELD	1.5-1.9	65%-68%	2.9	70%	2.7	0.9	0.1	1.0	1.6	0.2	1.8	2.3	0.3	2.6
ALFALFA	3.0-3.2	68%-70%	4.6	75%	4.3	1.8		1.8	5.7		5.7	8.2		8.2
ALFALFA - X														
CLOVER SEED														
PASTURE	3.3	65%	5.1	75%	4.4	0.3		0.3	1.0		1.0	1.5		1.5
PASTURE - X														
MEADOW PASTURE														
TOMATOES	2.1	70%	3.0	75%	2.8	5.4		5.4	11.4		11.4	16.5		16.5
POTATOES														
CUCURBITS	1.2-1.4	67%-75%	1.9	80%	1.8	2.8		2.8	3.5		3.5	5.2		5.2
OTHER TRUCK														
ALMONDS + PIST.														
OTHER DECIDUOUS	2.5-2.7	69%-70%	3.9	75%	3.6	0.6		0.6	1.6		1.6	2.3		2.3
KIWI														
CITRUS - OLIVES														
GRAPES														
EUCALYPTUS														
Totals						50.5	0.5	51.0	112.1	0.8	112.9	180.3	1.1	181.4
Double Crop Acreage						1.4		1.4						
Total Irrigated Land Area						49.1	0.5	49.6						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Reclamation District 108

NORMAL YEAR

DAU #/Name: 164/Glenn-Knights Landing (COL)
164/Glenn-Knights Landing (YOL)

Crop	Range Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water Ranges (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.5-0.6	67-70%	0.7	85%	0.6	8.0	0.1	8.1	4.3	0.1	4.4	6.2	0.1	6.3
RICE	3.3-3.4	60-63%	5.2	69%	4.8	21.6		21.6	72.1		72.1	116.5		116.5
COTTON	2.9	70%	4.1	75%	3.9	0.7		0.7	2.0		2.0	2.9		2.9
SUGAR BEETS	2.7	65%	4.2	75%	3.6		0.2	0.2		0.5	0.5		0.7	0.7
CORN	1.8-2.3	65-69%	4.2	70%	3.3	1.6		1.6	3.6		3.6	5.4		5.4
DRY BEANS	1.5-1.8	68-70%	2.6	80%	2.3	1.9		1.9	3.4		3.4	4.9		4.9
SAFFLOWER	0.4-0.7	78-90%	0.4	90%	0.4	5.0	0.1	5.1	2.8		2.8	3.3		3.3
OTHER FIELD	1.5-1.9	65-68%	2.7	70%	2.7	0.9	0.1	1.0	1.6	0.2	1.8	2.3	0.3	2.6
ALFALFA	3.0-3.2	68-70%	4.6	75%	4.3	1.6		1.6	5.0		5.0	7.3		7.3
ALFALFA - X														
CLOVER SEED														
PASTURE	3.3	65%	5.1	75%	4.4	0.1		0.1	0.3		0.3	0.5		0.5
PASTURE - X														
MEADOW PASTURE														
TOMATOES	2.1	70%	3.0	75%	2.8	6.6		6.6	13.9		13.9	19.8		19.8
POTATOES														
CUCURBITS	1.2-1.4	70-75%	1.9	80%	1.8	3.4		3.4	4.4		4.4	6.1		6.1
OTHER TRUCK														
ALMONDS + PIST.														
OTHER DECIDUOUS	2.5-2.7	70%	3.6-3.9	75%	3.6	0.6		0.6	1.6		1.6	2.3		2.3
KIWI														
CITRUS - OLIVES														
GRAPES														
EUCALYPTUS														
Totals						**52.0**	**0.5**	**52.5**	**115.0**	**0.8**	**115.8**	**177.5**	**1.1**	**178.6**
Double Crop Acreage						**1.8**		**1.8**						
Total Irrigated Land Area						**50.2**	**0.5**	**50.7**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Reclamation District 108

DROUGHT YEAR

DAU #/Name: 164/Glenn-Knights Landing (COL)
164/Glenn-Knights Landing (YOL)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9-1.1	56-70% 1.3-1.	85% 1.1	8.1	0.1	8.2	7.8	0.1	7.9	11.6	0.1	11.7
RICE	3.5-3.6	52-63% 5.7-6.	69% 5.2	21.5		21.5	76.6		76.6	130.8		130.8
COTTON	3.2	70% 4.6	75% 4.3	0.5		0.5	1.6		1.6	2.3		2.3
SUGAR BEETS	3.2	65% 4.9	75% 4.3	0.4	0.2	0.6	1.3	0.6	1.9	2.0	0.9	2.9
CORN	1.9-2.3	65-69% 2.8-3.	70% 3.3	1.3		1.3	2.9		2.9	4.5		4.5
DRY BEANS	1.6-1.9	68-70% 2.4-2.	80% 2.4	1.5		1.5	2.8		2.8	3.9		3.9
SAFFLOWER	0.5-0.8	78-90% 0.6-1.	90% 0.6	5.4	0.1	5.5	3.5	0.1	3.6	4.2	0.1	4.3
OTHER FIELD	1.6-2.0	65-68% 2.4-3.	70% 2.9	0.9	0.1	1.0	1.6	0.2	1.8	2.4	0.3	2.7
ALFALFA	3.7-4.0	68-70% 5.4-5.	75% 5.3	1.8		1.8	7.1		7.1	10.1		10.1
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	0.3		0.3	1.2		1.2	1.9		1.9
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.2-2.3	68-70% 3.1-3	75% 2.9	5.4		5.4	12.1		12.1	17.6		17.6
POTATOES												
CUCURBITS	1.3-1.4	67-75% 1.9	80% 1.9	2.8		2.8	3.7		3.7	5.3		5.3
OTHER TRUCK												
ALMONDS + PISTACHIOS												
OTHER DECIDUOUS	2.8-3.0	69-70% 4.1-4.	75% 4.0	0.6		0.6	1.8		1.8	2.5		2.5
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				50.5	0.5	51.0	124.0	1.0	125.0	199.1	1.4	200.5
Double Crop Acreage				1.4		1.4						
Total Irrigated Land Area				49.1	0.5	49.6						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Reclamation District 108

DROUGHT YEAR

DAU #/Name: 164/Glenn-Knights Landing (COL)
164/Glenn-Knights Landing (YOL)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.9-1.1	67-70% 1.3-1.	85% 1.1	8.0	0.1	8.1	7.8	0.1	7.9	11.2	0.1	11.3
RICE	3.5-3.6	60-63% 5.7-5.	69% 5.2	21.6		21.6	77.0		77.0	123.9		123.9
COTTON	3.2	70% 4.6	75% 4.3	0.7		0.7	2.2		2.2	3.2		3.2
SUGAR BEETS	3.2	65% 4.9	75% 4.3		0.2	0.2		0.6	0.6		0.9	0.9
CORN	1.9-2.3	65-69% 2.8-3.	70% 3.3	1.6		1.6	3.6		3.6	5.5		5.5
DRY BEANS	1.6-1.9	68-70% 2.4-2.	80% 2.4	1.9		1.9	3.5		3.5	5.0		5.0
SAFFLOWER	0.5-0.8	78-90% 0.6-1.	90% 0.6	5.0	0.1	5.1	3.3	0.1	3.4	4.0	0.1	4.1
OTHER FIELD	1.6-2.0	65-68% 2.4-3.	70% 2.9	0.9	0.1	1.0	1.6	0.2	1.8	2.4	0.3	2.7
ALFALFA	3.7-4.0	68-70% 5.4-5.	75% 5.3	1.6		1.6	6.3		6.3	9.0		9.0
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3	75% 5.5	0.1		0.1	0.4		0.4	0.6		0.6
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.2-2.3	70% 3.1-3.	75% 2.9	6.6		6.6	14.8		14.8	21.0		21.0
POTATOES												
CUCURBITS	1.3-1.4	70-75% 1.9	80% 1.8	3.4		3.4	4.6		4.6	6.4		6.4
OTHER TRUCK												
ALMONDS + PISTACHIOS												
OTHER DECIDUOUS	2.8-3.0	70% 4.0-4.	75% 4.0	0.6		0.6	1.8		1.8	2.5		2.5
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				**52.0**	**0.5**	**52.5**	**126.9**	**1.0**	**127.9**	**194.7**	**1.4**	**196.1**
Double Crop Acreage				**1.8**		**1.8**						
Total Irrigated Land Area				**50.2**	**0.5**	**50.7**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

RECLAMATION DISTRICT 1004 (RD 1004)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Reclamation District 1004

NORMAL YEAR

DAU #/Name: 167/Butte City (COL)
167/Butte City (GLE)
166/Durham-Sutter (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN														
RICE	3.3	63%	5.2	68%	4.9	12.7	0.1	12.8	41.9	0.3	42.2	66.1	0.5	66.6
COTTON	2.8	70%	4.0	75%	3.7	0.5		0.5	1.4		1.4	2.0		2.0
SUGAR BEETS														
CORN	2.3	65%	3.5	70%	3.3	0.1		0.1	0.2		0.2	0.4		0.4
DRY BEANS	1.8	70%	2.6	80%	2.3	1.4		1.4	2.5		2.5	3.7		3.7
SAFFLOWER	0.4	90%	0.4	90%	0.4	0.1	0.1	0.2						
OTHER FIELD														
ALFALFA														
ALFALFA - X														
CLOVER SEED														
PASTURE														
PASTURE - X														
MEADOW PASTURE														
TOMATOES	2.1	70%	3.0	75%	2.8	0.3		0.3	0.6		0.6	0.9		0.9
POTATOES														
CUCURBITS	1.4	75%	1.9	80%	1.8	0.2		0.2	0.3		0.3	0.4		0.4
OTHER TRUCK														
ALMONDS + PIST.														
OTHER DECIDUOUS	2.7	70%	3.9	75%	3.6	0.2		0.2	0.5		0.5	0.8		0.8
KIWI														
CITRUS - OLIVES														
GRAPES														
EUCALYPTUS														
Totals						15.5	0.2	15.7	47.4	0.3	47.7	74.3	0.5	74.8
Double Crop Acreage														
Total Irrigated Land Area						15.5	0.2	15.7						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Reclamation District 1004

NORMAL YEAR

DAU #/Name: 167/Butte City (COL)
167/Butte City (GLE)
166/Durham-Sutter (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN												
RICE	3.3	63% 5.2	69% 4.8	12.0	0.1	12.1	39.6	0.3	39.9	62.4	0.5	62.9
COTTON	2.8	70% 4.0	75% 3.7	0.5		0.5	1.4		1.4	2.0		2.0
SUGAR BEETS												
CORN	2.3	65% 3.5	70% 3.3	0.4		0.4	0.9		0.9	1.4		1.4
DRY BEANS	1.8	70% 2.6	80% 2.3	2.4		2.4	4.3		4.3	6.3		6.3
SAFFLOWER	0.4	90% 0.4	90% 0.4	0.1	0.1	0.2						
OTHER FIELD	1.9	65% 2.9	70% 2.7		0.1	0.1		0.2	0.2		0.3	0.3
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	70% 3.0	75% 2.8	0.3		0.3	0.6		0.6	0.9		0.9
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	0.3		0.3	0.4		0.4	0.6		0.6
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.7	70% 3.9	75% 3.6	0.2		0.2	0.5		0.5	0.8		0.8
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				16.2	0.3	16.5	47.7	0.5	48.2	74.4	0.8	75.2
Double Crop Acreage												
Total Irrigated Land Area				16.2	0.3	16.5						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Reclamation District 1004

DROUGHT YEAR

DAU #/Name: 167/Butte City (COL)
167/Butte City (GLE)
166/Durham-Sutter (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN												
RICE	3.6	63% 5.7	69% 5.2	12.7	0.1	12.8	45.7	0.4	46.1	72.4	0.5	72.9
COTTON	3.2	70% 4.6	75% 4.3	0.5		0.5	1.6		1.6	2.3		2.3
SUGAR BEETS												
CORN	2.3	65% 3.5	70% 3.3	0.1		0.1	0.2		0.2	0.4		0.4
DRY BEANS	1.9	70% 2.7	80% 2.4	1.4		1.4	2.6		2.6	3.8		3.8
SAFFLOWER	0.5	90% 0.6	90% 0.6	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.2	70% 3.1	75% 2.9	0.3		0.3	0.7		0.7	0.9		0.9
POTATOES												
CUCURBITS	1.4	75% 1.9	80% 1.8	0.2		0.2	0.3		0.3	0.4		0.4
OTHER TRUCK												
ALMONDS + PISTACHIOS												
OTHER DECIDUOUS	3.0	70% 4.3	75% 4.0	0.2		0.2	0.6		0.6	0.9		0.9
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				15.5	0.2	15.7	51.8	0.5	52.3	81.2	0.6	81.8
Double Crop Acreage												
Total Irrigated Land Area				15.5	0.2	15.7						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Reclamation District 1004

DROUGHT YEAR

DAU #/Name: 167/Butte City (COL)
167/Butte City (GLE)
166/Durham-Sutter (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)				Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface		Ground		Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN														
RICE	3.6	63%	5.7	69%	5.2	12.0	0.1	12.1	43.2	0.4	43.6	68.4	0.5	68.9
COTTON	3.2	70%	4.6	75%	4.3	0.5		0.5	1.6		1.6	2.3		2.3
SUGAR BEETS														
CORN	2.3	65%	3.5	70%	3.3	0.4		0.4	0.9		0.9	1.4		1.4
DRY BEANS	1.9	70%	2.7	80%	2.4	2.4		2.4	4.5		4.5	6.5		6.5
SAFFLOWER	0.5	90%	0.6	90%	0.6	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.2
OTHER FIELD	2.0	65%	3.1	70%	2.9		0.1	0.1		0.2	0.2		0.3	0.3
ALFALFA														
ALFALFA - X														
CLOVER SEED														
PASTURE														
PASTURE - X														
MEADOW PASTURE														
TOMATOES	2.2	70%	3.1	75%	2.9	0.3		0.3	0.7		0.7	0.9		0.9
POTATOES														
CUCURBITS	1.4	75%	1.9	80%	1.8	0.3		0.3	0.4		0.4	0.6		0.6
OTHER TRUCK														
ALMONDS + PISTACHIOS														
OTHER DECIDUOUS	3.0	70%	4.3	75%	4.0	0.2		0.2	0.6		0.6	0.9		0.9
KIWI														
CITRUS - OLIVES														
GRAPES														
EUCALYPTUS														
Totals						16.2	0.3	16.5	52.0	0.7	52.7	81.1	0.9	82.0
Double Crop Acreage														
Total Irrigated Land Area						16.2	0.3	16.5						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.
[2] Source: State of California Department of Water Resources, Northern District

SUTTER MUTUAL WATER COMPANY (SMWC)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Sutter Mutual Water Company

NORMAL YEAR

DAU#/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	66% 0.9		8.1		8.1	4.9		4.9	7.3		7.3
RICE	3.4	52% 6.5		17.4		17.4	59.2		59.2	113.1		113.1
COTTON												
SUGAR BEETS	2.3	68% 3.4		0.3		0.3	0.7		0.7	1.0		1.0
CORN	1.8	69% 2.6		0.3		0.3	0.5		0.5	0.8		0.8
DRY BEANS	1.5	68% 2.2		5.5		5.5	8.3		8.3	12.1		12.1
SAFFLOWER	0.7	78% 0.9		2.2		2.2	1.5		1.5	2.0		2.0
OTHER FIELD	1.5	68% 2.2		1.0		1.0	1.5		1.5	2.2		2.2
ALFALFA	3.0	68% 4.4		0.1		0.1	0.3		0.3	0.4		0.4
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	68% 3.1		12.2		12.2	25.6		25.6	37.8		37.8
POTATOES												
CUCURBITS	1.2	67% 1.8		4.8		4.8	5.8		5.8	8.6		8.6
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	69% 3.6		0.2		0.2	0.5		0.5	0.7		0.7
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				52.1		52.1	108.8		108.8	186.0		186.0
Double Crop Acreage				5.5		5.5						
Total Irrigated Land Area				46.6		46.6						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Sutter Mutual Water Company

NORMAL YEAR

DAU#/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	67% 0.9		8.0		8.0	4.8		4.8	7.2		7.2
RICE	3.4	60% 5.7		17.4		17.4	59.2		59.2	99.2		99.2
COTTON												
SUGAR BEETS	2.3	70% 3.3		0.3		0.3	0.7		0.7	1.0		1.0
CORN	1.8	69% 2.6		0.3		0.3	0.5		0.5	0.8		0.8
DRY BEANS	1.5	68% 2.2		4.9		4.9	7.4		7.4	10.8		10.8
SAFFLOWER	0.7	78% 0.9		2.5		2.5	1.8		1.8	2.3		2.3
OTHER FIELD	1.5	68% 2.2		0.5		0.5	0.8		0.8	1.1		1.1
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	70% 3.0		12.2		12.2	25.6		25.6	36.6		36.6
POTATOES												
CUCURBITS	1.2	70% 1.7		4.8		4.8	5.8		5.8	8.2		8.2
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	70% 3.6		0.1		0.1	0.3		0.3	0.4		0.4
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				**51.0**		**51.0**	**106.9**		**106.9**	**167.6**		**167.6**
Double Crop Acreage				**4.9**		**4.9**						
Total Irrigated Land Area				**46.1**		**46.1**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Sutter Mutual Water Company

DROUGHT YEAR

DAU#/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	66% 1.7		8.1		8.1	8.9		8.9	13.8		13.8
RICE	3.5	52% 6.7		17.4		17.4	60.9		60.9	116.6		116.6
COTTON												
SUGAR BEETS	2.7	68% 4.0		0.3		0.3	0.8		0.8	1.2		1.2
CORN	1.9	69% 2.8		0.3		0.3	0.6		0.6	0.8		0.8
DRY BEANS	1.6	68% 2.4		5.5		5.5	8.8		8.8	13.2		13.2
SAFFLOWER	0.8	78% 1.0		2.2		2.2	1.8		1.8	2.2		2.2
OTHER FIELD	1.6	68% 2.4		1.0		1.0	1.6		1.6	2.4		2.4
ALFALFA	3.7	68% 5.4		0.1		0.1	0.4		0.4	0.5		0.5
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	68% 3.4		12.2		12.2	28.1		28.1	41.5		41.5
POTATOES												
CUCURBITS	1.3	67% 1.9		4.8		4.8	6.2		6.2	9.1		9.1
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.8	69% 4.1		0.2		0.2	0.6		0.6	0.8		0.8
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				52.1		52.1	118.7		118.7	202.1		202.1
Double Crop Acreage				5.5		5.5						
Total Irrigated Land Area				46.6		46.6						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Sutter Mutual Water Company

DROUGHT YEAR

DAU#/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	67% 1.6		8.0		8.0	8.8		8.8	12.8		12.8
RICE	3.5	60% 5.8		17.4		17.4	60.9		60.9	100.9		100.9
COTTON												
SUGAR BEETS	2.7	70% 3.9		0.3		0.3	0.8		0.8	1.2		1.2
CORN	1.9	69% 2.8		0.3		0.3	0.6		0.6	0.8		0.8
DRY BEANS	1.6	68% 2.4		4.9		4.9	7.8		7.8	11.8		11.8
SAFFLOWER	0.8	76% 1.0		2.5		2.5	2.0		2.0	2.5		2.5
OTHER FIELD	1.6	68% 2.4		0.5		0.5	0.8		0.8	1.2		1.2
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	70% 3.3		12.2		12.2	28.1		28.1	40.3		40.3
POTATOES												
CUCURBITS	1.3	70% 1.9		4.8		4.8	6.2		6.2	9.1		9.1
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.8	70% 4.0		0.1		0.1	0.3		0.3	0.4		0.4
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				**51.0**		**51.0**	**116.3**		**116.3**	**181.0**		**181.0**
Double Crop Acreage				**4.9**		**4.9**						
Total Irrigated Land Area				**46.1**		**46.1**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

MERIDIAN FARMS WATER COMPANY (MFWC)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Meridian Farms Water Company

NORMAL YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	66% 0.9		1.0		1.0	0.6		0.6	0.9		0.9
RICE	3.4	52% 6.5		3.5		3.5	11.9		11.9	22.8		22.8
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS	1.5	68% 2.2		0.5		0.5	0.8		0.8	1.1		1.1
SAFFLOWER	0.7	78% 0.9		2.4		2.4	1.7		1.7	2.2		2.2
OTHER FIELD	1.5	68% 2.2		0.1		0.1	0.2		0.2	0.2		0.2
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	62% 5.3		0.1		0.1	0.3		0.3	0.5		0.5
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	68% 3.1		1.3		1.3	2.7		2.7	4.0		4.0
POTATOES												
CUCURBITS	1.2	67% 1.8		0.2		0.2	0.2		0.2	0.4		0.4
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	69% 3.6		0.6		0.6	1.5		1.5	2.2		2.2
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				9.7		9.7	19.9		19.9	34.3		34.3
Double Crop Acreage				0.5		0.5						
Total Irrigated Land Area				9.2		9.2						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Meridian Farms Water Company

NORMAL YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	67% 0.9		1.0		1.0	0.6		0.6	0.9		0.9
RICE	3.4	60% 5.7		3.5		3.5	11.9		11.9	20.0		20.0
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS	1.5	68% 2.2		0.5		0.5	0.8		0.8	1.1		1.1
SAFFLOWER	0.7	78% 0.9		2.4		2.4	1.7		1.7	2.2		2.2
OTHER FIELD	1.5	68% 2.2		0.1		0.1	0.2		0.2	0.2		0.2
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	65% 5.1		0.1		0.1	0.3		0.3	0.5		0.5
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	70% 3.0		1.3		1.3	2.7		2.7	3.9		3.9
POTATOES												
CUCURBITS	1.2	70% 1.7		0.2		0.2	0.2		0.2	0.3		0.3
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	70% 3.6		0.6		0.6	1.5		1.5	2.2		2.2
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				9.7		9.7	19.9		19.9	31.3		31.3
Double Crop Acreage				0.5		0.5						
Total Irrigated Land Area				9.2		9.2						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 1995[2]

Meridian Farms Water Company

DROUGHT YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	66% 1.7		1.0		1.0	1.1		1.1	1.7		1.7
RICE	3.5	52% 6.7		3.5		3.5	12.3		12.3	23.5		23.5
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS	1.6	68% 2.4		0.5		0.5	0.8		0.8	1.2		1.2
SAFFLOWER	0.8	78% 1.0		2.4		2.4	1.9		1.9	2.4		2.4
OTHER FIELD	1.6	68% 2.4		0.1		0.1	0.2		0.2	0.2		0.2
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	62% 6.6		0.1		0.1	0.4		0.4	0.7		0.7
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	68% 3.4		1.3		1.3	3.0		3.0	4.4		4.4
POTATOES												
CUCURBITS	1.3	67% 1.9		0.2		0.2	0.3		0.3	0.4		0.4
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.8	69% 4.1		0.6		0.6	1.7		1.7	2.5		2.5
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				**9.7**		**9.7**	**21.7**		**21.7**	**37.0**		**37.0**
Double Crop Acreage				**0.5**		**0.5**						
Total Irrigated Land Area				**9.2**		**9.2**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Meridian Farms Water Company

DROUGHT YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	67% 1.6		1.0		1.0	1.1		1.1	1.6		1.6
RICE	3.5	60% 5.8		3.5		3.5	12.3		12.3	20.3		20.3
COTTON												
SUGAR BEETS												
CORN												
DRY BEANS	1.6	68% 2.4		0.5		0.5	0.8		0.8	1.2		1.2
SAFFLOWER	0.8	78% 1.0		2.4		2.4	1.9		1.9	2.4		2.4
OTHER FIELD	1.6	69% 2.3		0.1		0.1	0.2		0.2	0.2		0.2
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3		0.1		0.1	0.4		0.4	0.6		0.6
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	70% 3.3		1.3		1.3	3.0		3.0	4.3		4.3
POTATOES												
CUCURBITS	1.3	70% 1.9		0.2		0.2	0.3		0.3	0.4		0.4
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.8	70% 4.0		0.6		0.6	1.7		1.7	2.4		2.4
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				9.7		9.7	21.7		21.7	33.4		33.4
Double Crop Acreage				0.5		0.5						
Total Irrigated Land Area				9.2		9.2						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

PELGER MUTUAL WATER COMPANY (PMWC)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 1995[2]

Pelger Mutual Water Company

NORMAL YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	66% 0.9		0.1		0.1	0.1	0.0	0.1	0.1	0.0	0.1
RICE	3.4	52% 6.5		0.6		0.6	2.0	0.0	2.0	3.9	0.0	3.9
COTTON												
SUGAR BEETS	2.3	68% 3.4										
CORN	1.8	69% 2.6		0.7		0.7	1.3	0.0	1.3	1.8	0.0	1.8
DRY BEANS	1.5	68% 2.2		0.3		0.3	0.5	0.0	0.5	0.7	0.0	0.7
SAFFLOWER	0.7	78% 0.9		0.4		0.4	0.3	0.0	0.3	0.4	0.0	0.4
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	68% 3.1		0.6		0.6	1.3	0.0	1.3	1.9	0.0	1.9
POTATOES												
CUCURBITS	1.2	67% 1.8		0.2		0.2	0.2	0.0	0.2	0.4	0.0	0.4
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				2.9	0.0	2.9	5.7	0.0	5.7	9.2	0.0	9.2
Double Crop Acreage				0.1		0.1						
Total Irrigated Land Area				2.8	0.0	2.8						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use For Year 2020[2]

Pelger Mutual Water Company

NORMAL YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	67% 0.9		0.1		0.1	0.1	0.0	0.1	0.1	0.0	0.1
RICE	3.4	60% 5.7		0.6		0.6	2.0	0.0	2.0	3.4	0.0	3.4
COTTON												
SUGAR BEETS												
CORN	1.8	69% 2.6		0.7		0.7	1.3	0.0	1.3	1.8	0.0	1.8
DRY BEANS	1.5	68% 2.2		0.3		0.3	0.5	0.0	0.5	0.7	0.0	0.7
SAFFLOWER	0.7	78% 0.9		0.4		0.4	0.3	0.0	0.3	0.4	0.0	0.4
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	70% 3.0		0.6		0.6	1.3	0.0	1.3	1.8	0.0	1.8
POTATOES												
CUCURBITS	1.2	70% 1.7		0.2		0.2	0.2	0.0	0.2	0.3	0.0	0.3
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	70% 3.6										
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				2.9	0.0	2.9	5.7	0.0	5.7	8.5	0.0	8.5
Double Crop Acreage				0.1		0.1						
Total Irrigated Land Area				2.8	0.0	2.8						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN
Agricultural Land and Water Use Drought Projection Year 1995[2]
Pelger Mutual Water Company
DROUGHT YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	66% 1.7		0.1		0.1	0.1	0.0	0.1	0.2	0.0	0.2
RICE	3.5	52% 6.7		0.6		0.6	2.1	0.0	2.1	4.0	0.0	4.0
COTTON												
SUGAR BEETS	2.7	68% 4.0										
CORN	1.9	69% 2.8		0.7		0.7	1.3	0.0	1.3	2.0	0.0	2.0
DRY BEANS	1.6	68% 2.4		0.3		0.3	0.5	0.0	0.5	0.7	0.0	0.7
SAFFLOWER	0.8	78% 1.0		0.4		0.4	0.3	0.0	0.3	0.4	0.0	0.4
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	68% 3.4		0.6		0.6	1.4	0.0	1.4	2.0	0.0	2.0
POTATOES												
CUCURBITS	1.3	67% 1.9		0.2		0.2	0.3	0.0	0.3	0.4	0.0	0.4
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS												
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				2.9	0.0	2.9	6.0	0.0	6.0	9.7	0.0	9.7
Double Crop Acreage				0.1								
Total Irrigated Land Area				2.8	0.0	2.9						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use Drought Projection Year 2020[2]

Pelger Mutual Water Company

DROUGHT YEAR

DAU #/Name: 165/Meridian-Robbins (SUT)

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	67% 1.6		0.1		0.1	0.1	0.0	0.1	0.2	0.0	0.2
RICE	3.5	60% 5.8		0.6		0.6	2.1	0.0	2.1	3.5	0.0	3.5
COTTON												
SUGAR BEETS												
CORN	1.9	69% 2.8		0.7		0.7	1.3	0.0	1.3	2.0	0.0	2.0
DRY BEANS	1.6	68% 2.4		0.3		0.3	0.5	0.0	0.5	0.7	0.0	0.7
SAFFLOWER	0.8	78% 1.0		0.4		0.4	0.3	0.0	0.3	0.4	0.0	0.4
OTHER FIELD												
ALFALFA												
ALFALFA - X												
CLOVER SEED												
PASTURE												
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	70% 3.3		0.6		0.6	1.4	0.0	1.4	2.0	0.0	2.0
POTATOES												
CUCURBITS	1.3	70% 1.9		0.2		0.2	0.3	0.0	0.3	0.4	0.0	0.4
OTHER TRUCK												
ALMONDS + PIST.												
OTHER DECIDUOUS	2.8	70% 4.0										
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				2.9	0.0	2.9	6.0	0.0	6.0	9.2	0.0	9.2
Double Crop Acreage				0.1								
Total Irrigated Land Area				2.8	0.0	2.9						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

[2] Source: State of California Department of Water Resources, Central District

NATOMAS CENTRAL MUTUAL WATER COMPANY (NCMWC)

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use for 1995

Natomas Mutual Water Company - REVISED PSA: Central Basin East
Sacramento and Sutter Counties HR: Sacramento River
DAU#/Name: 172 Placer DRY YEAR

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	66% 1.7		0.1		0.1	0.1	0.0	0.1	0.2	0.0	0.2
RICE	3.5	52% 6.7		18.0		18.0	63.0	0.0	63.0	120.6	0.0	120.6
COTTON												
SUGAR BEETS	2.7	68% 4.0		3.7		3.7	10.0	0.0	10.0	14.8	0.0	14.8
CORN	1.9	69% 2.8		1.0		1.0	1.9	0.0	1.9	2.8	0.0	2.8
DRY BEANS												
SAFFLOWER	0.8	78% 1.0		0.0								
OTHER FIELD	1.6	68% 2.4		0.2		0.2	0.3	0.0	0.3	0.5	0.0	0.5
ALFALFA	3.7	68% 5.4		0.0		0.0	0.1	0.0	0.1	0.2	0.0	0.2
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	62% 6.6		0.1		0.1	0.2	0.0	0.2	0.3	0.0	0.3
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	68% 3.4		0.6		0.6	1.4	0.0	1.4	2.0	0.0	2.0
POTATOES												
CUCURBITS	1.3	67% 1.9		0.1		0.1	0.1	0.0	0.1	0.2	0.0	0.2
OTHER TRUCK				0.1		0.1	0.0	0.0	0.0	0.0	0.0	0.0
ALMONDS + PIST.												
OTHER DECIDUOUS	2.8	69% 4.1		0.0		0.0	0.1	0.0	0.1	0.2	0.0	0.2
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				**23.9**	**0.0**	**23.9**	**77.2**	**0.0**	**77.2**	**141.8**	**0.0**	**141.8**
Double Crop Acreage												
Total Irrigated Land Area				**23.9**	**0.0**	**23.9**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

Note: Acreages are based on Natomas' actual deliveries. Potential acreage within USBR contract service area is approximately 35,000 acres.

Miscellaneous Land Use Information (1,000 of Acres)			
Seasonal Marsh	0.0	Idle	2,075.0
Permanent Marsh	0.0	Farmsteads	
Rice Fallow	2,304.0	Dairies	0.0

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use for 2020

Natomas Mutual Water Company
Sacramento and Sutter Counties

PSA: Central Basin East
HR: Sacamento River

DAU#/Name: 172 Placer

DRY YEAR

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	1.1	67% 1.6		1.1		1.1	1.2	0.0	1.2	1.8		1.8
RICE	3.5	60% 5.8		13.7		13.7	48.0	0.0	48.0	79.5		79.5
COTTON												
SUGAR BEETS	2.7	68% 4.0		1.8		1.8	4.9	0.0	4.9	7.2		7.2
CORN	1.9	69% 2.8		0.7		0.7	1.3	0.0	1.3	2.0		2.0
DRY BEANS												
SAFFLOWER	0.8	78% 1.0		1.0		1.0	0.8	0.0	0.8	1.0		1.0
OTHER FIELD	1.6	68% 2.4		0.3		0.3	0.5	0.0	0.5	0.7		0.7
ALFALFA	3.7	68% 5.4		0.3		0.3	1.1	0.0	1.1	1.6		1.6
ALFALFA - X												
CLOVER SEED												
PASTURE	4.1	65% 6.3		0.6		0.6	2.5	0.0	2.5	3.8		3.8
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.3	70% 3.3		0.5		0.5	1.2	0.0	1.2	1.7		1.7
POTATOES												
CUCURBITS	1.3	70% 1.9		0.1		0.1	0.1	0.0	0.1	0.2		0.2
OTHER TRUCK	1.3	70%		0.8		0.8	1.0	0.0	1.0	0.0		0.0
ALMONDS + PIST.												
OTHER DECIDUOUS	2.8	70% 4.0		0.4		0.4	1.1	0.0	1.1	1.6		1.6
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				21.3	0.0	21.3	63.7	0.0	63.7	101.1	0.0	101.1
Double Crop Acreage												
Total Irrigated Land Area				21.3	0.0	21.3						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

Miscellaneous Land Use Information (1,000 of Acres)			
Seasonal Marsh	0.0	Idle	
Permanent Marsh	0.0	Farmsteads	
Rice Fallow		Dairies	0.0

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use for 1995

Natomas Mutal Water Company - REVISED

Sacramento and Sutter Counties

DAU #/Name: 172/Placer

PSA: Central Basin West

HR: Sacramento River

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	66% 0.9		0.1		0.1	0.1		0.1	0.1		0.1
RICE	3.4	52% 6.5		18.0		18.0	61.2		61.2	117.0		117.0
COTTON												
SUGAR BEETS	2.3	68% 3.4		3.7		3.7	8.5		8.5	12.6		12.6
CORN	1.8	69% 2.6		1.0		1.0	1.8		1.8	2.6		2.6
DRY BEANS												
SAFFLOWER	0.7	78% 0.9										
OTHER FIELD	1.5	68% 2.2		0.2		0.2	0.3		0.3	0.4		0.4
ALFALFA	3.0	68% 4.4		0.0		0.0	0.1		0.1	0.2		0.2
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	62% 5.3		0.1		0.1	0.2		0.2	0.3		0.3
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	68% 3.1		0.6		0.6	1.2		1.2	1.8		1.8
POTATOES												
CUCURBITS	1.2	67% 1.8		0.1		0.1	0.1		0.1	0.2		0.2
OTHER TRUCK				0.1		0.1						
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	69% 3.6		0.0		0.0	0.1		0.1	0.2		0.2
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				**23.9**		**23.9**	**73.6**		**73.6**	**135.4**		**135.4**
Double Crop Acreage												
Total Irrigated Land Area				**23.9**		**23.9**						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

Note: Acreages are based on Natomas' actual deliveries. Potential acreage within USBR contract service area is approximately 35,000 acres.

Miscellaneous Land Use Information (1,000 of Acres)			
Seasonal Marsh		Idle	2,075.0
Permanent Marsh		Farmsteads	
Rice Fallow	2,304.0	Dairies	

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

Agricultural Land and Water Use for 2020

DAU #/Name: 172/Placer

Natomas Mutal Water Company - NO CHANGE

Sacramento and Sutter Counties

PSA: Central Basin West

HR: Sacamento River

Crop	Unit ET of Applied Water (acre-feet/acre)	Unit Applied Water (acre-feet/acre)		Net Irrigated Acreage[1] (1000's of acres)			ET of Applied Water (1000's of acre-feet)			Applied Water (1000's of acre-feet)		
		Surface	Ground	Surface	Ground	Total	Surface	Ground	Total	Surface	Ground	Total
GRAIN	0.6	67% 0.9		1.1		1.1	0.7		0.7	1.0		1.0
RICE	3.4	60% 5.7		13.7		13.7	46.6		46.6	78.1		78.1
COTTON												
SUGAR BEETS	2.3	68% 3.4		1.8		1.8	4.1		4.1	6.1		6.1
CORN	1.8	69% 2.6		0.7		0.7	1.3		1.3	1.8		1.8
DRY BEANS												
SAFFLOWER	0.7	78% 0.9		1.0		1.0	0.7		0.7	0.9		0.9
OTHER FIELD	1.5	68% 2.2		0.3		0.3	0.5		0.5	0.7		0.7
ALFALFA	3.0	68% 4.4		0.3		0.3	0.9		0.9	1.3		1.3
ALFALFA - X												
CLOVER SEED												
PASTURE	3.3	65% 5.1		0.6		0.6	2.0		2.0	3.1		3.1
PASTURE - X												
MEADOW PASTURE												
TOMATOES	2.1	70% 3.0		0.5		0.5	1.1		1.1	1.5		1.5
POTATOES												
CUCURBITS	1.2	70% 1.7		0.1		0.1	0.1		0.1	0.2		0.2
OTHER TRUCK	1.2	70%		0.8		0.8	1.0		1.0			
ALMONDS + PIST.												
OTHER DECIDUOUS	2.5	70% 3.6		0.4		0.4	1.0		1.0	1.4		1.4
KIWI												
CITRUS - OLIVES												
GRAPES												
EUCALYPTUS												
Totals				21.3		21.3	60.0		60.0	96.1		96.1
Double Crop Acreage												
Total Irrigated Land Area				21.3		21.3						

[1] Net irrigated acreage is equal to 95 percent of the gross acreage.

Miscellaneous Land Use Information (1,000 of Acres)			
Seasonal Marsh		Idle	
Permanent Marsh		Farmsteads	
Rice Fallow		Dairies	

Technical Memorandum No. 3

Sacramento River Basinwide Water Management Plan Water Resources Characterization

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

October 2004

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Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
AB 3030 Plan	Assembly Bill 3030 Groundwater Management Plan
ac-ft	acre-feet
ac-ft/yr	acre-feet per year
ACID	Anderson-Cottonwood Irrigation District
af	acre-feet
cfs	cubic feet per second
CVP	Central Valley Project
DWR	California Department of Water Resources
GCID	Glenn-Colusa Irrigation District
MFWC	Meridian Farms Water Company
mg/L	milligrams per liter
MID	Maxwell Irrigation District
MTCR	M&T Chico Ranch
NCMWC	Natomas Central Mutual Water Company
NOAA-Fisheries	National Oceanic and Atmospheric Administration Fisheries
NTU	nephelometric turbidity unit
PCGID	Princeton-Codora-Glenn Irrigation District
PID	Provident Irrigation District
PMWC	Pelger Mutual Water Company
RD	Reclamation District
RD 108	Reclamation District No. 108
RD 1004	Reclamation District No. 1004
Reclamation	U.S. Bureau of Reclamation
RGFC	River Garden Farms Company
SMWC	Sutter Mutual Water Company

SRSC	Sacramento River Settlement Contractors
SWRCB	California State Water Resources Control Board
TIDC	Tisdale Irrigation and Drainage Company
TM	Technical Memorandum

Introduction

Background

Technical Memorandum (TM) No. 3 is the third in a series of memoranda addressing demands, supplies, and needs associated with the Sacramento River Settlement Contractors (SRSC) participating in the Basinwide Water Management Plan.

The objectives of TM 3 are as follows:

- Describe each participating SRSC's Sacramento River supply (i.e., entitlement) and how it has been relied upon historically/presently.
- Describe how the SRSCs may have used other supplies, such as tributaries, ground-water, and tailwater, to help meet demands, and to what extent reuse/recycling of irrigation water was relied upon.
- Describe how future changes could impact existing supplies (i.e., Central Valley Project Improvement Act, Trinity Restoration Program, CALFED, Bay-Delta Hearings, and Endangered Species Act listings.

This memorandum is organized into the following sections:

- Overview of Sacramento Basin Water Resources Characteristics
- Water Resources Characteristics of the Participating SRSCs, discussed by sub-basin, as follows:
  - Redding Sub-basin
  - Colusa Sub-basin
  - Butte Sub-basin
  - Sutter Sub-basin
  - American Sub-basin

Sacramento Basin Water Resources Characteristics

The SRSCs are situated within the Sacramento River Basin, within the Sacramento River watershed, as shown on Figure 1. The basin is located in the northern portion of the Central Valley. Drainage is provided by the Sacramento River, which flows generally from north to south from its source near Mount Shasta to the Delta, and receives contributing flows from numerous major and minor streams and rivers that drain the east and west sides of the basin.

Basin Characteristics

Topography

The Sacramento River Basin's principal geographic features include the Sacramento Valley, which is bounded on the northwest by the Klamath mountains, the west by the Coast Range mountains, the northeast by the southern end of the Cascade Range, and the southeast by the northern end of the Sierra Nevada mountains. Elevations in the northern portion of the Sacramento River Basin range from over 14,000 feet above mean sea level in the headwaters of the Sacramento River, to approximately 1,065 feet mean sea level at Shasta Lake. The mountainous areas that border the Valley reach elevations above 5,000 feet mean sea level.

The floor of the Sacramento Valley, where the various districts are located, is relatively flat, with elevations ranging from approximately 60 to 300 feet above mean sea level.

Climate

The total annual precipitation in the headwaters area of the Sacramento River averages between 60 and 70 inches, and the Sierra Nevada and Cascade mountains receive as much as 95 inches. Snow is prevalent in the mountainous areas bordering the Valley, and areas at elevations above 5,000 feet receive an average of 42 inches of precipitation per year.

The Sacramento Valley is characterized by hot, dry summers and cool, wet winters (Table 1). Most of the precipitation in the Valley occurs during November through April. During the period between 1961 and 1999, the average annual rainfall in the area of the Valley from Sacramento to Red Bluff was 19.52 inches, and ranged from a low of 15.82 inches to a high of 22.62 inches. During that same period, the average annual rainfall in the Redding area was 40.94 inches. Snowfall in the Sacramento Valley is rare, with the highest annual average of 4.8 inches measured in Redding.

Winds in the Valley blow predominantly from the north and south because of the mountainous regions' alignment bordering the Valley.

TABLE 1
Average Temperature Range in the Sacramento Valley

Parameter[a]	Temperature in °F
Annual Average Maximum Temperature	74.9
Annual Average Minimum Temperature	48.7
Average High Temperature in January	54.3
Average Low Temperature in January	37.0
Average High Temperature in July	95.4
Average Low Temperature in July	61.1

[a] Averages derived from five selected areas within Sacramento Valley (Orland, Colusa, Red Bluff, Sacramento, and Marysville).

Note:

°F = degrees Fahrenheit

Source: Meteorological date were obtained from NOAA-Fisheries.

Surface Water Resources

Flow

Water supply facilities that affect flow conditions on the upper Sacramento River above Red Bluff include Central Valley Project (CVP) and local irrigation district facilities. The most significant feature is Shasta Dam, which was completed in 1944 and created the largest reservoir in the CVP having storage capacity of 4,552,000 acre-feet (ac-ft, also referred to as af). Keswick Dam, completed in 1950 as part of the CVP, has a storage capacity of 23,800 ac-ft and serves as an afterbay for Shasta Dam.

Since 1964, a portion of the flow from the Trinity River Basin has been exported to the Sacramento River Basin through CVP facilities. Historically, an average annual quantity of 1,269,000 ac-ft of water has been exported. This annual quantity is approximately 17 percent of the flows measured in the Sacramento River at Keswick.

Figure 2 shows the annual flows in the Sacramento River at Keswick from 1926 to 1997. Figure 2 also shows average monthly flows for the following three periods:

1. Prior to the completion of Shasta Dam
2. Following the completion of Shasta Dam and prior to the completion of the Trinity River Division
3. Following the completion of the Trinity River Division

Prior to the construction of Shasta Dam, monthly flows reflected the runoff patterns associated with winter precipitation and spring snow melt. Peak flows generally occurred during the months of February, March, and April. Following the construction of Shasta Dam, average monthly flows during March and April were reduced, and average monthly flows during the summer irrigation months were increased. Following the construction of the Trinity River Division of the CVP in 1964, exports from the Trinity River Basin to the Sacramento River Basin increased average releases from Keswick Dam on an annual basis.

FIGURE 1
SACRAMENTO RIVER BASN
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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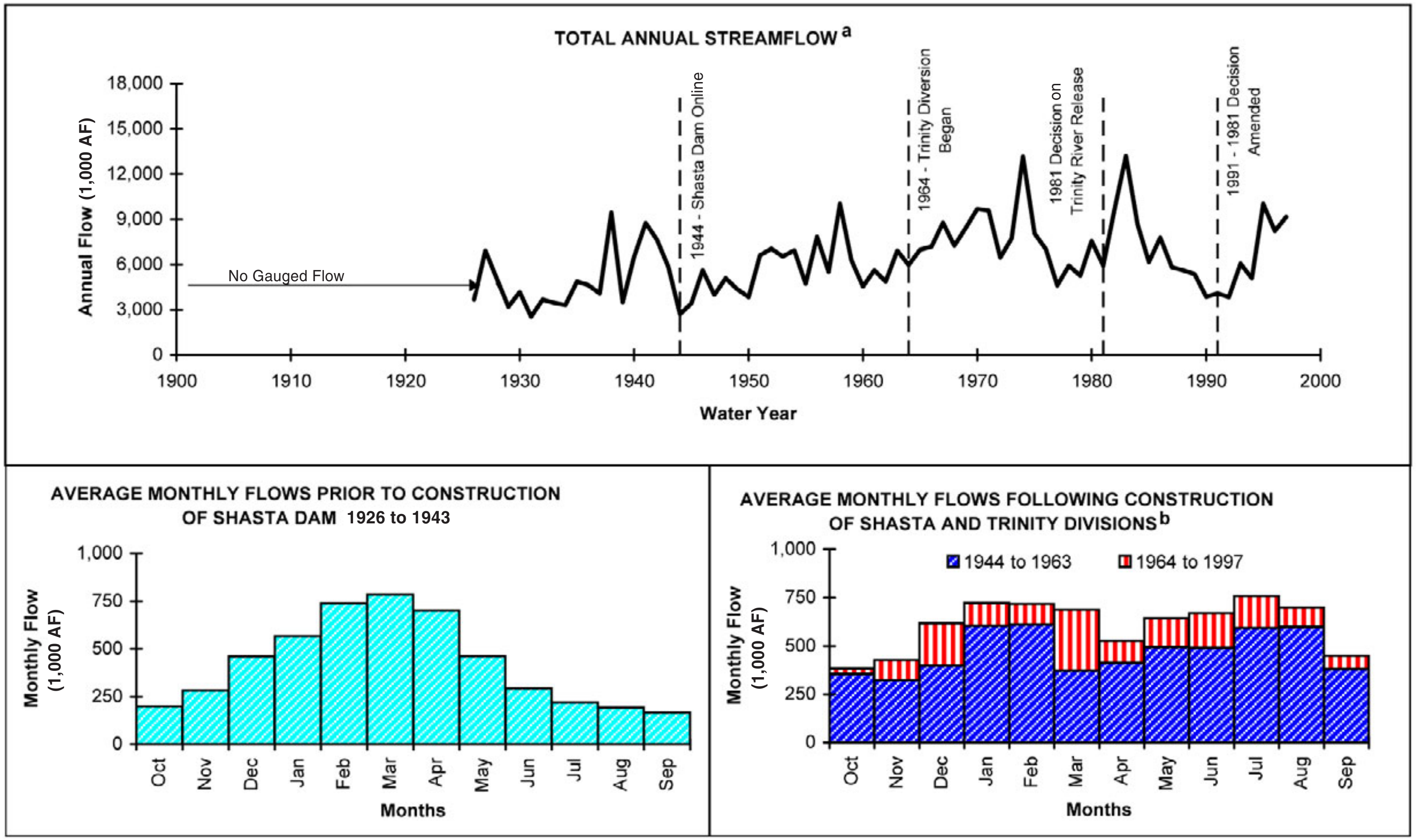

NOTE:
a First full year of streamflow data for station 11370500 was 1939. Data for 1926 to 1963 are from Station 1136950 (Sacramento River at Kennet); data for 1964 to 1997 from USGS Station 11370500 (National Stream Quality Network Station).
b Following the construction of the Trinity River Diversion of the CVP in 1964, exports from the Trinity River Basin to the Sacramento River Basin increased average releases from Keswick Dam on an annual basis.

FIGURE 2
HISTORICAL STREAMFLOW IN THE SACRAMENTO RIVER BELOW KESWICK DAM
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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The portion of the upper Sacramento River between Keswick Dam and Knights Landing (upstream of the confluence with the Feather River) is fed by several tributaries that drain the west slope of the Sierra Nevada Mountains and the east slope of the Coast Range. The lower Sacramento River is identified as the reach that extends from Knights Landing, just above the confluence with the Feather River, to Freeport, just below the point where the Sacramento River enters the legal Delta boundary (Delta Protection Act – Section 12220 of the Water Code). The flows in this portion of the Sacramento River are increased primarily by the addition of the Feather and American river flows.

Quality

The reach of the Sacramento River between Keswick Dam and Red Bluff has excellent to good mineral quality and, therefore, the water is suitable for most uses[1]. Most of the water can be classified as calcium-magnesium bicarbonate, and is slightly hard, but does not require softening. Mineral levels are satisfactory for most domestic and industrial uses. Many tributaries drain to the upper Sacramento River without deteriorating mineral quality, indicating the excellent mineral quality of the tributaries. Turbidity levels are generally excellent, but become elevated occasionally because of high flows on Cottonwood Creek, which is highly susceptible to sediment loading during high runoff[2]. The development of regional wastewater treatment plants has resulted in effluent with concentrated nutrient loads from urban areas, particularly from the Cities of Redding and Red Bluff. The Sacramento River downstream of Keswick Dam is a designated spawning area for anadromous fish and has a minimum allowable dissolved oxygen level of 7 milligrams per liter (mg/L). At the Red Bluff Diversion Dam, the river maintains oxygen levels near saturation, with concentrations that have ranged from slightly below 10 mg/L to over 12 mg/L.

From Red Bluff to the Delta, the Sacramento River is generally of good mineral quality, although water quality is periodically degraded because of the discharge of toxins, untreated sewage, and other nonpoint-source contaminants. In the lower Sacramento River, agricultural drainage influences water quality by contributing to increased turbidity and mineral, nutrient, and herbicide loads. The state agencies and agricultural entities continue to promote management practices to ensure that discharges from agricultural lands do not exceed performance goals established by the Central Valley Regional Water Quality Control Board.

The two primary parameters for characterizing irrigation water are “salinity hazard” and “sodium hazard.” “Salinity hazard” is classified as “low” if specific conductance is less than 250 microhms per centimeter at 25 degrees Celsius (°C). The maximum specific conductivity at any of the Sacramento River locations did not exceed 250 microhms per centimeter at 25°C during 1997. The “sodium hazard” is classified as “low” if the sodium adsorption ratio

[1] For drinking water purposes, mineral quality has been defined using the following hardness levels: $CaCO_3$ less than 75 mg/L – soft (excellent mineral quality); $CaCO_3$ between 75 and 150 mg/L – moderately hard (good mineral quality); $CaCO_3$ between 150 and 300 mg/L – hard (fair quality); and $CaCO_3$ greater than 300 mg/L – very hard (marginal to unacceptable mineral quality).

[2] For drinking water purposes, source-water turbidity levels have been defined accordingly: Turbidity less than 5 NTU – excellent; turbidity between 5 and 50 NTU – good; turbidity between 50 and 100 NTU – fair; and turbidity greater than 100 NTU – impaired. (Turbidity is reported in nephelometric units, or NTUs, which refers to the instrument (nephelometer) used to measure suspended particulate material.)

is less than 10. The sodium adsorption ratio values for Sacramento River water are generally below one (1) above Freeport (California Regional Water Quality Control Board, Central Valley Region, 1998).

The California Department of Water Resources (DWR) Northern and Central districts maintain a network of water quality monitoring and surface water sampling stations in the Redding Sub-basin and in counties throughout the Sacramento Valley. The agency operates electronic continuous recorders for field monitoring of water quality parameters; and periodically, agency personnel conduct field analyses and collect water quality samples for laboratory analysis from rivers, lakes, reservoirs, and certain drains within Sacramento Valley. The agency also conducts studies to determine the physical, chemical, and biological characteristics of streams, lakes, and reservoirs in the districts. The studies, in part, are conducted to evaluate factors contributing to enrichment (eutrophication), factors affecting drinking water quality, and the influence of watershed development. DWR also maintains a database of current and historical water quality data.

Groundwater Resources

The northern third of the Central Valley regional aquifer system is located in the Sacramento Valley, as shown on Figure 3. DWR identifies this portion of the Central Valley aquifer as the Sacramento Valley and Redding Basins, which cover over 5,500 square miles (DWR, 1978). Most of the Redding Basin is underlain by several hundred feet of water-bearing materials, and groundwater characteristics are governed by unconfined conditions. A majority of the groundwater development in the basin has occurred south of the City of Redding. Irrigation wells typically range between 100 and 500 feet deep, although in some places the static groundwater level may be within 10 feet of the ground surface (DWR, 1978). To date, an estimate of sustainable groundwater yield has not been determined for the Sacramento River Basin except in some specific areas.

Large amounts of groundwater are stored in thick sedimentary deposits in the Sacramento Valley Basin, ranging from several hundred feet thick in the northern portion of the basin, to 3,000 feet in the southern portion of the basin. Groundwater is used intensively in some areas but only slightly in areas where surface water supplies are abundant. On average, groundwater use in the basin accounts for 25 to 30 percent of total water use (DWR, 1998). Groundwater occurs in various degrees of confinement in the basin, typically behaving as unconfined conditions in the alluvial deposits, and becoming partially confined to confined at greater depths. Irrigation wells typically range from 100 to 600 feet deep; however, wells greater than 1,000 feet exist in the southern portion of the basin. Groundwater levels associated with the Sacramento Valley Basin have historically declined moderately during extended droughts, generally recovering to pre-drought levels because of subsequent wetter periods. Groundwater levels can be within 10 feet of the ground surface in low lying portions of the basin, and can increase to a depth of more than 100 feet toward the basin margins.

Groundwater in both the Sacramento and Redding Basins is typically replenished through deep percolation of streamflow, precipitation, and applied irrigation water; and recharge by subsurface inflow is relatively small in proportion. A majority of streambeds are in contact with the underlying aquifer, making the systems hydraulically connected. Many streams

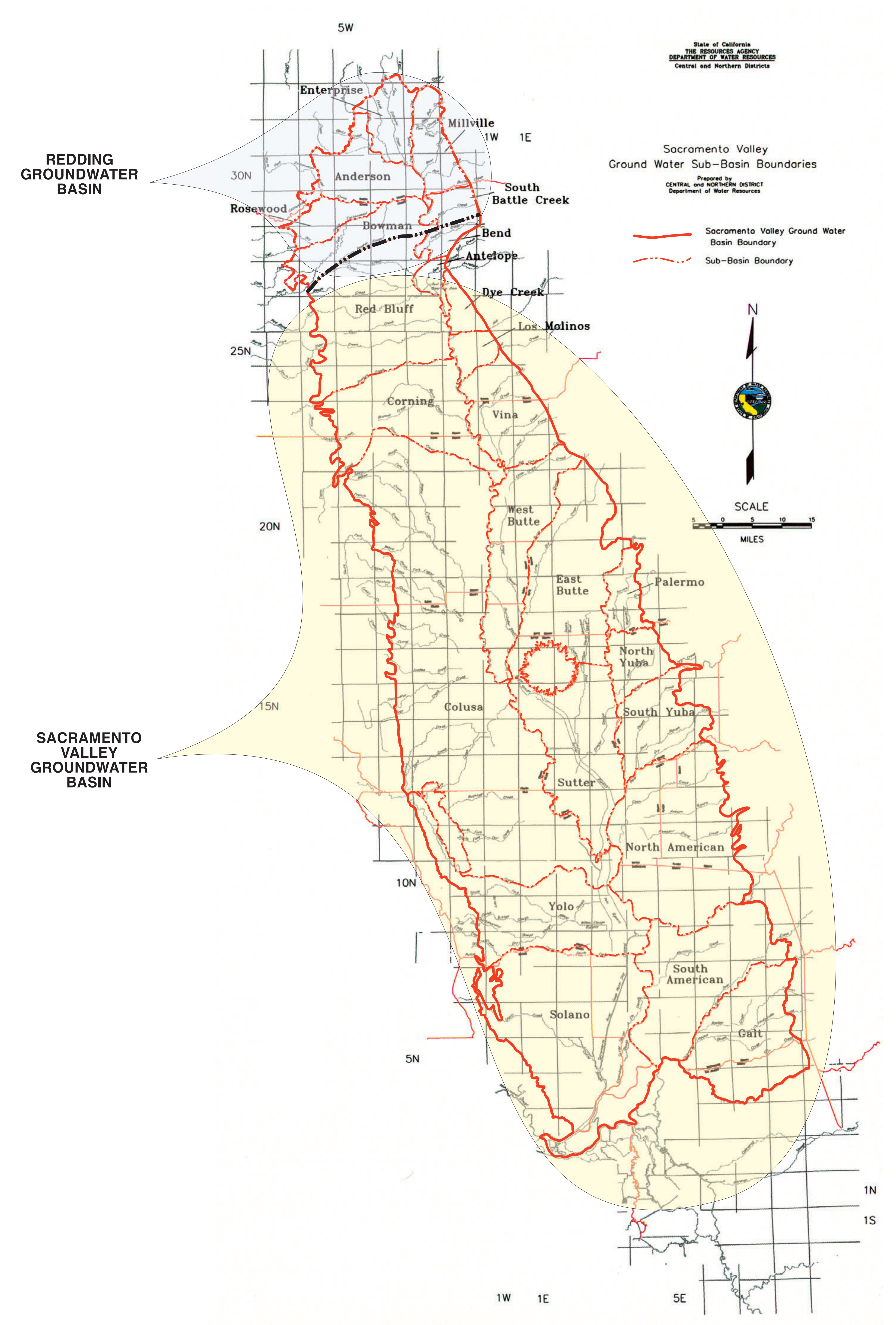

FIGURE 3
GROUNDWATER SUB-BASINS
IN SACRAMENTO RIVER BASIN
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have historically been gaining streams, a condition where groundwater is discharged into the stream. For conceptual model development and numerical modeling purposes, the system would be considered hydraulically disconnected only when the aquifer water levels fall below the elevation of the streambed. Typically, the Sacramento River is a gaining stream between Redding and Grimes, and a losing stream south of Grimes to south of Sacramento (DWR, 1978).

Attempts have been made to estimate sustainable yields for different regions of the basin; however, these estimates can vary significantly depending upon the methodology, water management, and land use assumptions. Discussion of these estimates is beyond the scope of this document; however, additional information is available in DWR Bulletins 118, 118-6, 118-80, 160-93, and U.S. Geological Survey Water Resources Investigation 1401-A. DWR Bulletin 118-6 identifies three areas of greatest concern (areas where discharge had historically exceeded recharge): Placer and Sacramento Counties, northern Yolo and southern Colusa Counties, and Glenn County west of Interstate 5. With the exception of Sacramento County, these areas have stabilized, that is, groundwater levels are not declining because, on average, discharge no longer exceeds recharge as a result of importing surface water.

Groundwater quality is generally excellent throughout the Redding and Sacramento Valley Basins, and is suitable for most uses. Concentration of total dissolved solids is normally less than 300 mg/L, although water in some areas may contain total dissolved solids to 1,500 mg/L (such as those observed in shallow groundwater, locally known as connate water, in areas to the south of the Sutter Buttes) (DWR, 1978). However, concerns over water quality are on the increase, as evidenced by recent actions taken by the Regional Water Quality Control Board with respect to the proposed extension of the Conditional Waiver of Water Discharge Requirements for Discharges from Irrigated Lands, commonly called the "Agricultural Waiver." In response to these concerns, the Sacramento Valley Water Quality Coalition was formed in 2002, and includes approximately 200 agricultural and wetlands entities in conjunction with local governments. The Coalition is developing and will soon be implementing a regional water quality monitoring and reporting program to ensure water quality levels are maintained in the Sacramento Valley**.** Additionally, the State Water Resources Control Board (SWRCB) is planning a comprehensive assessment of the state's groundwater quality as part of the implementation of the Groundwater Quality Monitoring Act of 2001 (DWR, 2003).

In a few places in the Sacramento Valley, shallow, high-salinity water makes the groundwater unusable. In other areas, elevated levels of naturally occurring boron restrict the type of crops that can be irrigated with groundwater. In some areas, nitrates and other introduced chemicals make the groundwater unfit for domestic use. DWR's Northern and Central districts currently monitor groundwater quality in 315 wells in Northern California and about 400 wells in central California to identify areas of poor quality and to track changes in overall groundwater quality (DWR Water Data Library at http://well.water.ca.gov/). Groundwater quality analyses typically include field measurements (temperature, pH, conductivity), minerals (calcium, magnesium, chloride), nutrients (phosphorus, nitrate), minor elements (arsenic, cadmium, iron), organic compounds (pesticides, petroleum derivatives), and pathogens (bacteria). The districts' groundwater quality data extend back to the early 1950s.

Water Rights and CVP Water Service Contracts

As indicated in the previous discussion, the CVP was constructed after many of the major water rights in the Sacramento Valley had been established. With the development of the CVP, the U.S. Bureau of Reclamation (Reclamation) entered into long-term contracts with some of these existing water right holders to establish the quantity of water that could be diverted from the Sacramento River on an annual basis to meet their respective water delivery requirements. In addition, Reclamation entered into water service contracts with other irrigators.

Sacramento River Settlement Contractors

The SRSCs, also referred to as the Sacramento River Water Rights Settlement Contractors, are contractors who, for the most part, hold water rights on the Sacramento River. With the control of the Sacramento River by Shasta Dam, these water right holders entered into contracts with Reclamation. Most of the agreements established a quantity of water the contractor is allowed to divert from April through October without charge (i.e., Base Supply) and provided a supplemental CVP supply allocated by Reclamation (i.e., Project Supply).

Base Supply is the quantity of water that the United States agrees can be diverted by the contractor from the Sacramento River each month during the period of April through October of each year without payment to the United States for such quantities diverted. Project Supply is all water diverted each month during the period April through October of each year by the contractor from the Sacramento River that is in excess of the Base Supply. Project Water is supplemental to Base Supply, and therefore, Base Supply is used prior to using Project Supply to the extent available under the terms of the contract.

Both the Base Supply and Project Supply allocations are specified on a monthly basis. The sum of these monthly allocations represents the total supply available under contract. SRSCs are allowed to reschedule contract allocations between months as long as the following two criteria are met according to the current contract set to expire in 2006:

1. The total quantity of water diverted from April through October does not exceed the aggregate of the total supply for those months.
2. The total quantity of water diverted during the critical-month period (July, August, and September for most SRSCs) does not exceed the aggregate of the total supply for those months.

The contract provided for a 10-year build-out period for Project Water. The contract allowed for an eleventh-year reduction where the contractors were given one opportunity, prior to April 1 of the eleventh year of the contract, to order a lesser supply of water than specified in Exhibit A, thereby permanently and unilaterally amending Exhibit A. The only exception was the contract with Glenn-Colusa Irrigation District (GCID); Article 3(d) allowed GCID to unilaterally increase its total supply by up to 30,000 ac-ft by ordering more water prior to April 1 of the eleventh year. All of the contracts also provided for reductions by mutual agreement of the parties after the eleventh year of the contract. The Settlement Contract entitlements provided in this document reflect current contract quantities set to expire in 2006.

Settlement Contract History

After the completion of Shasta Dam in 1944, nearly 20 years passed before a negotiated agreement was reached between the SRSCs and Reclamation on contract terms and quantities. The following outlines the development of the contracting process:

- 1944 to 1946—Initial contract negotiation efforts were made. This effort was not successful because of (1) the difficulty in reaching agreement with such a large group of water users, and (2) dependence upon water-user representatives to negotiate with individual water users.
- 1952—A "Memorandum of Understanding Relating to a General Approach to Negotiations for Settlement of Water Diversion from the Sacramento River and Sacramento-San Joaquin Delta with the Objective of Avoiding Litigation" was entered into by Reclamation, the Sacramento Valley Water Users Committee, and DWR.
- 1956—Reclamation, DWR, and the Sacramento River and Delta Water Association conducted a cooperative study of water use and water rights along the Sacramento River and in the Sacramento-San Joaquin Delta. The results of this study were published in 1957 as "Report on the 1956 Cooperative Study Program."
- 1958—Water supply data for April through October for 1924 to 1954 were published in the "Hydrology Supplement to the Report on the 1956 Cooperative Study Program."
- 1960—Reclamation prepared Study C-2BR, which was similar to Study C-2 of the Cooperative Study Program, but assumed different salinity control requirements by specifying different specific Delta outflows. During this same period, DWR prepared Study C-650B, which determined the water right yield to each of the 200 individual diverters.

Negotiations regarding individual contractor's Base Supply began with an averaging of the yield studies from Studies C-2BR and C-650B. These average yield quantities provided for an initial starting point for the negotiations on Base Supply. Adjustments to these quantities were then made for factors that affect the particular contractor. These adjustments included factors such as water supplies from other sources including return flows both within and outside the contractor's service area. Cropping and monthly distribution patterns also entered into these negotiations. The contracts were then agreed upon as a compromise settlement of controversy as to the respective rights of the parties to divert and use water and the average annual yield of such rights during the term of the contract. The contract placed a limit on the total supply to be diverted annually by the contractor during the term of the contract, and segregated it into Base Supply and Project Water. The contract does not jeopardize the rights or position of either party (i.e., the contractor or the United States) with respect to its water rights or the yield thereof in the event the contracts terminate. In the event there is a general adjudication of rights to the use of water of the Sacramento River system, the rights of the parties to divert and use water shall exist as if the contract had not been entered into.

CVP Water Service Contracts

Before construction of the CVP in the 1930s and 1940s, many irrigators on the west side of the Sacramento Valley, and irrigators in CVP service areas outside the Sacramento Valley, relied primarily on groundwater. With the completion of CVP facilities in these areas, the irrigators signed agreements with Reclamation for the delivery of CVP water as a supplemental supply. Several cities also have similar contracts. In addition, many areas of the west side of the Sacramento Valley were dryland farmed, and these farmers also signed agreements for the delivery of CVP water.

Criteria for Defining Water Availability

Except in times of critical-year reductions and water shortages, the CVP makes available the amount of water specified in the terms of its water right settlement and CVP water service contracts. Conditions for determining the quantity of water available to the SRSC during years of water shortages are based on the “Shasta Criteria.” The Shasta Criteria is used to determine when a water year is considered critical, based on inflow to Shasta Lake. If a water year is determined to be critical, deliveries of Base and Project Supplies to SRSCs are reduced to 75 percent of the contract amount. A critical year is any year when on or before February 15 the forecast full natural inflow to Shasta Lake for the current water year (October of the preceding calendar year through September 30 of the current calendar year) is equal to or less than 3.2 million ac-ft. A year is also critical when the total accumulated actual deficiencies are below 4 million ac-ft in the immediately prior water year or series of successive prior water years, each of which had inflows of less than 4 million ac-ft, together with the forecast deficiency for the current water year, exceed 800,000 ac-ft.

Water availability for delivery to CVP water service contractors during periods of insufficient water supply is determined at the discretion of Reclamation and based on a combination of operational objectives, hydrologic conditions, and reservoir storage conditions. In years of shortage, Reclamation has historically allocated shortages equally among water service contractors within the same general area, for instance, north of the Delta. There is no limit on the shortage that Reclamation can declare for CVP agricultural water service contractors. Reclamation can reduce their water supplies to zero. Some CVP municipal and industrial water service contracts provide for a minimum allocation of 75 percent of the contract supply; and in drought years, Reclamation has applied that same standard to all municipal and industrial water service contracts.

Regulations and Agreements that Affect Water Availability

Affects on Surface Water Resources

The construction and operation of the integrated and coordinated CVP changed the regimen of the Sacramento River. Various institutional and regulatory measures since construction of this project have occurred that continue to change the way Sacramento River flows are managed. These are discussed briefly below, and are revisited as they pertain to each SRSC discussed below.

The operation of the CVP is, and historically has been, affected by the provisions of several regulatory requirements and agreements. The operation of the CVP was affected by SWRCB Decisions 990 (1961), 1422 (1973), and 1485 (1978), and the Coordinated Operations Agreement (1986). Decision 990 authorized the issuance of permits for the operation of most major CVP facilities. Decisions 1422 and 1485 identify minimum water flow and water quality conditions at specified locations, which are to be maintained in part through the operation of the CVP. The Coordinated Operations Agreement specifies the responsibilities between the CVP and State Water Project for meeting the requirements of Decision 1485.

Beginning in 1987, a series of actions by the SWRCB, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries; formerly known as National Marine Fisheries Service), and the U.S. Fish and Wildlife Service affected interim water quality standards in the Delta. In 1993, NOAA Fisheries in formal consultation issued a Long-term Winter-run Chinook Salmon Biological Opinion, which addresses modifications to the long-term CVP operational plan to avoid jeopardizing the continued existence of the Sacramento River winter-run Chinook salmon. Also in 1993, the U.S. Fish and Wildlife Service released a biological opinion on the effects of operational actions by the CVP and State Water Project on Delta smelt and associated habitat.

The Central Valley Project Improvement Act was enacted in October 1992. This act defined fish and wildlife purposes as co-equal with other authorized purposes of the project. These requirements further modified the way the CVP was operated.

In December 1994, representatives of the state and federal governments and urban, agricultural, and environmental interests reached an agreed-upon recommendation to the SWRCB for changes in the Bay-Delta water quality objectives to provide ecosystem protection for the Bay-Delta Estuary. This agreed-upon recommendation was called the Principles for Agreement on Bay-Delta Standards between the State of California and the Federal Government. The SWRCB used several elements of this agreement and recommendations from other interested parties in preparing a 1995 draft Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, which it adopted as final in May 1995. The 1995 Bay-Delta Plan superseded the 1978 Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh adopted by the SWRCB in D-1485.

There are a number of ongoing efforts that will likely have some effect on the way the CVP is operated, including the Bay-Delta CALFED Program, the Trinity River Environmental Restoration Investigation, the Bay-Delta Hearings, and numerous other regional programs. In general, the net result of these efforts would likely further narrow the operating flexibility of the CVP. These programs should be taken into consideration by SRSCs, and anticipated changes should be factored into potential management options considered as part of the Basinwide Water Management Plan.

Affects on Groundwater Resources

Assembly Bill (AB) 3030, passed by the legislature in 1992, authorized existing local water service agencies to develop and implement groundwater management plans within their service areas. AB 3030 encourages basinwide coordination of groundwater management. Joint powers agreements among authorized water services agencies, memorandums of understanding, or other agreements between authorized water service agencies and other public or private entities can form the organizational basis for regional groundwater management. Because district and county boundaries were not delineated with groundwater basins in mind, it is not uncommon for a single agency to be involved with groundwater management in several sub-basins.

Within the Sacramento River Basin, several coordinated groundwater management plans have been developed. Groups that have developed these plans include the Redding Area Water Council and the Tehama County Flood Control and Water Conservation District in cooperation with individual private pumpers and water-related districts. In northern Sacramento and southeastern Sutter Counties, coordinated groundwater management is being planned and implemented by the Sacramento Area Water Forum and the Sacramento North Area Groundwater Management Authority pursuant to the Sacramento County Water Agency Act.

In the northernmost area of the Sacramento River Basin, the Redding Area Water Council has developed an AB 3030 Groundwater Management Plan (AB 3030 Plan) for the Redding Groundwater Sub-basin (Figure 3). Members of the Redding Area Water Council include the following:

- City of Anderson
- City of Redding
- City of Shasta Lake
- Shasta County Water Agency
- Anderson-Cottonwood Irrigation District (ACID)
- Bella Vista Water District
- Clear Creek Community Services District
- Centerville Community Services District
- Cottonwood Water District
- Shasta Community Services District
- Mountain Gate Community Services District
- Simpson Paper Company
- McConnell Foundation

This association of public agencies and private entities has agreed to prepare, adopt, and implement an AB 3030 Plan with the Shasta County Flood Control and Water Conservation District serving as lead agency. The Redding Area Water Council plans to develop a cooperative program to assess, monitor, and protect the quality of groundwater in the Redding Sub-basin.

The Tehama County Flood Control and Water Conservation District has adopted a Coordinated AB 3030 Plan for the area of Tehama County. This plan will address the management of groundwater resources in the Bend, Antelope, Dye Creek, Los Molinos, Vina, Corning, and Red Bluff Sub-basins, and the southern part of the Redding Sub-basin.

In the Colusa Sub-basin (Figure 3), AB 3030 Plans have been drafted and adopted by water service agencies both individually and jointly. GCID and Reclamation District (RD) No. 108 have each adopted plans for their service areas. A joint AB 3030 Plan has been adopted by the Princeton-Codora-Glenn Irrigation District (PCGID) and Provident Irrigation District (PID). In the southern part of the Colusa Sub-basin, the Yolo County Flood Control and Water Conservation District is developing a management plan for the conjunctive water management of their surface water and groundwater supplies.

In the West Butte Sub-basin (Figure 3), located on the eastern side of the Sacramento River, an AB 3030 Plan has been adopted by the Western Canal Water District whose service area is located in both Glenn and Butte Counties. RD 1004, located primarily in Colusa and extending into Sutter County, is currently drafting an AB 3030 Plan.

In the Sutter Sub-basin (Figure 3), which lies between the Sutter Bypass and the Sacramento River, RD 1500 has adopted an AB 3030 Plan. The boundaries of Sutter Mutual Water Company (SMWC) roughly coincide with the boundaries of RD 1500, and Pelger Mutual Water Company (PMWC) lies within RD 1500.

In the American Sub-basin (Figure 3), South Sutter Water District and the Sacramento Metropolitan Water Authority have adopted AB 3030 plans. RD 1000 and Natomas Central Mutual Water Company (NCMWC) are working cooperatively on an AB 3030 Plan for their service areas. Participants in the Sacramento North Area Groundwater Management Authority include the following:

- NCMWC
- Arcade Water District
- Carmichael Water District
- Citizens Utilities
- Citrus Heights Water District
- City of Folsom
- City of Sacramento
- County of Sacramento
- Del Paso Manor Water District
- Fair Oaks Water District
- Northridge Water District
- Orangevale Water District
- Rio Linda/Elverta Community Water District

- San Juan Water District
- Southern California Water District

Many of the above agencies and private companies are also participants in the Sacramento Area Water Forum, which is pursuing groundwater management for an area that extends into both the North American and South American Sub-basins. Part of Placer County is also included in this sub-basin. Groundwater management for the portion of this sub-basin in western Placer County is under the authority of the Placer County Water Agency, which has adopted an AB 3030 Plan for this area.

Additional authority to manage groundwater is provided through county ordinances. Within the Sacramento River Basin, Shasta, Tehama, Glenn, Butte, Colusa, Yolo, and Sacramento Counties have adopted groundwater ordinances. Each of these ordinances establish procedures for applying for a permit to export water and criteria that must be met prior to any out-of-county water transfer. Groundwater overdraft, land subsidence, salt-water intrusion, injury to overlying groundwater users, and adverse effects on long-term groundwater storage or transmission characteristics of the aquifer are among the issues addressed in these ordinances. Each county ordinance requires the completion of an environmental review with financial responsibility for this review resting with the applicant. Butte, Colusa, and Glenn Counties have adopted additional groundwater ordinances that address well spacing and health and safety issues.

SRSC Water Resources Characteristics

The surface water and groundwater resources of the participating SRSCs were evaluated. Surface water supplies associated with the Sacramento River were evaluated on a monthly and annual basis. Total contract supply (Base plus Project) was used for characterizing this component and is summarized in Table 2 for each district. Other tributaries that may contribute supplies to each area were identified; however, a review of existing water rights for these supplies was not conducted. Surface water quality was discussed on a basinwide basis above, and was not addressed at the SRSC level. Groundwater resources were identified in terms of documented and potential resources. No additional fieldwork to assess groundwater resources was conducted.

TABLE 2
Sacramento River Settlement Contract Quantities Scheduled to Expire in 2006

	Contract		**Current Contract Amount (ac-ft/yr)**			**Percent of Total for All Settlement Contracts**
Contractor	**Type**	**Number**	**Base**	**Project**	**Total**	
ACID	Purveyor (metered)	3346A	165,000	10,000	175,000	8
GCID	Purveyor (metered)	0855A	720,000	105,000	825,000	37
MTCR	Long-form Individual (metered)	0940A	16,980	976	17,956	<1
MID	Purveyor (metered)	6078A	11,980	6,000	17,980	<1
MFWC	Purveyor (metered)	0838A	23,000	12,000	35,000	2
NCMWC	Purveyor (metered)	0885A	98,200	22,000	120,200	5
PMWC	Purveyor (metered)	2073A	7,110	1,750	8,860	<1
PCGID	Purveyor (metered)	0849A	52,810	15,000	67,810	3
PID	Purveyor (metered)	0856A	49,730	5,000	54,730	2
RD 1004	Purveyor (metered)	0890A	56,400	15,000	71,400	3
RD 108	Purveyor (metered)	0876A	199,000	33,000	232,000	10
RGFC	Long-form Individual (metered)	0878A	29,300	500	29,800	1
SMWC[a]	Purveyor (metered)	0815A	172,900	95,000	267,900	12
TIDC	Purveyor (metered)	2781A	7,900	2,000	9,900	<1
Total for Study Participants			1,610,310	323,226	1,933,536	87
Other SRSCs			232,808	60,595	293,403	13
Total for all Settlement Contracts			1,843,118	383,821	2,226,939	100

[a]SMWC’s proposed renewal contract is for 226,000 ac-ft/yr (169,500 ac-ft/yr of Base Supply and 56,000 ac-ft/yr of Project Water).

Notes:
“Study participants” refers to SRSCs participating in the Basinwide Water Management Plan.

ac-ft/yr = acre-feet per year
MTCR = M&T Chico Ranch
MID = Maxwell Irrigation District
MFWC = Meridian Farms Water Company
RGFC = River Garden Farms Company
TIDC = Tisdale Irrigation and Drainage Company

Source: Reclamation, 1998.

The participating SRSCs extend throughout the Sacramento Valley. For purposes of summarizing basinwide characteristics unique to different areas, the Valley was divided into sub-basins, as shown on Figure 4. Water resources characteristics are discussed at a sub-basin level first, followed by a detailed discussion of each SRSC within the corresponding sub-basin. The following three criteria were used to define the sub-basin boundaries:

1. The sub-basin should encompass participating SRSC boundaries.
2. The sub-basin should be based on common hydrologic, land, and water use characteristics.
3. The sub-basin should be consistent with DWR planning boundaries, particularly the Detailed Analysis Units and/or Planning Subareas.

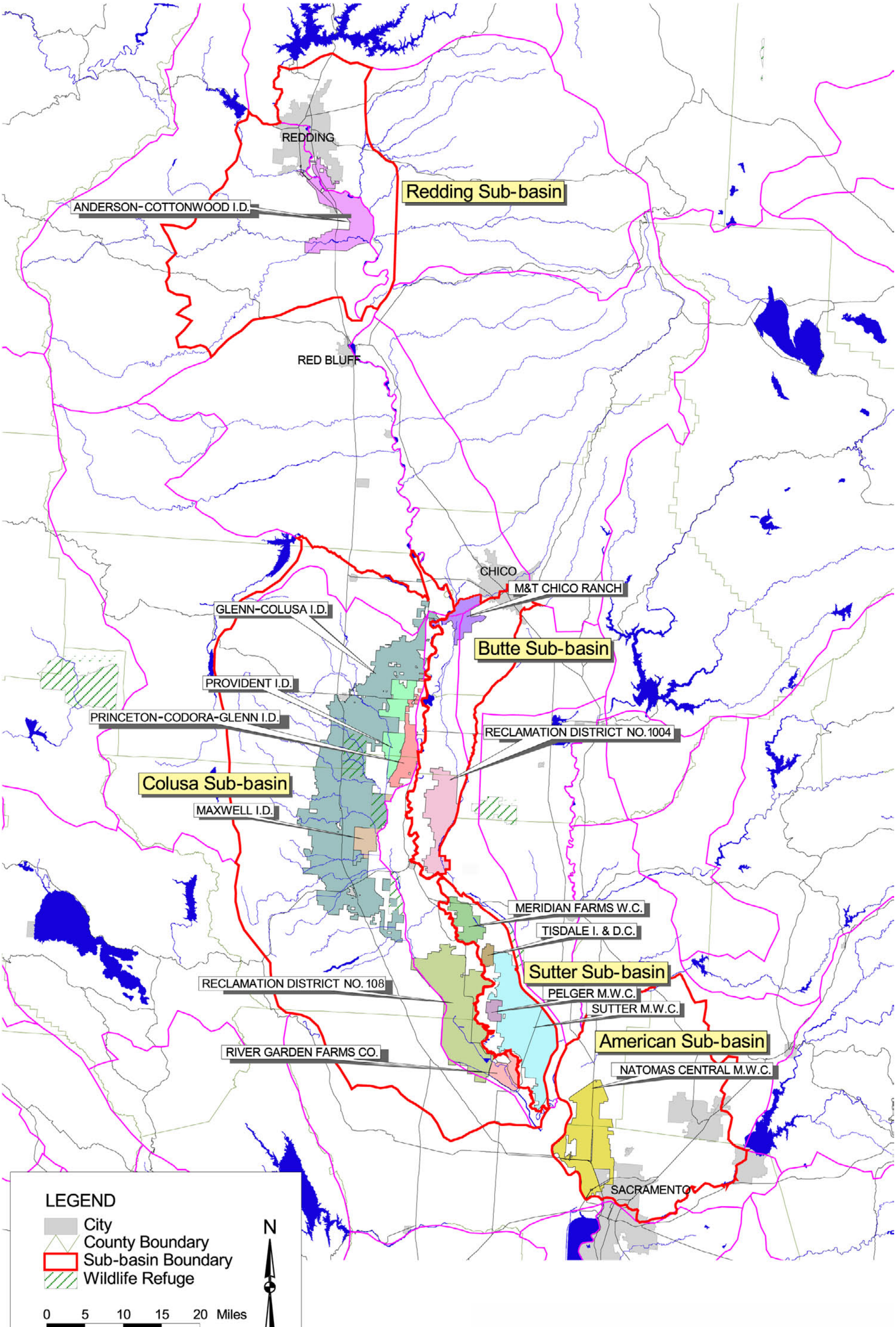

FIGURE 4
SRSC SUB-BASINS IN THE SACRAMENTO RIVER BASIN
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Redding Sub-basin

- Anderson-Cottonwood Irrigation District

Redding Sub-basin

The Redding Sub-basin, as shown on Figure 5, is located at the northern part of the Sacramento Valley floor. It covers the segment of the Sacramento River from Shasta Dam to just above Red Bluff. This sub-basin consists of significant urban areas, including the Cities of Redding, Anderson, and Shasta Lake, and the community of Cottonwood. ACID is the participating SRSC within this sub-basin.

Relative to the sub-basins in the central and southern end of the study area, the Redding Sub-basin receives approximately twice as much rainfall annually, and the rainy season may extend further into the spring months and delay the demand for irrigation water. Inflows to the sub-basin are dominated by natural runoff from tributaries to the Sacramento River and regulated Sacramento River flows released from Shasta Dam. Water is also imported from the Trinity River Basin. Outflows from the basin consist primarily of the Sacramento River flows.

Numerous water users along the Sacramento River divert water for agricultural and municipal uses. Many diversions are controlled by contracts with Reclamation between April 1 and October 31. There are also numerous water users with riparian and appropriative rights to Sacramento River water and associated tributaries in the sub-basin. There are no State Water Project contractors located in the sub-basin. A portion of most diversions returns back to the sub-basin water system as system leakage or deep percolation, which enters the groundwater system. Once in the groundwater system, a portion remains in storage, and the rest of this water flows as subsurface flow until reaching the Sacramento River or another part of the surface water system. A small percentage of these flows may be rediverted for irrigation purposes before reaching the river. Also unique to this sub-basin is the large percentage of irrigated pasture relative to other crop types. For example, over 75 percent of irrigated lands in the ACID service area is pasture.

Anderson-Cottonwood Irrigation District

ACID (or District) is located in the northern portion of the Sacramento Valley within the Redding Sub-basin. The ACID service area encompasses approximately 32,000 acres in Shasta and northern Tehama Counties. The Sacramento River serves as the principal water source for the District. The District has water rights to the Sacramento River, as shown in Table 3. Minimal quantities, in comparison to Sacramento River diversions, of recycled water and groundwater are used by users within the District. The following discussion describes these sources and their historical use.

Sacramento River Supply

Settlement Contract Entitlements. ACID holds a water right, under pre-1914 postings, to divert water from the natural flow of the Sacramento River. The ACID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1967, Contract No. 14-06-200-3346A (3346A). This contract provides for an agreement between ACID and the United States on ACID's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 3346A provides for a maximum total of 175,000 ac-ft/yr, of which 165,000 ac-ft is considered to be Base Supply and 10,000 ac-ft is CVP water (Project Supply), as shown in Table 4. The contract also provides that additional Project Water can be purchased if surplus water is available.

TABLE 3
Anderson-Cottonwood Irrigation District: Water Rights

	Water Rights[a,b]				
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity (cfs)[e]**
Sacramento River	S012208[f] (N/A)	N/A	N/A	Mar 1 to Oct 31	50
Sacramento River	Z000916 (N/A)	N/A	120003 (6/12/18)	Jan 1 to Dec 31	400

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

[f]Water right is for nonconsumptive power use.

Note:
cfs = cubic feet per second

TABLE 4
Anderson-Cottonwood Irrigation District: Settlement Contract Supply

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Month	46,000	10,000
Non-critical Month	119,000	0
Total Annual	165,000	10,000

The contract specifies the total quantity of water that may be diverted by ACID each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 6. The monthly Base Supply ranges from a minimum of 20,000 ac-ft in October to a maximum of 27,000 ac-ft in June. CVP water (Project Supply) is available during the months of July and August, with entitlements of 3,500 and 6,500 ac-ft, respectively. The contract identifies July and August as the critical months. For the critical months, the total Base Supply is 46,000 ac-ft, and the total Project Supply is 10,000 ac-ft, as shown in Table 4.

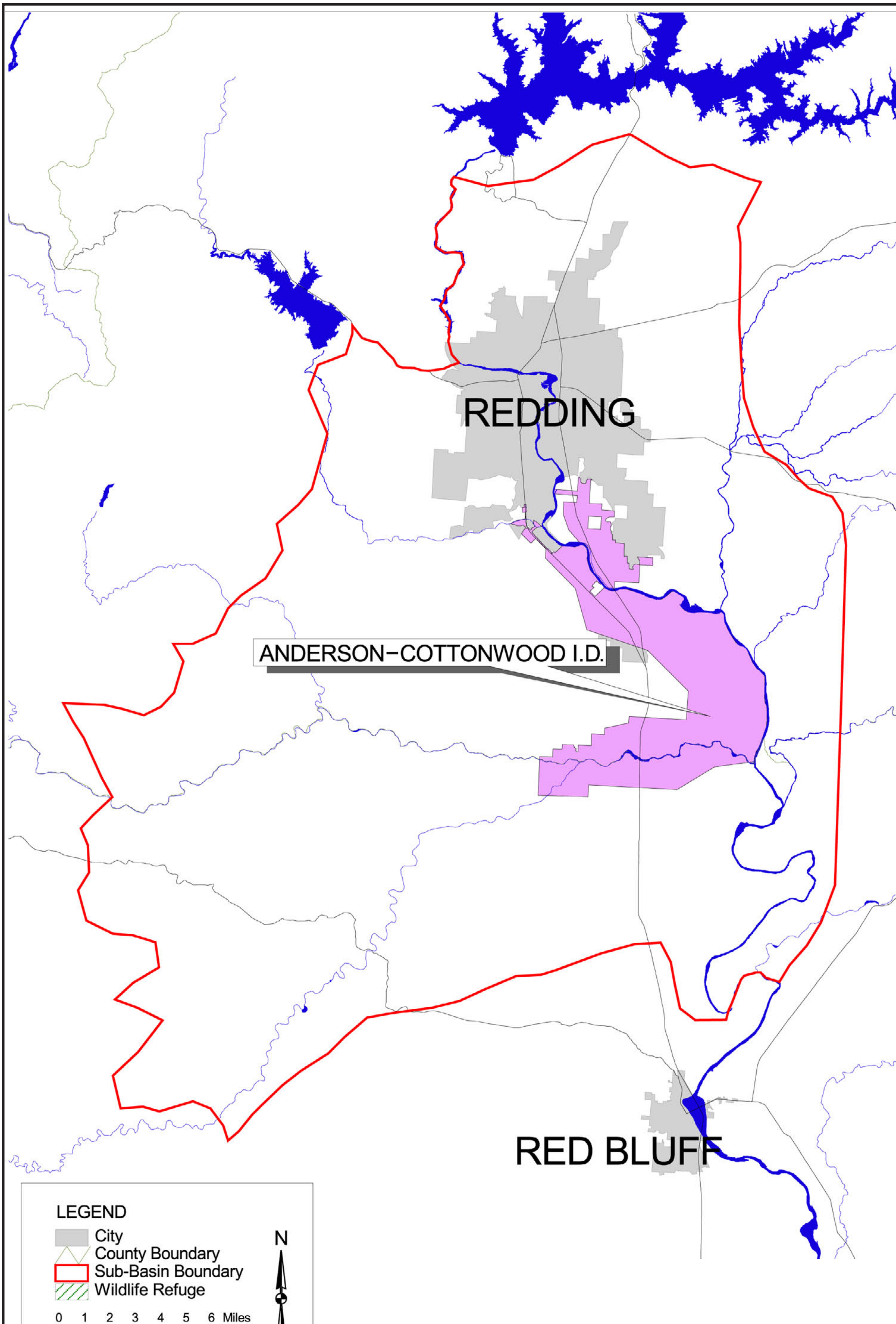

FIGURE 5
REDDING SUB-BASIN
AND PARTICIPATING SACRAMENTO
RIVER SETTLEMENT CONTRACTORS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Settlement Contract Historical Diversions. Until the 1990s, ACID historically used between 121,000 to 158,100 ac-ft of their Base and Project entitlements, as shown on Figure 7. In recent years, ACID's ability to divert their entitlement was reduced because of fishery limitations associated with the District's operation and management of its distribution facilities. In response to a pending lawsuit by NOAA Fisheries in 1992, ACID reduced the quantity of water circulating in their delivery system. Previously, ACID had maintained higher water levels within its distribution system that corresponded to larger diversions from the Sacramento River but also maintained large return flows from the conveyance facilities back to the Sacramento River. In addition, 4 years (1977, 1991, 1992, and 1994) were classified as "critical years" and contract supplies were reduced to 75 percent or 131,250 ac-ft. During this period, ACID diverted between 96,500 and 125,800 ac-ft of their surface water entitlement. ACID, in 1999, completed the improvements to the fish ladder and screen facilities at their seasonal dam near Redding. These improvements will provide greater flexibility in diverting their contract entitlements but are not expected to affect diversion quantities.

Figure 6 shows the historical monthly average diversions for the following three periods:

1. 1977 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species (also NOAA Fisheries lawsuit filed) in 1992.
2. 1979 to 1982: A period of near-normal hydrologic and water use conditions.
3. 1992 to 1996: The period following the listing of the winter-run Chinook salmon (also NOAA Fisheries lawsuit filed) to present.

The following observations are noted:

- The average monthly diversions of Sacramento River water by ACID reflect the pattern of monthly quantities specified in the contract entitlements.
- With the exception of April, the average monthly diversions (1977 to 1991) are within 5,000 ac-ft of the total contract entitlement. However, diversions in April (1977 to 1991) average less than 10,000 ac-ft in comparison to the monthly contract entitlement of 21,000 ac-ft. Diversions in the month of April are greatly affected by late-spring precipitation.
- Since 1991, total annual diversions have decreased and, thus, average diversions during each respective month have also decreased.
- Every year between 1977 and 1991, ACID had diverted some portion of their CVP Project Water.
- Since 1991, ACID has only diverted CVP Project Water during critically dry years (also see Figure 7). Reductions in Project Water diversions relates to the increased cost of Project Water associated with CVPIA Restoration Fees assessed on diverted Project Water.

Non-contract Period (November – March). Contract No. 3346A does not limit ACID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. However, the existing land use within ACID's service area does not require non-contract-period diversions.

Other Surface Water Sources

Excluding Sacramento River water rights/contract entitlements, ACID does not hold water rights to any other surface water sources, as shown in Table 3.

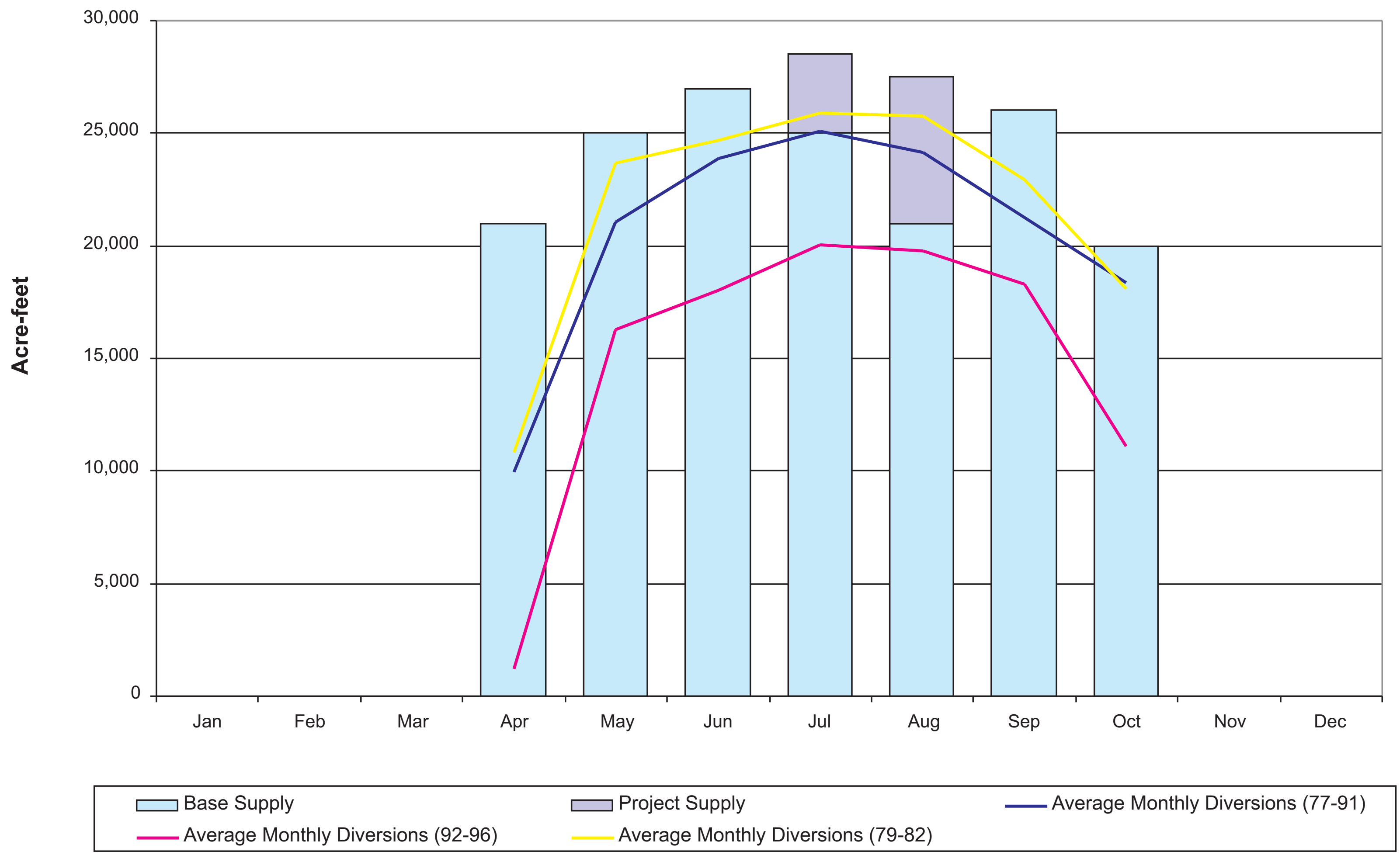
Tailwater, Reuse/Recirculation, and Water Transfers

No tailwater from outside of the service area is available for use by ACID. However, the District does operate five pumping plants to recapture some return flows from lands within the District's boundaries. ACID reuses approximately 5,000 ac-ft annually.

Groundwater

Approximately 12 privately owned wells are located within the District's boundaries. The District does not own/operate any wells. Very little groundwater is used within the District for agricultural purposes, except occasionally during drought years. Groundwater used within the District is limited primarily to deciduous crops. (Additional information about wells and groundwater conditions in this area can be found online at the DWR Water Data Library; see http://well.water.ca.gov/.)

ACID's facilities and irrigation are significant contributors to groundwater recharge in the Redding Sub-basin. Annual seepage from the ACID main canal is estimated to be approximately 44,000 ac-ft.



Notes:
1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (77-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-96).
3. Monthly diversions based on contract period for April to October.

FIGURE 6
ANDERSON-COTTONWOOD IRRIGATION DISTRICT MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS

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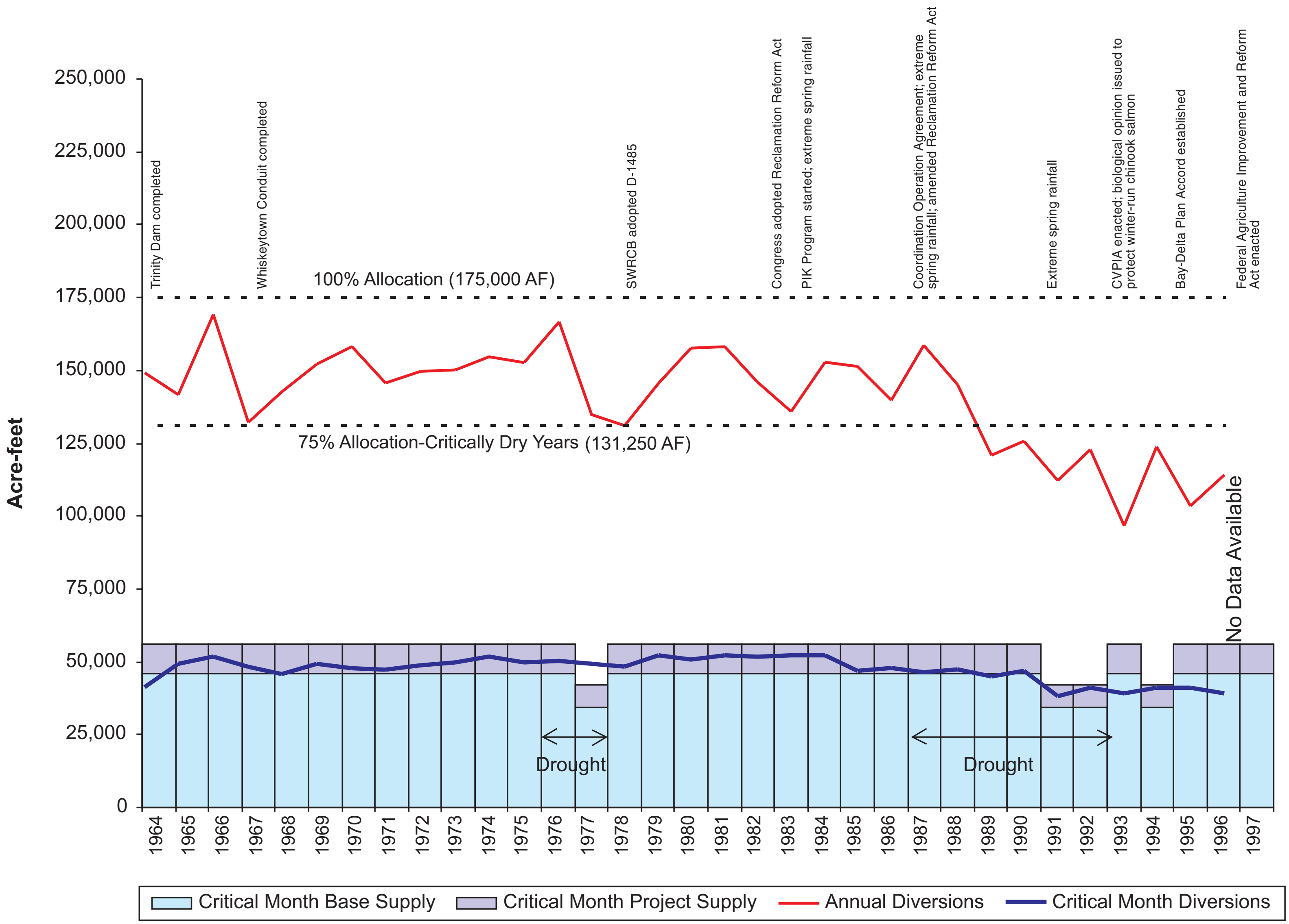

Note: Annual quantities are based on contract period from April to October; Critical Months include July and August.

FIGURE 7
ANDERSON-COTTONWOOD IRRIGATION DISTRICT ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Colusa Sub-basin

- **Glenn-Colusa Irrigation District**
- **Provident Irrigation District**
- **Princeton-Codora-Glenn Irrigation District**
- **Maxwell Irrigation District**
- **Reclamation District No. 108**
- **River Garden Farms Company**

Colusa Sub-basin

The Colusa Sub-basin, shown on Figure 8, represents the drainage area on the west side of the Sacramento Valley floor and is bounded on the west by the Coast Ranges, on the north by Stony Creek, on the east by the Sacramento River (from GCID's Sacramento River diversion facility to the Knights Landing Outfall Gates), and on the south by Cache Creek. The participating SRSCs within this sub-basin include the following:

- GCID
- PID
- PCGID
- MID
- RD 108
- RGFC

This sub-basin has the largest number of participating SRSCs. Combined, these SRSCs make up more than 50 percent of the Sacramento River Settlement Contract entitlements. There are three other metered SRSCs in the sub-basin, and numerous short-form SRSCs. Other water users in the basin include CVP contractors, such as Tehama-Colusa Canal districts, Sacramento River riparian diverters, and groundwater users. There are no State Water Project contractors in the sub-basin.

Inflows to the sub-basin include diversions from the west bank of the Sacramento River and imports through Tehama-Colusa Canal. Outflows occur either through Colusa Basin Drain to the Sacramento River, Knights Landing Ridge Cut to Yolo Bypass, or RD 108's pumping plant to the Sacramento River. Surplus water from precipitation and return flows from irrigation typically flow to the Colusa Basin Drain. This surplus water is rediverted (several times in some cases) for irrigation before leaving the basin as outflow. Rice is the predominant crop grown by irrigators in the sub-basin. For example, irrigated lands in GCID, the largest water purveyor in the area, typically consists of over 75 percent rice. This percentage is typically less towards the southern end of the sub-basin.

Glenn-Colusa Irrigation District

GCID (or District) is located in the central portion of the Sacramento Valley on the west side of the Sacramento River, and is the largest irrigation district in the Sacramento Valley. The District's service area extends from northeastern Glenn County near Hamilton City to south of Williams in Colusa County. The Sacramento River serves as the principal water source for the District. The District's pre- and post-1914 appropriative water rights to divert from the Sacramento River and several other surface water sources are shown in Table 5. The following discussion describes these sources and their historical use.

Sacramento River Supply

Settlement Contract Entitlements. GCID holds both pre- and post-1914 appropriative water rights to divert water from the natural flow of the Sacramento River. GCID also has adjudicated pre-1914 water rights under the Angle Decree, issued in 1930 by the Federal District Court, Northern District of California, to divert water from the natural flow of Stony Creek, a tributary to the Sacramento River. In addition, as the successor in interest to Central

Canal and Irrigation Company, GCID may have, under a May 9, 1906 Act of Congress, "the right to divert, at all seasons of the year, from the Sacramento River . . . an amount of water which . . . shall not exceed nine hundred cubic feet per second, to be used for irrigating the lands of the Sacramento Valley, on the west side of the Sacramento River . . ." (Pub. L. No. 151, Ch. 439.)

TABLE 5
Glenn-Colusa Irrigation District: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A000018 (3/3/15)	000029 (10/20/15)	002871 (5/14/47)	Mar 1 to Nov 1	110 cfs
Sacramento River	A001554 (12/3/19)	000796 (12/14/20)	007208 (3/20/65)	Apr 15 to Oct 1	83.27 cfs
Sacramento River	A001624 (1/14/20)	000797 (12/14/20)	007209 (3/30/65)	Apr 15 to Nov 1	32.0 cfs
Hunters Creek	A008688 (5/28/36)	004795 (8/17/36)	005387 (1/14/59)	Apr 15 to Oct 1	2 cfs
Stone Corral Creek	A012125 (10/8/47)	008272 (12/20/50)	004340 (4/24/56)	Apr 20 to Sep 30	11 cfs
Unnamed Stream Tributary to Funks Creek	A023005 (3/12/68)	015687 (9/10/68)	010635 (4/23/76)	Primary: Apr 1 to Jun 30 Secondary: Sep 1 to Dec 31	2 cfs 415 ac-ft/yr
Sacramento River	A030838 (2/19/1999)	21101 (5/16/2001)	Pending	Nov 1 to Mar 31	1,200 cfs 182,900 ac-ft/yr
Sacramento River	S007367 (N/A)	N/A	N/A	Apr 1 to Oct 31	2,700 cfs
Colusa Basin Drain	S007368 (N/A)	N/A	N/A	Apr 1 to Aug 31	134 cfs

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

The GCID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0855A (Contract No. 0855A). This contract provides for an agreement between GCID and the United States on GCID's diversion of water from both the Sacramento River and Stony Creek during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Pursuant to provisions of the contract, Reclamation can require GCID to divert from the Sacramento River water quantities equal to and in lieu of its entitlement under the Angle Decree. Such water, along with Sacramento River water, is made available to GCID under Contract No. 0855A for diversion at its Main Pump Station. Under the terms of a separate wheeling agreement with Reclamation, GCID can request to receive a portion of its entitlement water via two points on interconnections with the Tehama-Colusa Canal. In 1998, GCID executed a new agreement with Reclamation (Agreement No. 1425-98-FC-20-17620) for the conveyance of wildlife refuge water and other related purposes. GCID will annually pay to Tehama-Colusa Canal Authority the operation and maintenance costs associated with the delivery of 25,000 ac-ft of water from the Tehama-Colusa Canal to GCID.

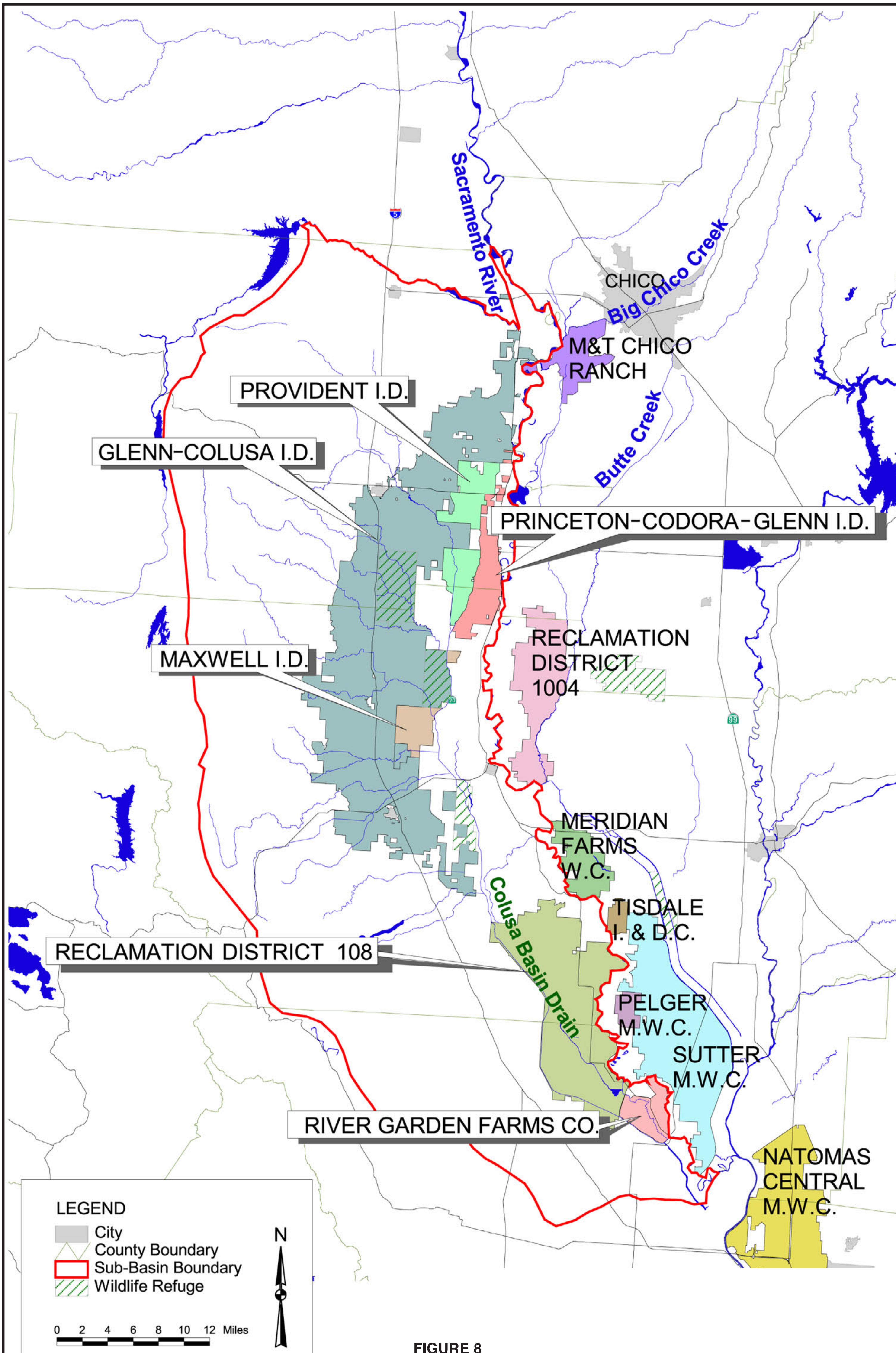

FIGURE 8
COLUSA SUB-BASIN
AND PARTICIPATING SACRAMENTO
RIVER SETTLEMENT CONTRACTORS

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The use of the Tehama-Colusa Canal for delivery of entitlement water is subject to available capacity as determined by Reclamation, in accordance with the terms and conditions of the wheeling agreement.

Contract No. 0855A provides for a maximum total of 825,000 ac-ft/yr, of which 720,000 ac-ft is considered to be Base Supply and 105,000 ac-ft is CVP water (Project Supply). The contract also provides that additional Project Supply can be purchased if surplus water is available. Water from Stony Creek and water diverted from the Sacramento River at the Main Pump Station is accounted for as water diverted under Contract No. 0855A. For purposes of the contract, it was determined that GCID's Angle Decree rights yielded, on a long-term average, about 15,000 ac-ft/yr. This yield was included in the 720,000 ac-ft of Base Supply entitlement recognized under Contract No. 855A.

The contract specifies the total quantity of water that may be diverted each month during the period April through October each year. The monthly Base Supply ranges from a minimum of 45,000 ac-ft in October to a maximum of 150,000 ac-ft in June. CVP Supply water is available during the months of July and August, with entitlements of 55,000 and 50,000 ac-ft, respectively. The contract identifies July and August as the critical months. For the critical months, the total Base Supply is 220,000 ac-ft and the total Project Supply is 105,000 ac-ft, as shown in Table 6. The monthly distribution of the Base and Project Supply is shown on Figure 9.

TABLE 6
Glenn-Colusa Irrigation District Settlement: Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	220,000	105,000
Non-critical Months	500,000	0
Total Annual	720,000	105,000

Settlement Contract Historical Diversions. Historically, GCID has used all of its Base Supply and diverted a majority of their Project Supply. In 1981 and 1984, GCID purchased additional CVP water above the 105,000 ac-ft amount provided for in the contract. During the critical months, GCID diverted CVP water every year from 1964 to 1997, as shown on Figure 10. Furthermore, during the 1980s and early 1990s, GCID used nearly all their entitlement water (Base and Project Supply) during the critical months.

In recent years, GCID's ability to divert their entitlement was reduced because of the endangered species limitations associated with the District's current fish screen operation. In addition, 3 years were classified as "critical years," and contract supplies were reduced to 75 percent of contract entitlements. The District managed several programs to supplement these reduced supplies, including a water reuse program, water conservation program, and groundwater conjunctive water management program.

GCID, in 2001, completed the improvement and enlargement of the fish screen facility at the Main Pump Station located near Hamilton City. Once these improvements are completed, the District will be able to divert its full entitlement.

Figure 9 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

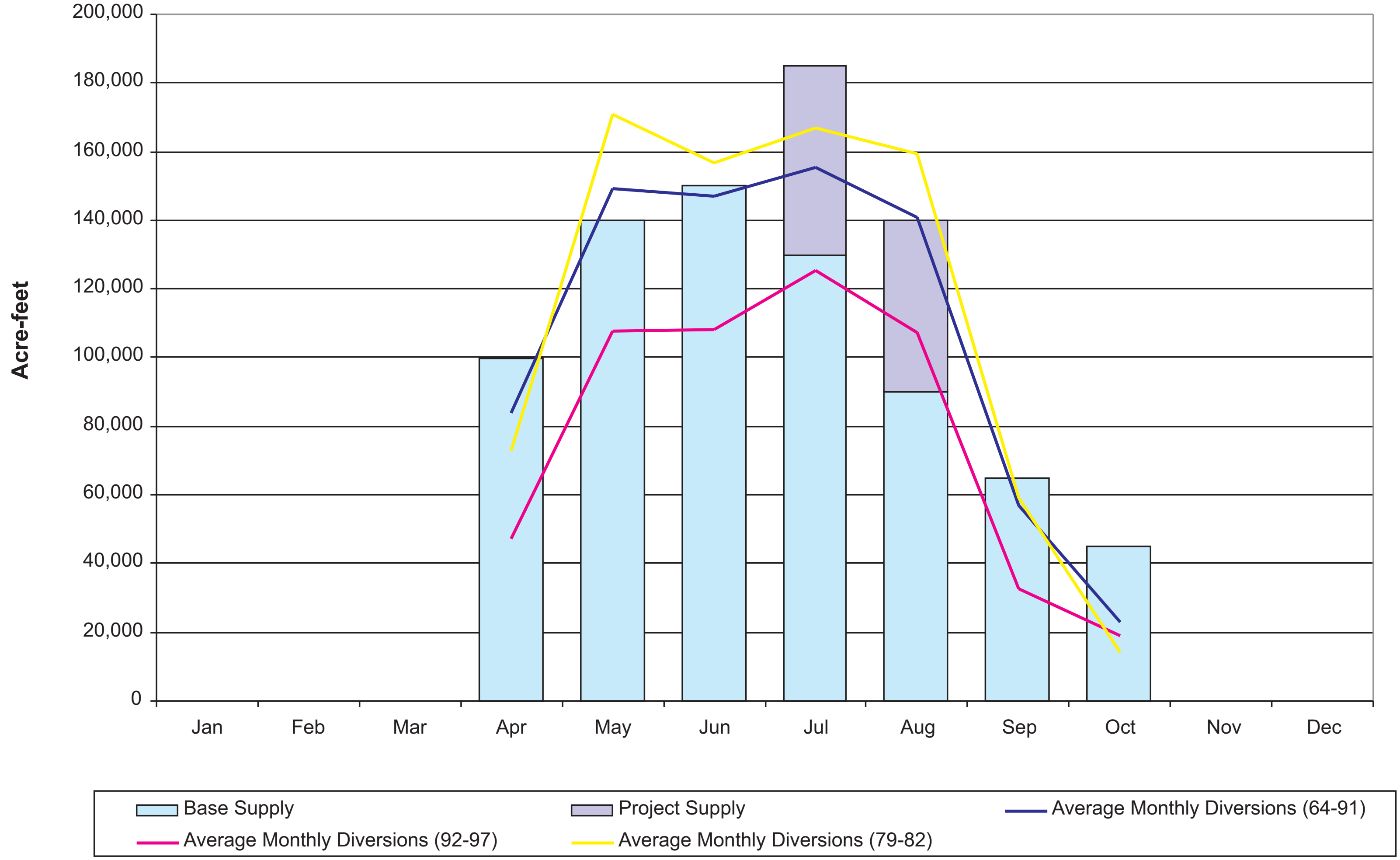
- The distribution of the monthly average diversions for the three periods is similar.
- The average monthly diversions for the recent period (1992 to 1997) are about 75 percent of those observed for the 1964 to 1991 and 1979 to 1982 periods. The recent decline in diversions correlates with restrictions from the listing of the winter-run Chinook salmon and drought periods. This required GCID to reuse greater quantities of water, reducing tailwater leaving the District.
- On average, GCID diverts at or above their contract amounts in May and June, except during the recent period. This is because of high cultural practice demands for rice during the month of May. (As previously stated, the District is permitted to shift contract supply allocations between non-critical months.)
- During the recent period, diversions in May and June show the greatest decline relative to the other two period averages. This decline is attributed to strict conservation practices implemented and monitored by the District.

Non-contract Period (November – March). Contract No. 0855A does not limit GCID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. GCID has recently obtained a water right permit for non-contract-period diversions in the amount of 182,900 ac-ft (up to 1,200 cfs), as shown in Table 5. Although some pre-irrigation occurs within the District, non-contract-period diversions are predominantly used for rice straw decomposition and waterfowl habitat. In response to increasingly stringent limitations on rice burning, many of the District’s landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 26,000 acres have been flooded in the past. Estimates indicate that up to 50,000 acres may be flooded in the future.

In addition, as noted above, GCID may hold a right to divert up to 900 cfs from the Sacramento River during “all seasons of the year,” pursuant to the May 9, 1906 Act of Congress (Pub. L. No. 151, Ch. 2439).

Other Surface Water Sources

As discussed above, GCID has entitlements to water from Stony Creek, which can be diverted from Stony Creek, or equivalent quantities can be diverted from the Sacramento River. The GCID service area is relatively large and contains a number of small tributaries to the Sacramento River. GCID holds water rights to pump from Hunters Creek, Funks Creek, and Colusa Basin Drain, as shown in Table 5.



Notes:
1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 9
GLENN-COLUSA IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY AND AVERAGE
MONTHLY SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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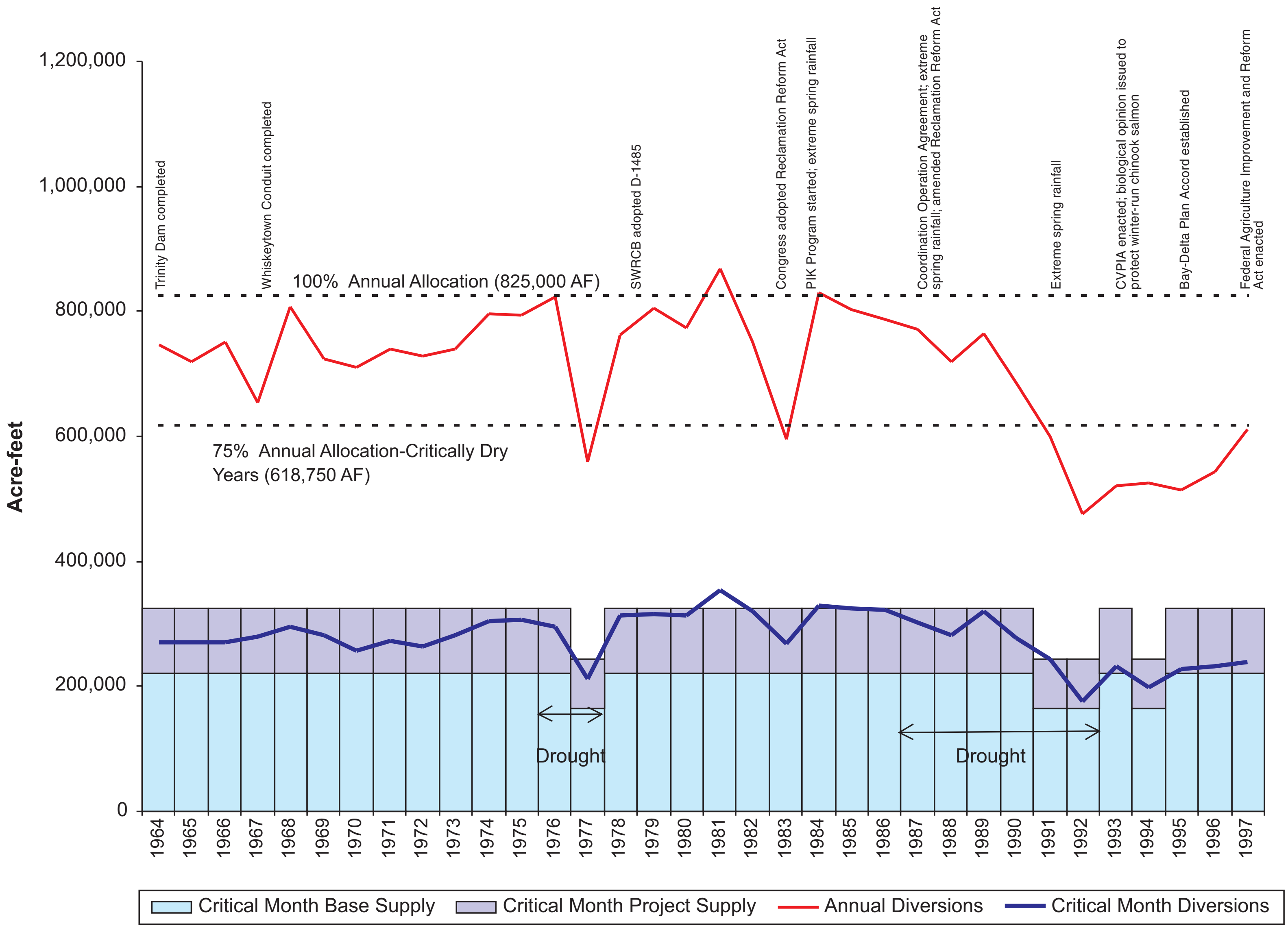


Note: Annual quantities are based on contract period from April to October; Critical Months include July and August.

FIGURE 10
GLENN-COLUSA IRRIGATION DISTRICT
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS

Tailwater, Reuse/Recirculation, and Water Transfers

An aggressive drainwater recapture program, which captures both subsurface flows (from system leakage and deep percolation recovered by open surface drains) and tailwater runoff from cultivated fields from within GCID's service area, is a part of GCID's overall water management program. GCID recaptures this water with both gravity and pump systems. This captured water is delivered to either laterals or the main canal for reuse. Currently, GCID recycles approximately 155,000 ac-ft annually. Relatively small quantities of tailwater are available to GCID from areas outside of the District's boundaries.

Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability. The District has established a program that encompasses the entire District to monitor soil and water salinity and test for electrical conductivity and pH.

Much of GCID's drainwater is captured for use by downstream districts such as the PID, PCGID, and MID. GCID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share operation and maintenance of the drains within their respective service areas and to share the right to recirculate the water in those drains. In addition, Colusa Basin Drain Mutual Water Company members (57,000 acres, gross) rely on tailwater from GCID and other upstream water users.

GCID adopted a Water Transfer Policy in 1995. This policy identifies agricultural water users within the Sacramento Valley as the highest priority, and environmental purposes as the second highest priority for future water transfers. An In-basin Water Transfer Program was introduced in 1997 that provides for up to 20,000 ac-ft to be transferred to neighboring lands in full water supply years.

Groundwater

Approximately 200 privately owned wells are located within the District's boundaries. GCID operates one well with an approximate capacity of 10 cfs. The Stony Creek Aquifer, the predominant aquifer within the District, has been placed to greater use since Endangered Species Act restrictions on GCID.

GCID manages and operates a voluntary groundwater conjunctive water management program to increase capacity when water supply does not meet demand. Up to 100 landowners have participated in the groundwater program, representing a combined capacity of approximately 500 cfs. A maximum of approximately 60,000 ac-ft/yr were pumped during the program; however, the total annual groundwater capacity is estimated at 100,000 ac-ft/yr (DWR, 1978).

Provident Irrigation District

Provident Irrigation District (PID or District) is located in the central portion of the Sacramento Valley on the west side of the Sacramento River in the Colusa Basin in Glenn and Colusa Counties. PID is bordered by PCGID to the east and GCID to the west. The District encompasses approximately 15,965 acres and serves 120 landowners. The

Sacramento River serves as the principal water source for the District, although the District also uses tailwater from both inside and outside of the District. The District has water rights to the Sacramento River and several other surface water sources as shown in Table 7. The following discussion describes these sources and their historical use.

TABLE 7
Provident Irrigation District: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River, Colusa Basin Drain, Willow Creek, Unnamed Drain[d]	A000462 (9/15/16)	000303 (7/12/17)	007205 (3/30/65)	Apr 1 to Oct 1	250 cfs
Sacramento River, Colusa Basin Drain, Willow Creek, Unnamed Drains[d]	A000640 (4/9/17)	000304 (7/12/17)	007206 (3/30/65)	Apr 1 to Oct 1	100 cfs
Sacramento River, Colusa Basin Drain, Drain 13, Drain 55, Unnamed Drain, Willow Creek	A000892 (1/18/18)	000416 (3/28/18)	007207 (3/30/65)	Apr 1 to Oct 1	110 cfs
Colusa Basin Drain	A001422 (9/2/19)	000847 (3/4/21)	001109 (9/15/31)	Apr 15 to Oct 1	10 cfs
Colusa Basin Drain	A013452 (11/9/49)	008290 (12/20/50)	004364 (5/21/56)	Apr1 to Oct 1	3.25 cfs
Sacramento River, Colusa Basin Drain, Drain 13, Drain 55, Unnamed Drain, Willow Creek	A030813 (1995 or later)	Pending	Pending	Oct 1 to Mar 31	483.25 cfs 26,747 ac-ft/yr
Colusa Basin Drain	A010595 (1/27/43)	6210	4331 (4/24/56)	Apr 15 to Oct 1	10 cfs

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).
[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.
[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings
[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.
[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Sacramento River Supply

Settlement Contract Entitlements. PID holds water rights to divert water from the natural flow of the Sacramento River. The PID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-16-200-0856A (Contract No. 0856A). This contract provides for an agreement between PID and the United States on PID's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 0856A provides for a maximum total of 54,730 ac-ft/yr, of which 49,730 ac-ft is considered to be Base Supply and 5,000 ac-ft is CVP water (Project Supply), as shown in

Table 8. The contract also provides that additional Project Water can be purchased if surplus water is available.

The contract specifies the total quantity of water that may be diverted by PID each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 11. The monthly Base Supply ranges from a minimum of 2,500 ac-ft in August to a maximum of 12,920 ac-ft in June. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 3,500, 1,000, and 500 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 16,200 ac-ft, and the total Project Supply is 5,000 ac-ft, as shown in Table 8.

TABLE 8
Provident Irrigation District: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	16,200	5,000
Non-critical Months	33,530	0
Total Annual	49,730	5,000

Settlement Contract Historical Diversions. PID's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 12. From 1964 to the mid-1970s, diversions typically increased from one year to the next. The increase in diversions during this period is attributed to an increase in rice acreage. During the early 1960s, government programs limited rice production within the District. Wheat and safflower, crops with lower water requirements compared to rice, were planted in place of rice. Total annual diversions in 1964 were only 16,000 ac-ft in comparison to 56,000 ac-ft in 1975 when the District purchased water in addition to Base and Project entitlements. Between 1975 and 1986, diversions fluctuated between 35,000 and 51,000 ac-ft/yr. During drought conditions in the late 1980s and early 1990s, annual diversions declined. The decrease in diversion during this period is associated with the management philosophy to reduce river diversions. In addition, several years were classified as "critical years," and contract supplies were reduced to 75 percent of contract entitlements. During 1991, a critically dry year, annual diversion only totaled 23,000 ac-ft when 75 percent allocation was 41,048 ac-ft. During the past several years, annual diversions have dramatically increased, as diversions for 1996 and 1997 were 54,300 and 53,000 ac-ft, respectively.

Figure 11 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- Due to the relatively small, 3,500 ac-ft, Base and Project Supply entitlement for August, the average diversions for the District are well above this amount, nearly 6,000 ac-ft on average (1977 to 1991).
- During the 1980s and in the last several years, PID has used nearly all of its entitlement water (Base and Project Supply) during the critical months (also see Figure 12).
- During the recent period (1992 to 1997), the average monthly diversions have been greater than long-term averages (1964 to 1991).
- During the recent period (1992 to 1997), the average monthly diversion in the month of October was approximately 6,900 ac-ft, an increase of over 5,000 ac-ft in relation to the other two period averages. Increased diversions during the month of October (1992 to 1997) are attributed to increased rice straw decomposition acreage.

Non-contract Period (November – March). Contract No. 0856A does not limit PID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. Recently, PID has filed for a water right permit for non-contract-period diversions in the amount of approximately 26,700 ac-ft, as shown in Table 7. Relatively little pre-irrigation occurs within the District, and therefore, non-contract-period diversions are predominantly used for rice straw decomposition. In response to increasingly stringent limitations on burning, many of the District’s landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 4,000 to 8,000 acres have been flooded in the past; however, acreage is expected to increase over the next few years.

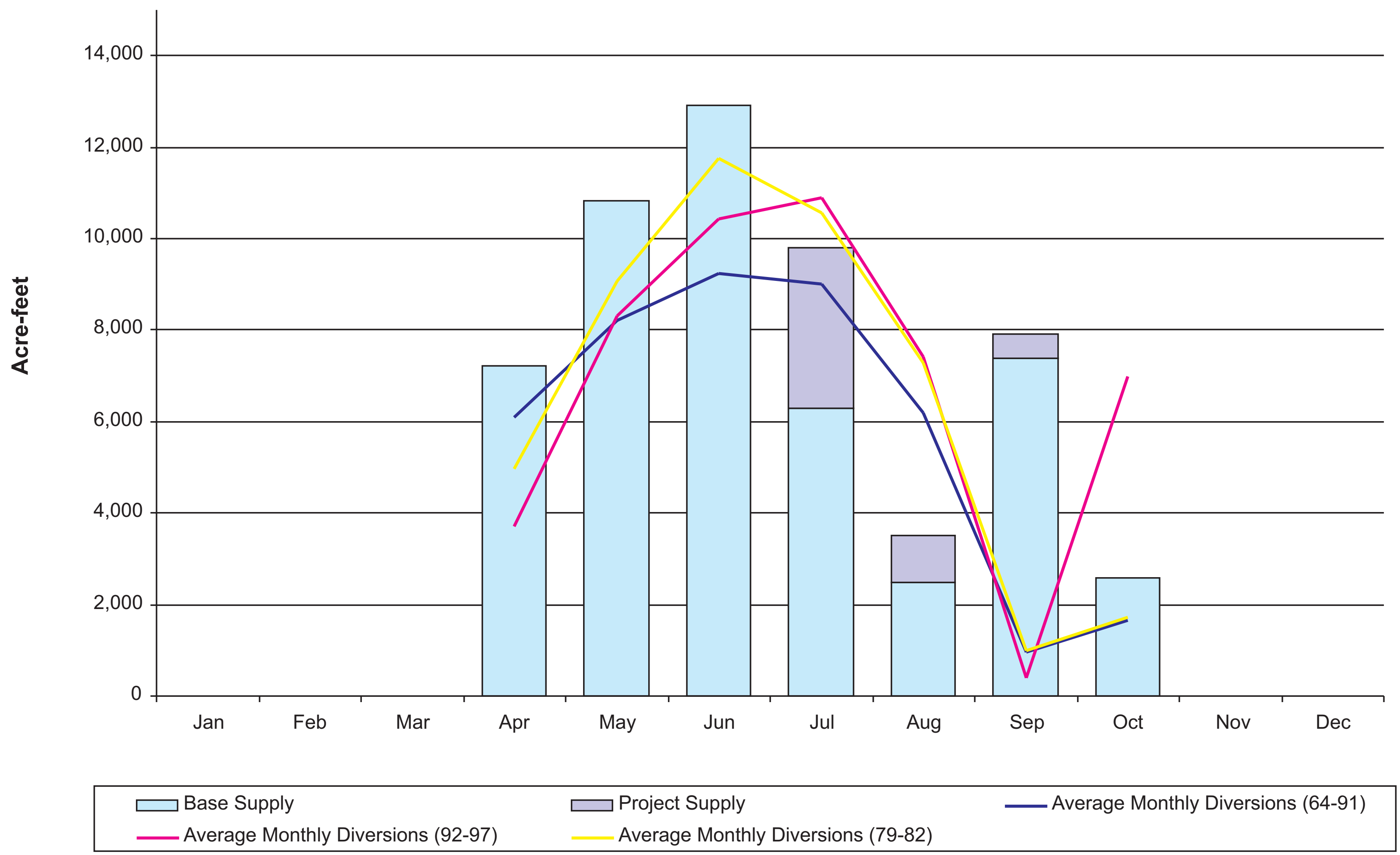
Other Surface Water Sources

PID has water rights to several surface water sources within or bordering the District’s service area. As shown in Table 7, PID holds water rights to Willow Creek, Colusa Basin Drain, Drain 13, Drain 55, and several other unnamed drains.

Tailwater, Reuse/Recirculation, and Water Transfers

In recent years, PID has relied heavily upon tailwater, approximately 45,000 to 55,000 ac-ft/yr, from both inside and outside of the District’s service area to supplement its Sacramento River entitlement. PID operates two gravity surface diversions on Drain 13 and Drain 55. These two drains primarily convey tailwater from GCID. In addition, Colusa Basin Drain, Quint Canal, and Willow Creek also convey tailwater from GCID and other sources. Approximately 25,000 to 30,000 ac-ft annually have been used in the past from these sources. PID meters all water pumped from these drains.

In the past, PID has recycled internally about 20,000 to 25,000 ac-ft annually. All water recirculated within PID is metered. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability.



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 11
PROVIDENT IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY AND AVERAGE
MONTHLY SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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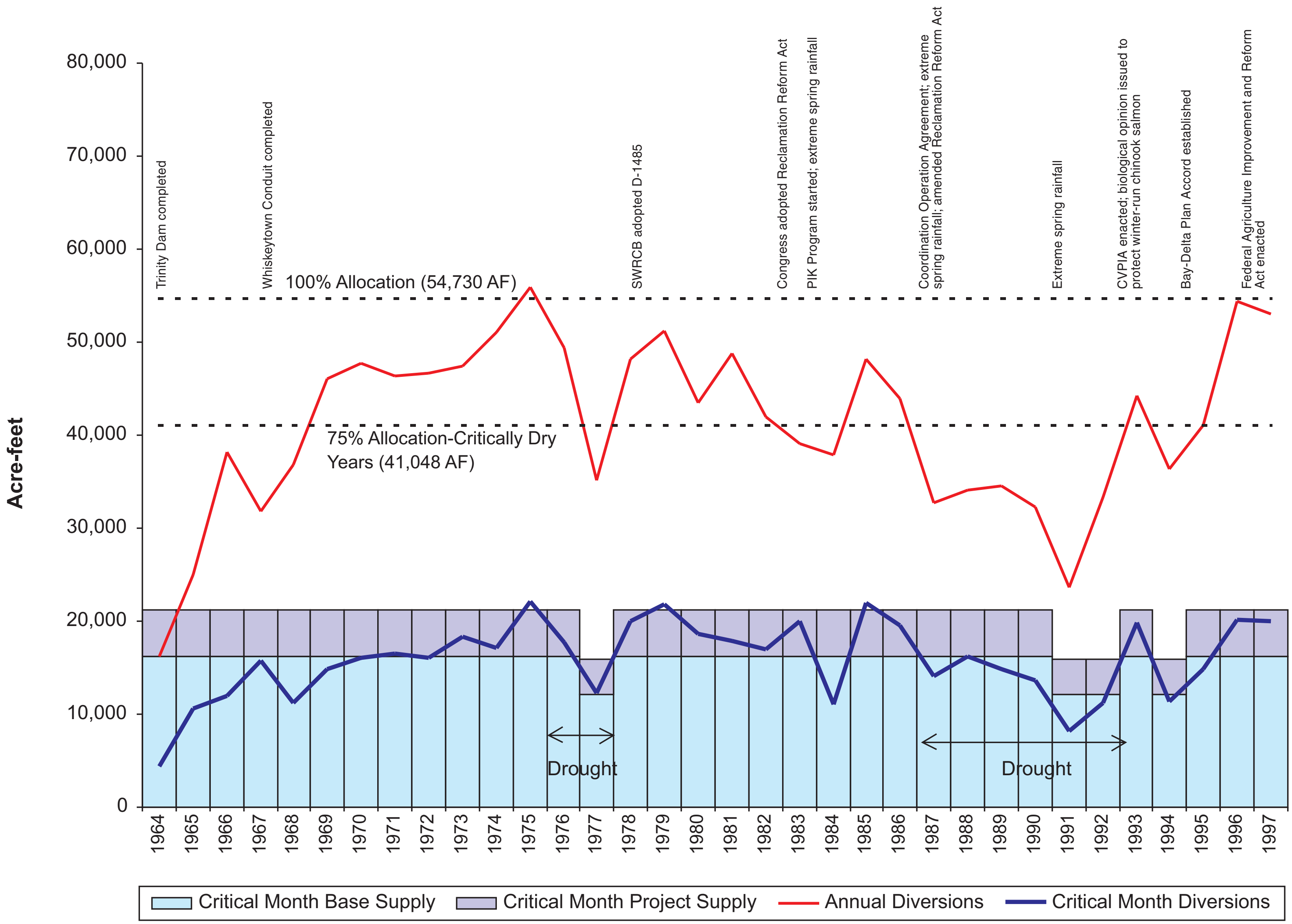

Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 12
PROVIDENT IRRIGATION DISTRICT
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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PID is involved with several water transfer agreements. Several of the irrigation and reclamation districts adjacent to the Colusa Basin Drain have agreed to provide additional flow, when possible, to the drain for use by the Colusa Basin Drain Mutual Water Company. The districts are compensated by Colusa Basin Drain Mutual Water Company for this water. In addition, PID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share operation and maintenance of the drains within their respective service areas and to share the right to recirculate the water in those drains. PID also diverts water to Willow Creek Mutual Water Company via a transfer agreement.

Groundwater

Approximately 15 to 20 privately owned wells and four District-owned wells are located within the District's boundaries. During the drought years of 1976 to 1977, PID installed three agricultural groundwater wells to supplement its water supply. An additional well was installed in 1991. During the drought of 1986 to 1993, several private groundwater wells were installed. The total capacity of the District-owned wells is approximately 3,000 to 4,000 ac-ft/yr. Groundwater is used to help with the initial flooding of the rice fields and to increase flexibility during the peak demand periods (DWR, 1978).

Princeton-Codora-Glenn Irrigation District

Princeton-Codora-Glenn Irrigation District (PCGID or District) is along the western bank of the Sacramento River in Glenn and Colusa Counties. The Colusa Basin Drain runs along most of PCGID's western boundary, beyond which lies PID. The District encompasses approximately 11,700 acres and serves 125 landowners. The Sacramento River serves as the principal water source for the District, although the District also uses tailwater from both inside and outside of the District. The District has water rights to the Sacramento River and several other surface water sources as shown in Table 9. The following discussion describes these sources and their historical use.

TABLE 9
Princeton-Codora-Glenn Irrigation District: Water Rights

	Water Rights[a,b]				
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A000244 (2/3/16)	00463 (8/15/18)	002646 (4/10/44)	Apr 1 to Oct 31	120 cfs
Sacramento River	A000770 (9/5/17)	000464 (8/15/18)	004161 (12/30/55)	Apr 1 to Oct 31	120 cfs
Colusa Basin Drain	A017066 (5/2/56)	013869 (2/15/63)	008989 (2/21/69)	Primary:Ap r 1 to Jun 30 Secondary: Sep 1 to Oct 31	50 cfs
Sacramento River, Colusa Basin Drain	A030812 (1995 or later)	Pending	Pending	Nov 1 to Mar 31	290 cfs 24, 370 ac-ft /yr

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
- A – Appropriative right
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Sacramento River Supply

Settlement Contract Entitlements. PCGID holds water rights to divert water from the natural flow of the Sacramento River. The PCGID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-16-200-0849A (Contract No. 0849A). This contract provides for an agreement between PCGID and the United States on PCGID's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 0849A provides for a maximum total of 67,810 ac-ft/yr, of which 52,810 ac-ft is considered to be Base Supply and 15,000 ac-ft is CVP water (Project Supply), as shown in Table 10. The contract also provides that additional Project Water can be purchased if surplus water is available.

The contract specifies the total quantity of water that may be diverted by PCGID each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 13. The monthly Base Supply ranges from a minimum of 1,400 ac-ft in August to a maximum of 13,500 ac-ft in May. CVP water (Project Supply) is available during the months of June, July, August, and September with entitlements of 400, 6,000, 8,400, and 200 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 14,320 ac-ft, and the total Project Supply is 14,600 ac-ft, as shown in Table 10.

Settlement Contract Historical Diversions. PCGID's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 14. From 1972 to 1981, except for the 1977, which was designated as a critically dry year, annual diversions consistently approached total contract entitlements. In 1975, 1979, and 1981, PGCID purchased additional CVP water above the 15,000 ac-ft amount provided for in the contract. During drought conditions in the late 1980s and early 1990s, annual diversions declined. Several years were classified as "critical years," and contract supplies were reduced to 75 percent of contract entitlements.

TABLE 10
Princeton-Codora-Glenn Irrigation District: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	14,320	14,600
Non-critical Months	38,490	400
Total Annual	52,810	15,000

Figure 13 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.

- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- On average, monthly diversions by PCGID have been similar to their corresponding monthly entitlements. From 1964 to 1991, PCGID diverted over 80 percent of their contract amounts from May through August.
- Every year, from 1964 to 1997, PCGID has diverted some portion of their CVP contract entitlement during critical months. Furthermore, during the 1980s and in the last several years, PCGID has used nearly all of its entitlement water (Base and Project Supply) during the critical months (also see Figure 14).
- During the recent period (1992 to 1997), the average monthly diversion in the months of April, May, and June have declined between 20 and 50 percent in relation to the long-term period of record (1964 to 1991). This trend is attributed to wet hydrologic conditions during the spring months, thereby reducing diversions during this time.

Non-contract Period (November – March). Contract No. 0849A does not limit PCGID from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. Recently, PCGID has filed for a water right permit for non-contract-period diversions in the amount of approximately 24,400 ac-ft, as shown in Table 9. Non-contract-period diversions are predominantly used for rice straw decomposition and pre-irrigation. PCGID has historically irrigated in months prior to April (pre-irrigation), especially for orchards, tomatoes, and sugar beets. In response to increasingly stringent limitations on burning, some of the District's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 1,200 to 2,500 acres have been flooded in the past. A lower percentage of rice acreage is flooded in PCGID compared to other adjacent districts because of the high cost of decomposition water (relative to other districts).

Other Surface Water Sources

Several minor creeks are located within PCGID boundaries, including Canal Creek and Bounde Creek. Canal and Bounde Creeks are seasonal and provide no additional surface water source during the irrigation season. However, these waterways are used as conveyance facilities for tailwater and/or recirculation purposes. PCGID has permits to pump water from the Colusa Basin Drain. PCGID may divert up to approximately 50 cfs from April 1 to June 30.

Tailwater and Reuse/Recirculation

In recent years, PCGID has relied heavily upon tailwater to supplement its Sacramento River entitlement. GCID has been the primary source of this tailwater. As discussed above, PCGID has water rights to tailwater in Colusa Basin Drain. All water pumped from this and other drains is metered by PCGID.

PCGID has initiated a Recapture Plan for recirculating water through the District. Currently, four recapture plants are located within PCGID. In the past, PCGID has recycled about 20,000 to 25,000 ac-ft annually. All water recirculated within PCGID is metered. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability. PCGID is involved with several water transfer agreements. Several of the irrigation and reclamation districts adjacent to the Colusa Basin Drain have agreed to provide additional flow, when possible, to the drain for use by Colusa Basin Drain Mutual Water Company. The districts are compensated by Colusa Basin Drain Mutual Water Company for this water. In addition, PCGID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share operation and maintenance of the drains within their respective service areas and to share the right to recirculate the water in those drains.

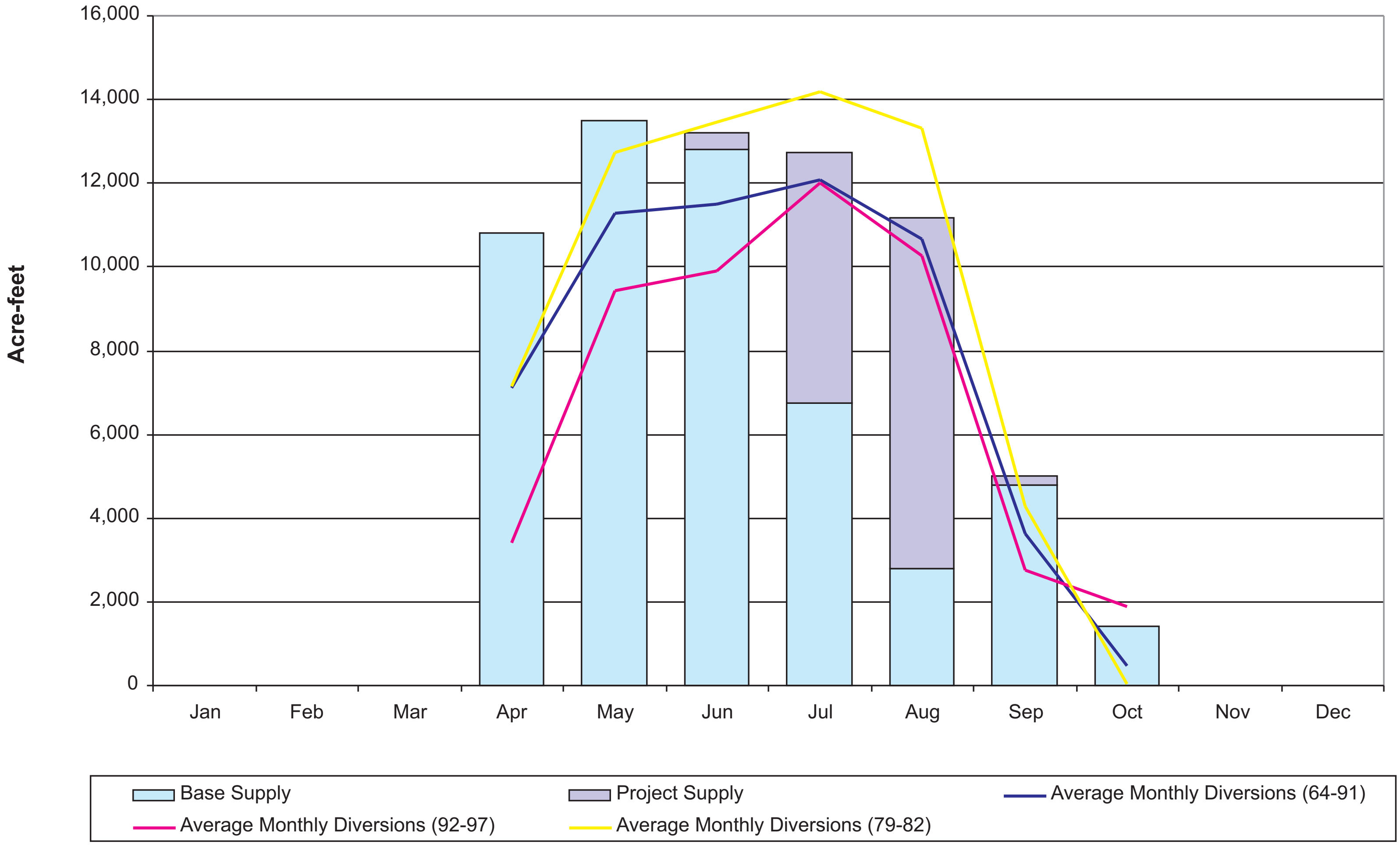
Groundwater

Approximately 20 privately owned wells and 5 District-owned wells are located within the District's boundaries. The total capacity of the District-owned wells is approximately 3,000 to 4,000 ac-ft/yr. Groundwater is used to help with the initial flooding of the rice fields and to increase flexibility during the peak demand periods. Operations of these wells are coordinated with the river pumps to maximize flexibility and serve those within the District during times of short water supplies (e.g., drought conditions).

Although PCGID has no formal agreement with private well owners, in the past, the District has established seasonal agreements (one irrigation season duration). In 1994, PCGID developed a conjunctive water management program with landowners that encouraged landowners to pump groundwater to supplement Sacramento River diversions (DWR, 1978).

Maxwell Irrigation District

Maxwell Irrigation District (MID or District) is located on the west side of the Sacramento River approximately 5 miles northwest of the town of Colusa in Colusa County. The District is located directly east of the southern portion of GCID and south of the Delevan National Wildlife Area. The Sacramento River serves as a water source for the District; however, due to facilities limitation, the predominant source for the District has been tailwater from outside of the District. The District has water rights to the Sacramento River, the Colusa Basin Drain, and several other surface water sources as shown in Table 11. The following discussion describes these sources and their historical use.



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 13
PRINCETON-CODORA-GLENN IRRIGATION DISTRICT MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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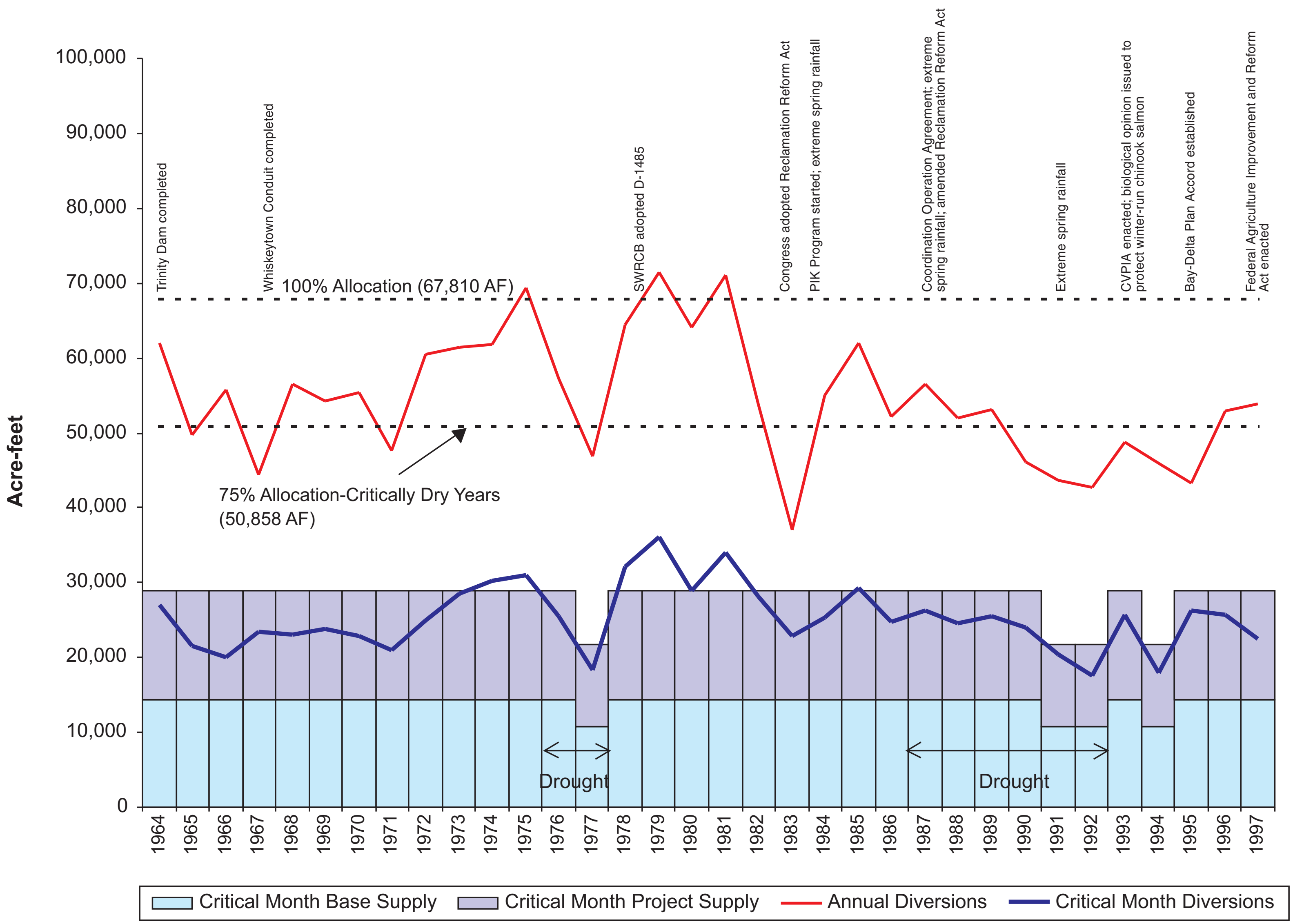

Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 14
PRINCETON-CODORA-GLENN IRRIGATION DISTRICT ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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TABLE 11
Maxwell Irrigation District: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A008631 (4/8/36)	005128 (4/4/38)	007210 (3/30/65)	Mar 15 to Nov 1	63
RD 2047 Main Drain	A011955 (6/24/47)	008265 (12/20/50)	004643 (6/10/57)	Apr 15 to Oct 1	14
RD 2047 Main Drain	A011956 (6/24/47)	008266 (12/20/50)	004586 (3/13/57)	Apr 1 to Oct 1	8.5
Logan Creek RD 2047 Main Drain	A011957 (6/24/47)	008267 (12/20/50)	004644 (6/10/57)	Apr 15 to Oct 1	65.5
Stone Corral Creek	A011958 (6/24/47)	008268 (12/20/50)	004694 (9/20/57)	Apr 15 to Oct 1	13.5
Lateral Drain RD 2047	A013735 (5/15/50)	008320 (12/28/50)	004734 (10/11/57)	Apr 15 to Oct 1	7
Lurline Creek	A013919 (8/25/50)	009042 (7/28/52)	005692 (4/10/59)	May 1 to Dec 1	11.6
RD 2047 Lateral Drain F	A014378 (6/28/51)	008808 (11/13/51)	004523 (1/9/57)	Apr 15 to Sep 30 (Mar 1 to Nov 30 for recreation purposes)	3
Sacramento River, Colusa Basin Drain, Stone Corral Creek, Lurline Creek	A030445 (5/30/95)	Pending	Pending	Sep 15 to Apr 30	186

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
- A – Appropriative right
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Sacramento River Supply

Settlement Contract Entitlements. The MID surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1972, Contract No. 14-06-200-6078A (Contract No. 6078A). This contract provides for an agreement between MID and the United States on MID's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 6078A provides for a maximum total of 17,980 ac-ft/yr, of which 11,980 ac-ft is considered to be Base Supply, and 6,000 ac-ft is CVP water (Project Supply), as shown in Table 12. The contract also provides that additional Project Water can be purchased if surplus water is available.

TABLE 12
Maxwell Irrigation District: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	960	6,000
Non-critical Months	11,020	0
Total Annual	11,980	6,000

The contract specifies the total quantity of water that may be diverted by MID each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 15. The monthly Base Supply ranges from a minimum of 30 ac-ft in August to a maximum of 3,520 ac-ft in June. CVP water (Project Supply) is available during the months of July, August, and September with an entitlement of 2,000 ac-ft per month. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 960 ac-ft, and the total Project Supply is 6,000 ac-ft, as shown in Table 12.

Settlement Contract Historical Diversions. Historically, MID has taken only a small percentage of their contract entitlement, as shown on Figure 16. Until 1999, contract water diverted from the Sacramento River was mixed with tailwater in the Colusa Basin Drain. Recently, conveyance facilities have been improved, which allows the diversion of Sacramento River water without mixing with other tailwater supplies. In addition, MID operations are influenced by the actions of GCID as MID uses tailwater from the GCID system that is diverted from the Colusa Basin Drain.

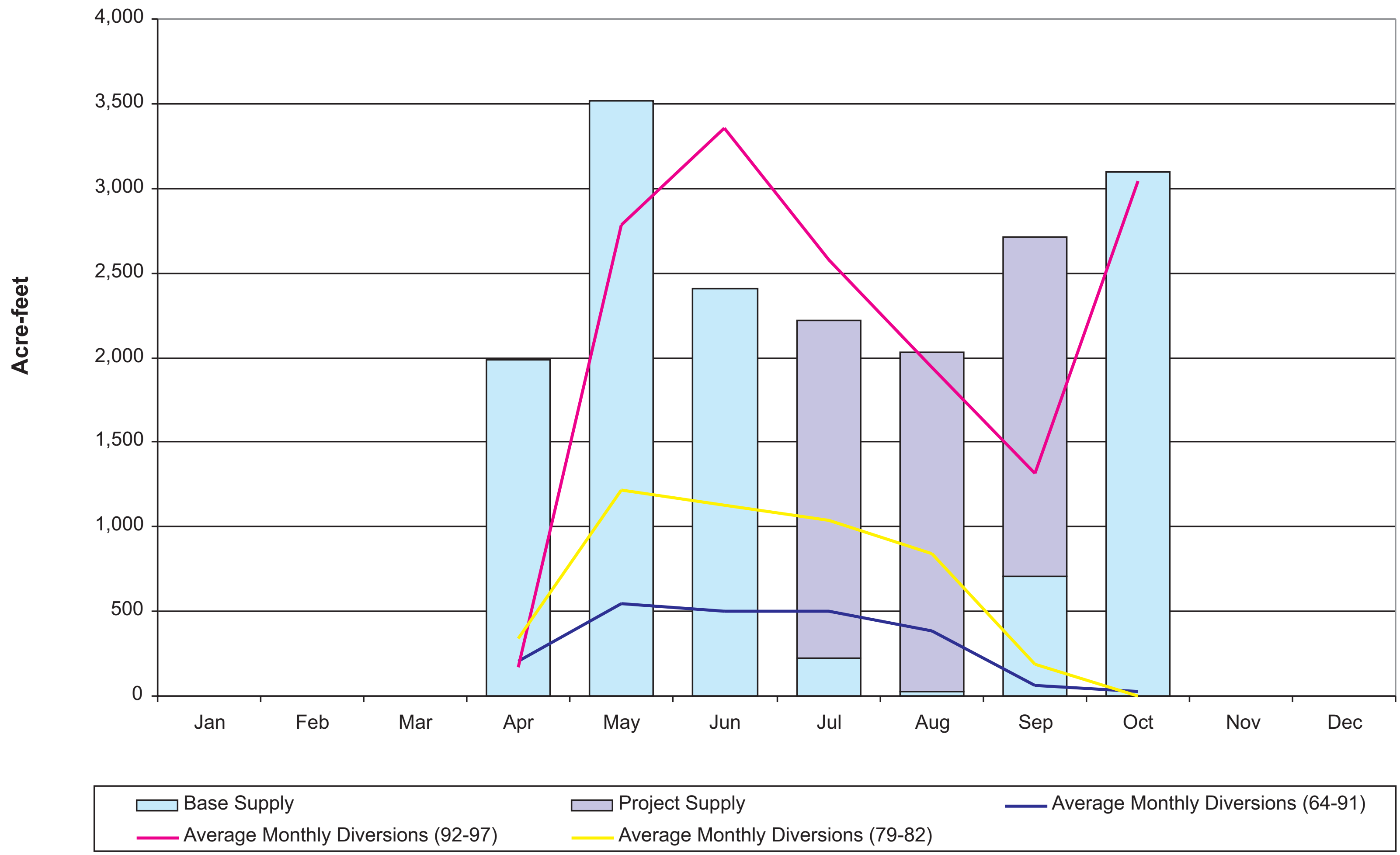
Figure 15 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

Non-contract Period (November – March). In addition to the contract water, MID have entitlements to pump water during the non-contract period for wetlands and rice straw decomposition. The methods and quantities of diversions have varied in the past.

Other Surface Water Sources

The Stone Corral, Logan, and Lurline Creeks are located within MID's service area. MID has established water rights to these three creeks and has a license to divert water from these sources, as shown in Table 11. In addition, MID has water rights to several drains including Lateral Drain RD 2047, RD 2047 Main Drain, Lateral Drain F, and Colusa Basin Drain.



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 15
MAXWELL IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY AND AVERAGE
MONTHLY SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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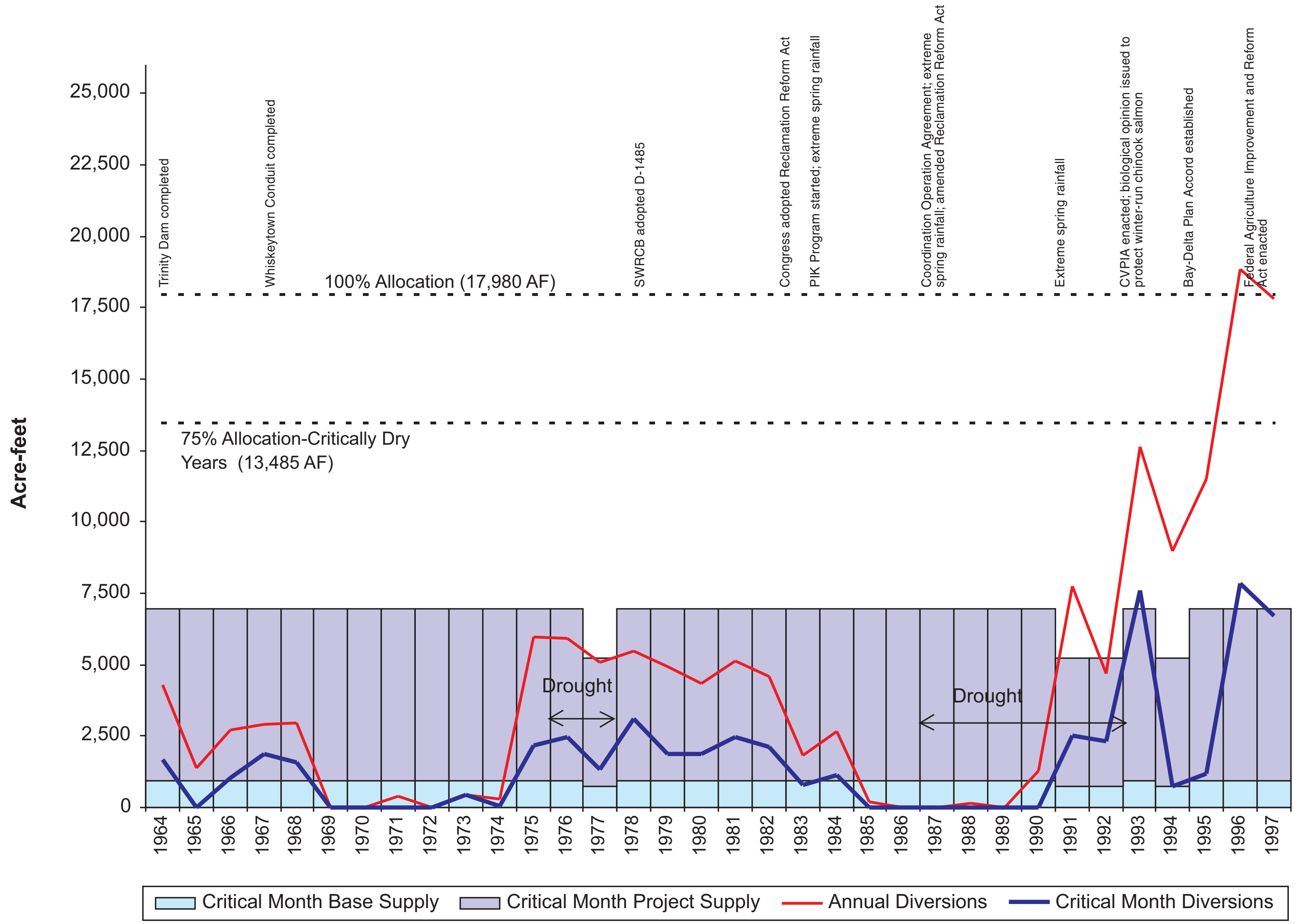

Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 16
MAXWELL IRRIGATION DISTRICT
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Tailwater and Reuse/Recirculation

MID made extensive use of drainwater prior to the early 1990s, at times supplying up to 80 percent or more of its supply from area drains. The District's use of drainwater was motivated by the lack of reliable diversion capacity on the Sacramento River. Relocation and improvement of their Sacramento River pump station has allowed MID to begin using its Sacramento River supply more reliably, with a corresponding decrease in drainwater use.

Until the early 1990s, MID's primary surface water source was tailwater from Colusa Basin, East, and Lurline Drains. The tailwater conveyed in these drains was primarily from GCID. The District also operates five pumping plants that recapture some internal return flows. In addition, MID is one of the irrigation districts that signed the Five-Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved (Compton-Delevan Irrigation District and Jaciento Irrigation District) to share operation and maintenance of the drains within their respective service areas and to share the right to recirculate the water in those drains. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability.

Groundwater

MID has not historically used any groundwater as part of the District's supply. Six privately owned wells are located within the District's boundaries; however, these facilities are not operated in coordination with MID. MID is currently investigating the use of groundwater to supplement surface water supplies (DWR, 1978).

Reclamation District No. 108

Reclamation District No. 108 (RD 108 or District) is located on the west side of the Sacramento River in southern Colusa County and northern Yolo County between the towns of Grimes and Knights Landing. The service area encompasses approximately 48,000 acres and is surrounded on three sides by flood control levees (i.e., on the east by the western levee of the Sacramento River, on the west and southwest by the Colusa Basin Drain, and on the southeast by the northern levee of RD 787). The Sacramento River serves as the principal water source for the District. The District has water rights to the Sacramento River and several other surface water sources as shown in Table 13. The following discussion describes these sources and their historical use.

Sacramento River Supply

Settlement Contract Entitlements. RD 108 holds a water right, primarily under 1917 and 1918 priority dates, to divert water from the natural flow of the Sacramento River. The RD 108 surface water supply entitlement was initially addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0876A (Contract No. 0876A). This contract provided for an agreement between RD 108 and the United States on RD 108's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. The length of this contract is 40 years and will remain in effect until March 31, 2006.

TABLE 13
Reclamation District No. 108: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A000576 (1/25/17)	000315 (7/24/17)	003065 (2/24/50)	Feb 1 to Oct 31	180
Sacramento River	A000763 (8/27/17)	000388 (1/16/18)	003066 (2/24/50)	Feb 1 to Oct 31	500
Sacramento River	A001589 (12/26/19)	001885 (11/22/24)	003067 (2/24/50)	May 1 to Oct 1	255.25
RD 108 Back Levee Borrow Pit (Colusa Basin Drain)	A011899 (5/26/47)	008251	(12/20/50)	Apr 1 to Oct 1	75

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

- A – Appropriative right
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Contract No. 0876A provided for a maximum total of 253,500 ac-ft/yr, of which 199,000 ac-ft was considered to be Base Supply and 54,500 ac-ft was CVP water (Project Supply). In 1974, the District reduced its Project Water allocation to 33,000 ac-ft with the expectation that conservation efforts including canal lining and recirculation of drainage water by the District would reduce diversion requirements. Thus the current contract provides for a maximum total of 232,000 ac-ft/yr, of which 199,000 ac-ft is considered to be Base Supply, and 33,000 ac-ft is CVP water (Project Supply), as shown in Table 14. The contract also provides that additional Project Water can be purchased if surplus water is available.

TABLE 14
Reclamation District No. 108: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	64,000	33,000
Non-critical Months	135,000	0
Total Annual	199,000	33,000

The contract specifies the total quantity of water that may be diverted by RD 108 each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 17. The monthly Base Supply ranges from a minimum of 1,500 ac-ft in October to a maximum of 50,500 ac-ft in May. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 16,000, 15,000, and 2,000 ac-ft, respectively. The contract identifies July, August, and

September as the critical months. For the critical months, the total Base Supply is 64,000 ac-ft, and the total Project Supply is 33,000 ac-ft, as shown in Table 14.

Settlement Contract Historical Diversions. RD 108's total annual diversions from the Sacramento River can be characterized into two time periods, 1964 to 1982 and 1983 to 1997 (shown on Figure 18). From 1964 to 1982, annual diversions fluctuated between a maximum of 214,700 ac-ft in 1968 to a minimum of 140,400 ac-ft in 1977 (critically dry year). During the early 1980s, RD 108 slowly phased in a "lock-up" program to control rice pesticides. This lock-up program was in effect from approximately 1983 until 1997. This lock-up program provided for complete recycling of drainwater, as no drainwater was discharged into the Sacramento River during the lock-up period. Due to the recycling effects of this program, diversions from the Sacramento River were reduced. From 1983 to 1997, annual diversions fluctuated between a maximum of 143,900 ac-ft in 1992 (critically dry year) to a minimum of 93,900 ac-ft in 1983.

Similar to trends in annual diversions, RD 108 diverted a portion of their Project Water every year during the period of 1964 to 1982. In critical months during 1982 to 1990, RD 108 diverted a portion of their Project Water during only one year. Since 1991, RD 108 has increased their diversions during critical months and has diverted a portion of their Project Water.

Figure 17 shows the historical monthly average diversions for the following three periods:

- 1964 to 1982: Beginning of recording period to prior to start-up of the lock-up program.
- 1983 to 1990: Period when the lock-up program was active and minimal diversion of Project Supply entitlements occurred.
- 1991 to 1997: Similar to 1982 to 1990 period, except increased diversions of Project Supply entitlements occurred.

The following observations are noted:

- Since the beginning of the water recycling program in 1983, Base Supply diversions decreased most significantly in April, May, and June. On average, these diversions were cut nearly in half. These reductions in diversions are attributed to the implementation of the lock-up program, as the lock up period was typically from May 1 to early July.
- Between 1983 and about 1990, less than 20 percent of the total Project Supply entitlements were diverted. A majority of the Project Supply diversions occurred during the critical month of August.
- Beginning in 1991, average monthly diversions of Project Water in July and August increased to nearly 50 percent of the Project Supply entitlement.

Non-contract Period (November – March). Contract No. 0876A does not limit RD 108 from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. As previously discussed, RD 108 also has riparian water rights to the Sacramento River, which allow for diversion during the entire water year (October through September). RD 108 has historically irrigated in months prior to April (pre-irrigation), especially for tomatoes and grain crops. With the phase-out of rice straw burning over the past several years, there has been an increased interest by rice growers in fall and winter flooding of rice fields to enhance decomposition of rice straw and stubble. Approximately 6,000 acres were flooded each of the past 4 years.

Other Surface Water Sources

No creeks or other surface water sources, excluding the Sacramento River and the Colusa Basin Drain, are available to RD 108. The use of tailwater from Colusa Basin Drain is discussed below.

Tailwater and Reuse/Recirculation

In recent years, RD 108 has relied heavily upon tailwater and reuse/recirculation to supplement its Sacramento River entitlement. The Colusa Basin Drain has been the primary source of tailwater, as this canal flows along the western edge of the District. However, the tailwater supply from the Colusa Basin Drain is primarily used as an alternative supply. RD 108 holds a permit to pump 75 cfs from the Colusa Basin Drain (RD 108 Back Levee Borrow Pit).

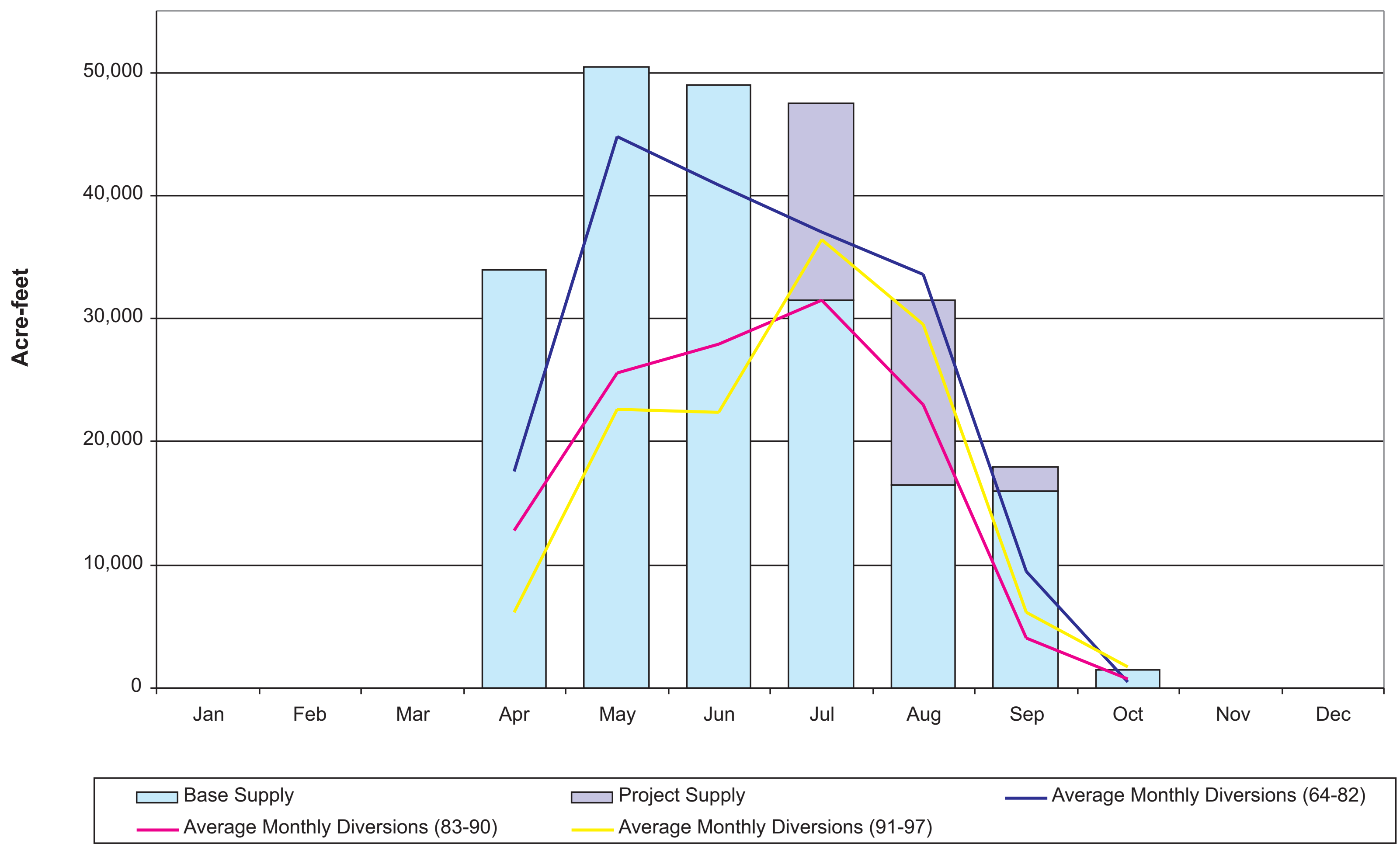
Because a large portion of RD 108 lies within an area of relatively little slope, the District has a unique capability of recirculating all drainage water so that no drainage is pumped into the Sacramento River. As previously discussed, this lock-up capability allowed the District to control rice pesticide-contaminated water within its drainage and irrigation systems for the prescribed holding period, thereby permitting early release of pesticide water from rice fields. Typically, the lock-up period was an 8 to 10 week period, approximately from May 1 to early July. In addition, RD 108 has recirculated a certain amount of drainage water beyond the normal 2-month lock-up period as a water management practice. Approximately 60,000 ac-ft was recycled annually during the lock-up program. However, after about 15 years of recycling water during the peak irrigation season, it was found that continued recycling of drainage water detrimentally affected crop production within certain areas of the District because of salt buildup in the soil. Therefore, in 1997, RD 108 suspended the lock-up program and has curtailed its recirculation of drainage water.

Groundwater

Irrigation water requirements are met through the contract surface water supply, although groundwater is used by a few individual growers to supplement the surface supply, particularly in dry years. Approximately 12 privately owned wells and three District-owned wells are located within the District’s boundaries. During some dry years or peak demand periods, RD 108 uses groundwater to increase system flexibility and responsiveness to grower water needs (i.e., increase speed of water deliveries). The District’s three groundwater wells have a total capacity of approximately 20 cfs (DWR, 1978).

River Garden Farms Company

River Garden Farms Company (RGFC or Company) is located on the west side of the Sacramento River in northern Yolo County near the town of Knights Landing. The Sacramento River serves as the principal water source for the Company. The Company has water rights to the Sacramento River and several other surface water sources, as shown in Table 15. The following discussion describes these sources and their historical use.



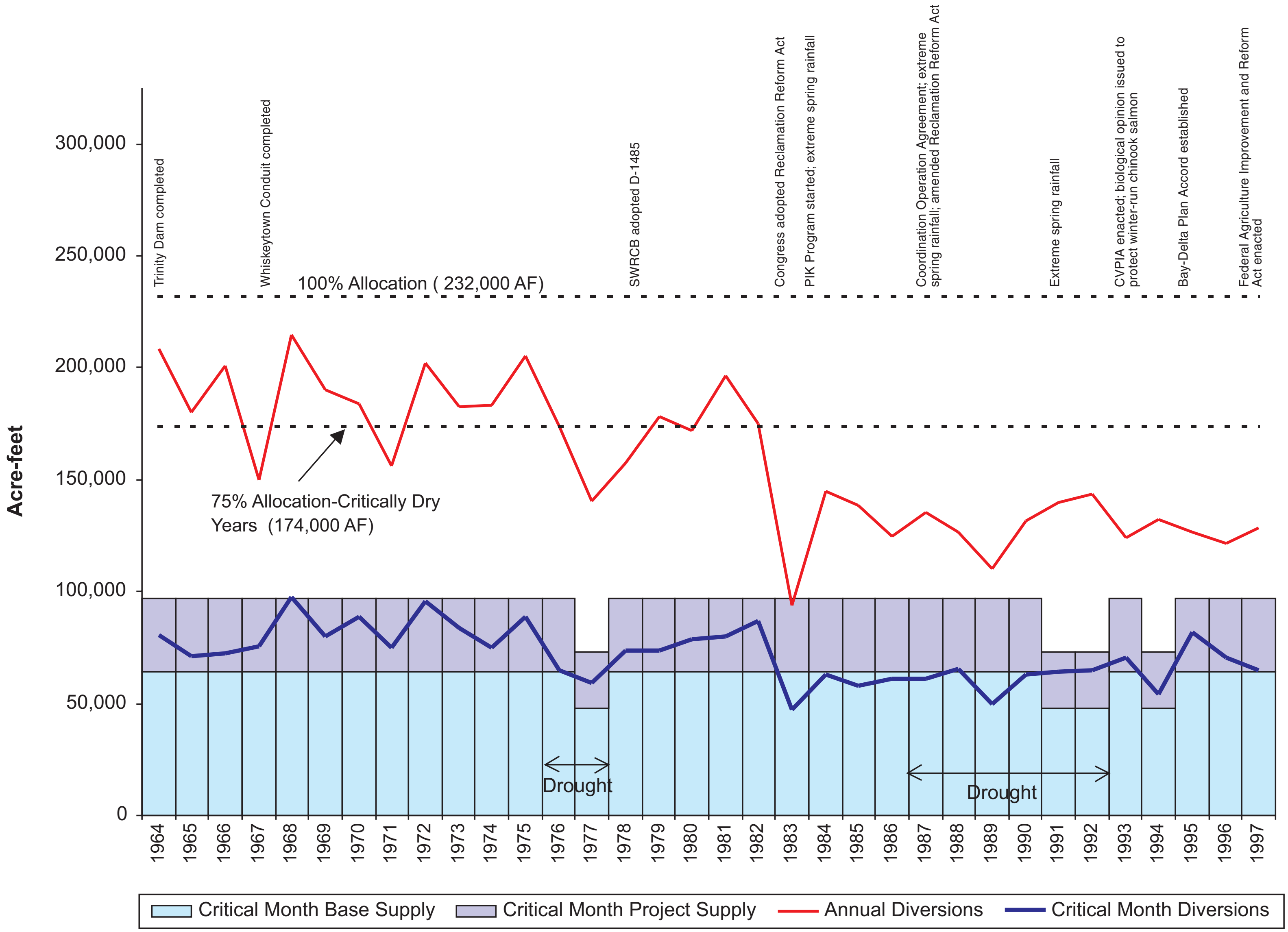
Notes:

1. Critically dry years 1977, 1991, 1992, and 1994 are omitted from Average Monthly Diversions.
2. Monthly diversions based on contract period for April to October.

FIGURE 17
RECLAMATION DISTRICT NO. 108
MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

W032003010RDD_856_TM 3 (5/7/03)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 18
RECLAMATION DISTRICT 108
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK

TABLE 15
River Garden Farms Company: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A000575 (1/25/17)	000314 (7/24/17)	001718 (3/26/37)	Mar 1 to Oct 31	32
Sacramento River	A000577 (1/25/17)	000316 (7/24/17)	003123 (12/11/50)	Apr 1 to Oct 15	35
Knights Landing Ridge Cut	A011910 (5/29/47)	008258 (12/20/50)	004636 (5/21/57)	Apr 1 to Sep 15	19

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).
[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.
[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings
[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.
[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Sacramento River Supply

Settlement Contract Entitlements. RGFC holds water rights to divert water from the natural flow of the Sacramento River. The RGFC surface water supply entitlement is currently addressed in a contract with Reclamation entered into in 1964, Contract No. 14-16-200-0878A (Contract No. 0878A). This contract provides for an agreement between RGFC and the United States on RGFC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 0878A provides for a maximum total of 29,800 ac-ft/yr, of which 29,300 ac-ft is considered to be Base Supply and 500 ac-ft is CVP water (Project Supply), as shown in Table 16. The contract also provides that additional Project Supply can be purchased if surplus water is available.

TABLE 16
River Garden Farms Company: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	12,200	500
Non-critical Months	17,100	0
Total Annual	29,300	500

The contract specifies the total quantity of water that may be diverted by RGFC each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 19. The monthly Base Supply ranges from a minimum of 500 ac-ft in October to a maximum of 6,500 ac-ft in May. CVP water (Project Supply) is available during the months of July and August with entitlements of 300 and 200 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 12,200 ac-ft, and the total Project Supply is 500 ac-ft, as shown in Table 16.

Settlement Contract Historical Diversions. Referring again to Figure 19, average monthly diversions are depicted for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

RGFC's total annual diversion from the Sacramento River for the time period 1964 to 1997 is shown on Figure 20.

Non-contract Period (November – March). Contract No. 0878A does not limit RGFC from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. In response to increasingly stringent limitations on burning, many of the Company's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose.

Other Surface Water Sources

In addition to the Sacramento River water rights/entitlements, RGFC also has established water rights on Knights Landing Ridge Cut.

Tailwater and Reuse/Recirculation

Detailed information regarding tailwater use and recirculation was unavailable for RGFC.

Groundwater

Detailed information regarding groundwater use was unavailable for RGFC. An unknown number of privately owned wells and Company-owned wells are located within the Company's boundaries.

Other Surface Water Sources

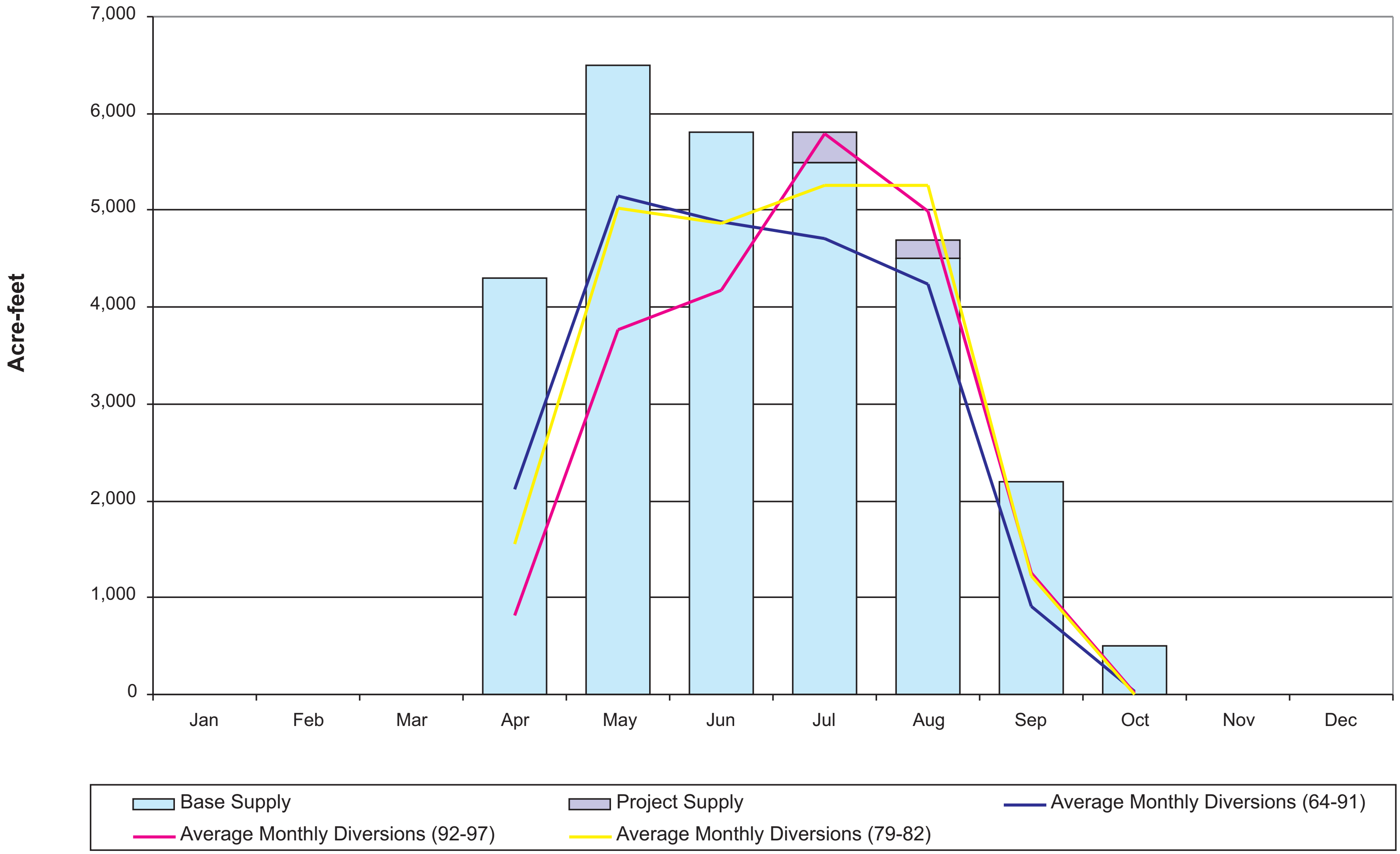
In addition to the Sacramento River water rights/entitlements, RGFC also has established water rights on Knights Landing Ridge Cut.

Tailwater and Reuse/Recirculation

Detailed information regarding tailwater use and recirculation was unavailable for RGFC.

Groundwater

Detailed information regarding groundwater use was unavailable for RGFC. An unknown number of privately owned wells and Company-owned wells are located within the Company's boundaries.



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 19
RIVER GARDEN FARMS COMPANY MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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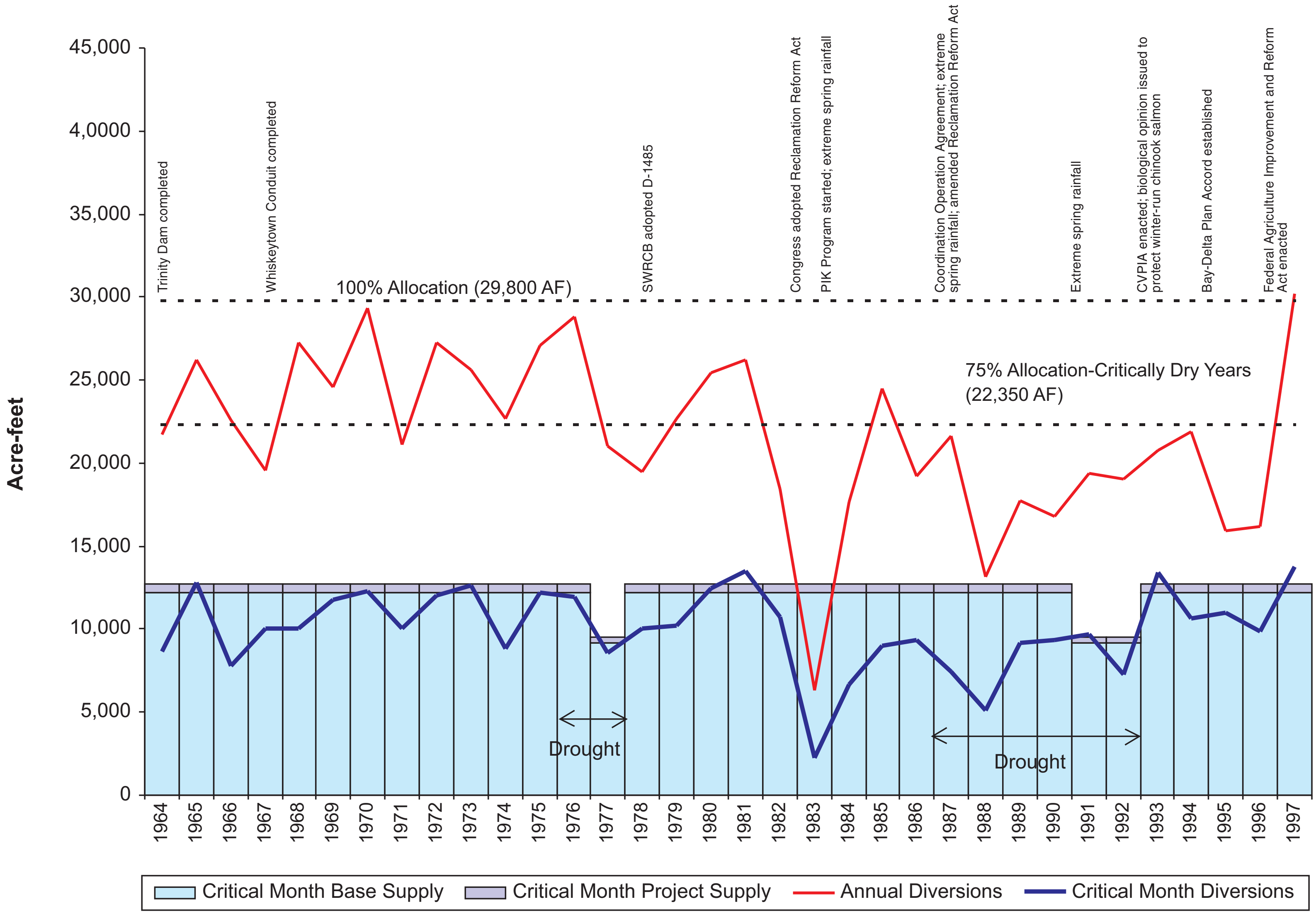
MBK



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 20
RIVER GARDEN FARMS COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Butte Sub-basin

- M&T Chico Ranch
- Reclamation District No. 1004

Butte Sub-basin

The Butte Sub-basin, shown on Figure 21, is located on the east side of the Sacramento Valley floor and is bounded on the west by the Sacramento River, on the north by Big Chico Creek, on the east by Butte Creek and Butte Slough, and the south by the Sacramento River and Butte Slough. The participating SRSCs within this sub-basin include the following:

- MTCR
- RD 1004

Inflows to the sub-basin include diversions from the east bank of the Sacramento River, Butte Creek, and Big Chico Creek. Outflows occur either through Butte Slough to Sutter Bypass or RD 1004's pumping plants to Sacramento River. Surplus water from precipitation and return flows from irrigation flow to Butte Slough. This surplus water can be rediverted for irrigation before leaving the basin as outflow.

M&T Chico Ranch

M&T Chico Ranch (MTCR) is located on the east side of the Sacramento River directly southwest of the town of Chico in Butte County. MTCR has water rights to the Sacramento River and several other surface water sources as shown in Table 17. The following discussion describes these sources and their historical use.

TABLE 17
M&T Chico Ranch: Water Rights

	Water Rights[a,b]				
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Butte Creek	A005109 (7/17/26)	003210 (2/11/29)	002614 (6/22/43)	Jan 1 to Dec 31	20
Butte Creek	A008188 (12/1/34)	004700 (2/18/36)	002617 (6/22/43)	Jan 1 to Dec 31	100
Sacramento River	A008213 (1/15/35)	004516 (4/9/35)	002618 (6/28/43)	Apr 1 to Dec 30	3
Butte Creek	A015866 (5/10/54)	010390 (6/7/56)	009267 (4/7/70)	Mar 1 to Jul 15	5.9
Big Chico Creek	J008565 (2/27/36)	004744 (6/11/36)	Pending	Apr 1 to Jun 1	50
Big Chico Creek	J009735 (9/22/39)	005847 (7/22/41)	Pending	Jun 1 to Oct 15	50

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Sacramento River Supply

Settlement Contract Entitlements. MTCR holds water rights to divert water from the natural flow of the Sacramento River. The MTCR surface water supply entitlement is currently addressed in a contract with Reclamation entered into in 1964, Contract No. 14-16-200-0940A (Contract No. 0940A). This contract provides for an agreement between MTCR and the United States on MTCR's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 0940A provides for a maximum total of 17,956 ac-ft/yr, of which 16,980 ac-ft is considered to be Base Supply and 976 ac-ft is CVP water (Project Supply), as shown in Table 18. The contract also provides that additional Project Supply can be purchased if surplus water is available.

The contract specifies the total quantity of water by MTCR that may be diverted each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 22. The monthly Base Supply ranges from a minimum of 760 ac-ft in October to a maximum of 4,260 ac-ft in August. CVP water (Project Supply) is available during the months of June, July, August, and September with entitlements of 272, 320, 304, and 80 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 10,650 ac-ft, and the total Project Supply is 704 ac-ft, as shown in Table 18.

TABLE 18
M&T Chico Ranch: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	10,650	704
Non-critical Months	6,330	272
Total Annual	16,980	976

Settlement Contract Historical Diversions. Referring to Figure 22, average monthly diversions are depicted for the following three periods:

- 1965 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

MTCR's total annual diversion from the Sacramento River for the time period 1965 to 1997 is shown on Figure 23.

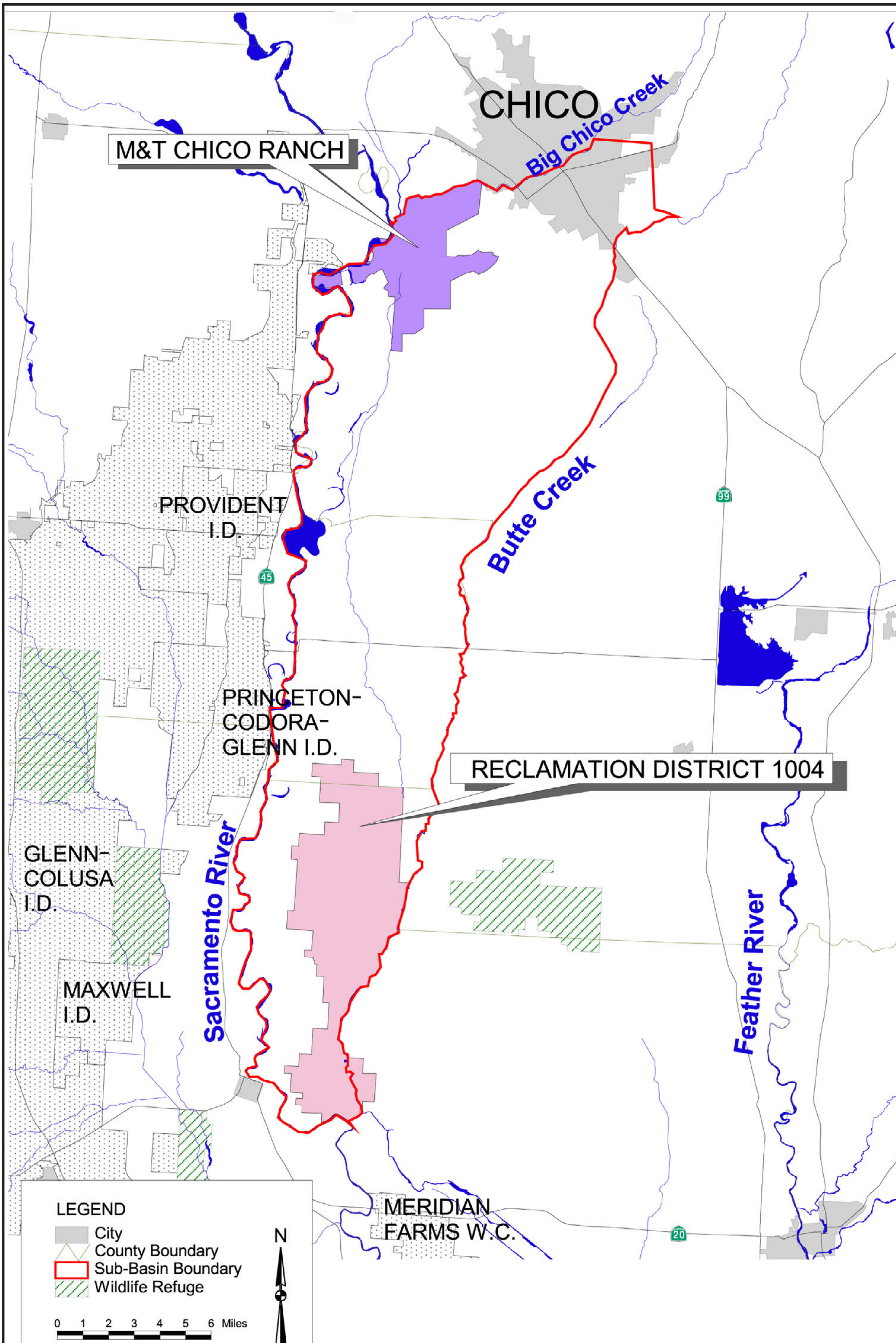

FIGURE 21
BUTTE SUB-BASIN
AND PARTICIPATING SACRAMENTO
RIVER SETTLEMENT CONTRACTORS

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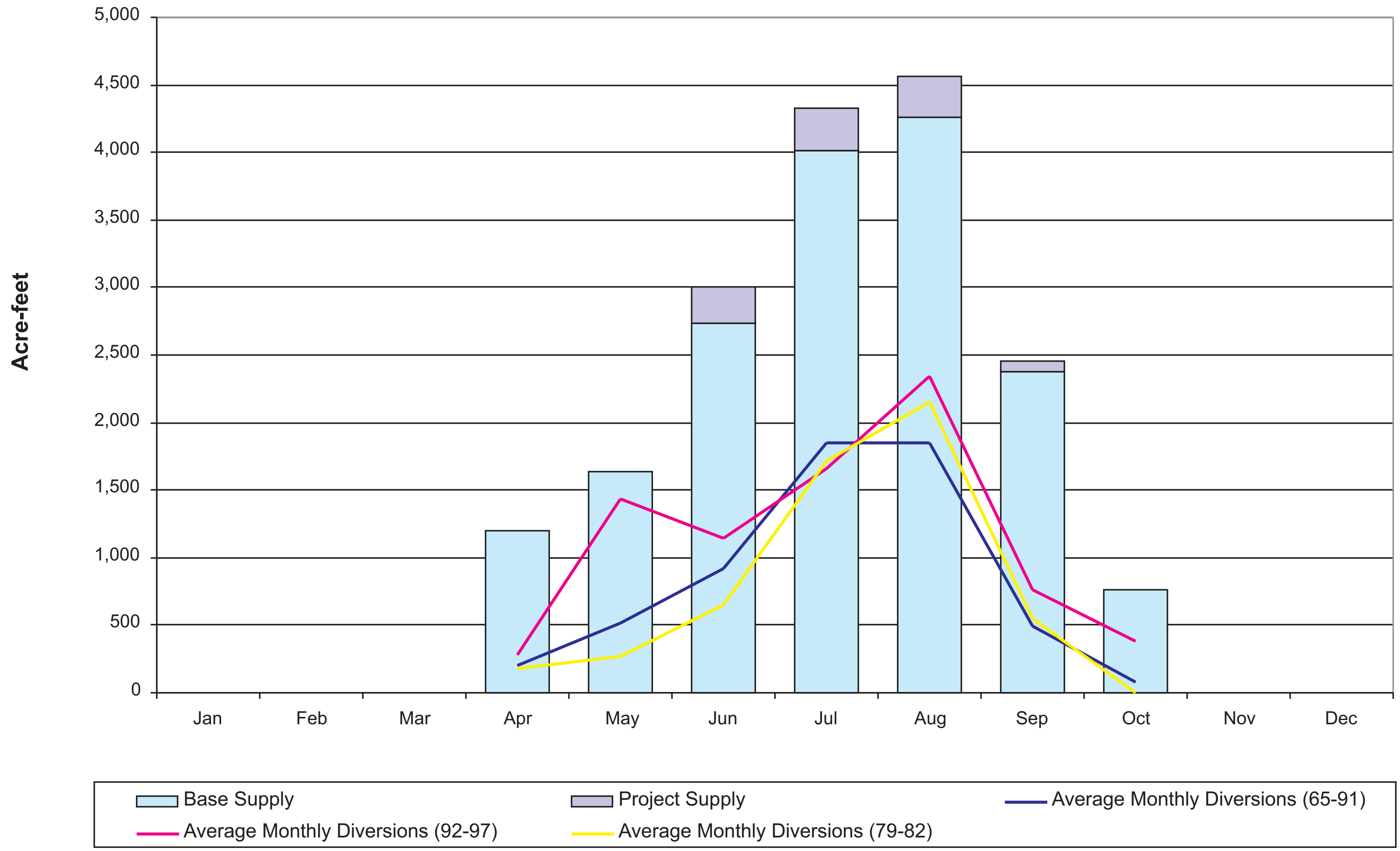

Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (65-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 22
M&T CHICO RANCH
MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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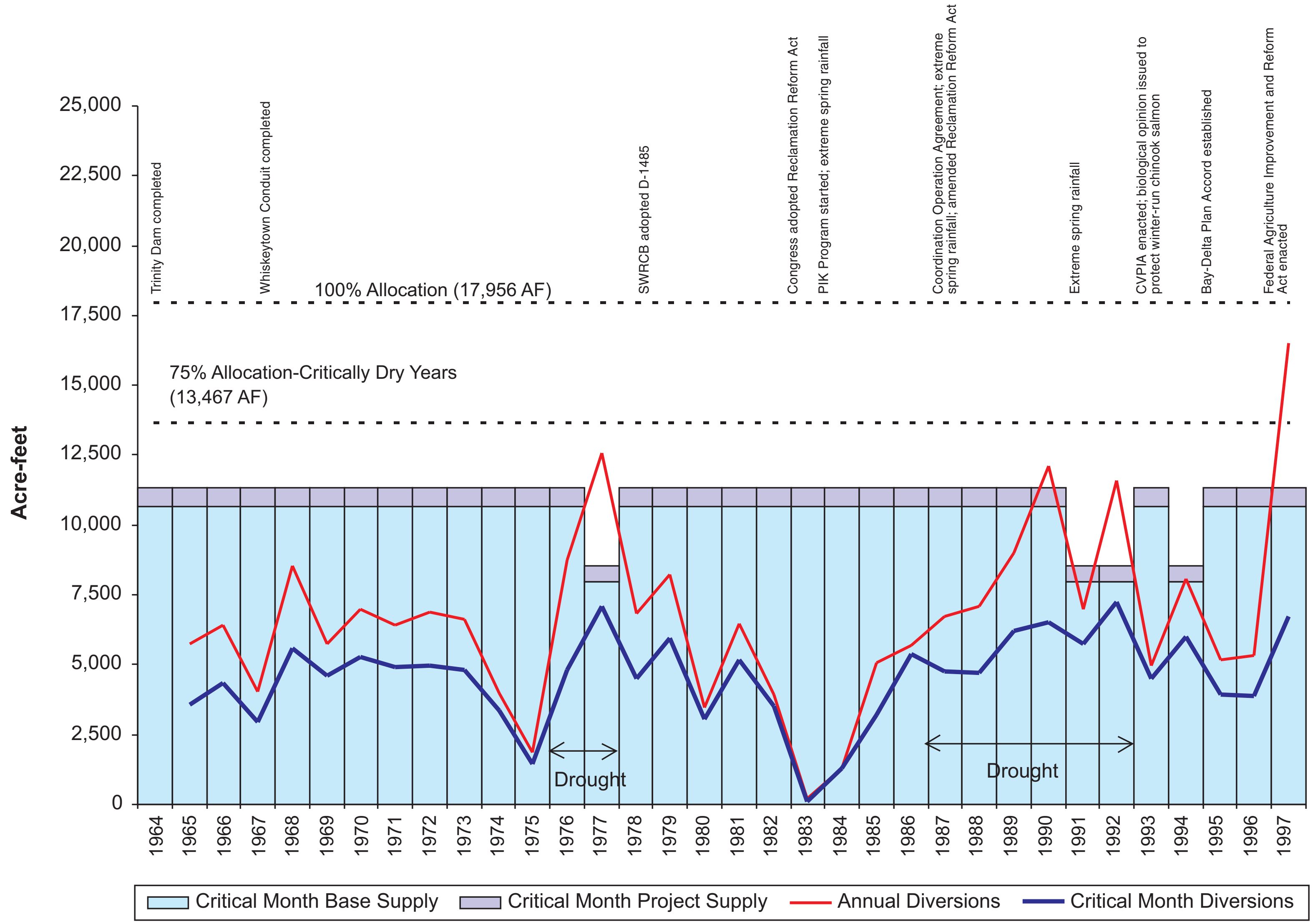
W032003010RDD_858_TM 3 (4/24/03)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 23
M&T CHICO RANCH
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Non-contract Period (November – March). Contract No. 0940A does not limit MTCR from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. In response to increasingly stringent limitations on burning, many of MTCR's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose.

Other Surface Water Sources

In addition to the Sacramento River water right/entitlement, MTCR also has water rights and permits to pump from Butte Creek and Big Chico Creek.

Tailwater and Reuse/Recirculation

Detailed information regarding tailwater use and recirculation was unavailable for MTCR.

Groundwater

Detailed information regarding groundwater use was unavailable for MTCR.

Reclamation District No. 1004

Reclamation District No. 1004 (RD 1004 or District) is located on the east side of the Sacramento River approximately 2 miles east of Colusa and directly west of the Sutter Buttes. The District is primarily in Colusa County, with the southeastern portion extending into Sutter County. Butte Creek runs along a portion of the eastern edge of RD 1004. The Sacramento River serves as the principal water source for the District. The District has water rights to the Sacramento River and several other surface water sources, as shown in Table 19. The following discussion describes these sources and their historical use.

Sacramento River Supply

Settlement Contract Entitlements. The RD 1004 surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0890A (Contract No. 0890A). This contract provides for an agreement between RD 1004 and the United States on RD 1004's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 0890A provides for a maximum total of 71,400 ac-ft/yr, of which 56,400 ac-ft is considered to be Base Supply and 15,000 ac-ft is CVP water (Project Supply), as shown in Table 20. The contract also provides that additional Project Water can be purchased if surplus water is available.

The contract specifies the total quantity of water that may be diverted by RD 1004 each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 24. The monthly Base Supply ranges from a minimum of 3,600 ac-ft in August to a maximum of 14,700 ac-ft in May. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 6,000, 8,400, and 600 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 17,900 ac-ft, and the total Project Supply is 15,000 ac-ft, as shown in Table 20.

TABLE 19
Reclamation District No. 1004: Water Rights

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A000027 (4/2/15)	000031 (11/1/15)	003165 (4/30/51)	Apr 1 to Oct 15	166 cfs 56,000 ac-ft /yr
Butte Slough, Butte Creek	A023201 (12/26/68)	016771 (10/27/75)	Pending	Apr 1 to Jun 15 (Sep 15 to Jan 31 for recreation purposes)	140 cfs

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

TABLE 20
Reclamation District No. 1004: Settlement Contract Supply

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Months	17,900	15,000
Non-critical Months	38,500	0
Total Annual	56,400	15,000

Settlement Contract Historical Diversions. RD 1004's total annual diversions from the Sacramento River have fluctuated greatly since the initiation of the entitlement contract, as shown on Figure 25. From 1964 to the mid-1970s, diversions fluctuated from a minimum of 42,100 ac-ft in 1964 to a maximum of 54,200 ac-ft in 1973. From the mid-1970s until 1990, total annual diversions continued to fluctuate from year to year; however, an overall increase in diversions occurred over this period. Due to critically dry years and the listing of the winter-run Chinook, diversions decreased in the early 1990s. However, since 1995, diversions have increased each year relative to the previous year.

Referring again to Figure 24, average monthly diversions are depicted for the following three periods:

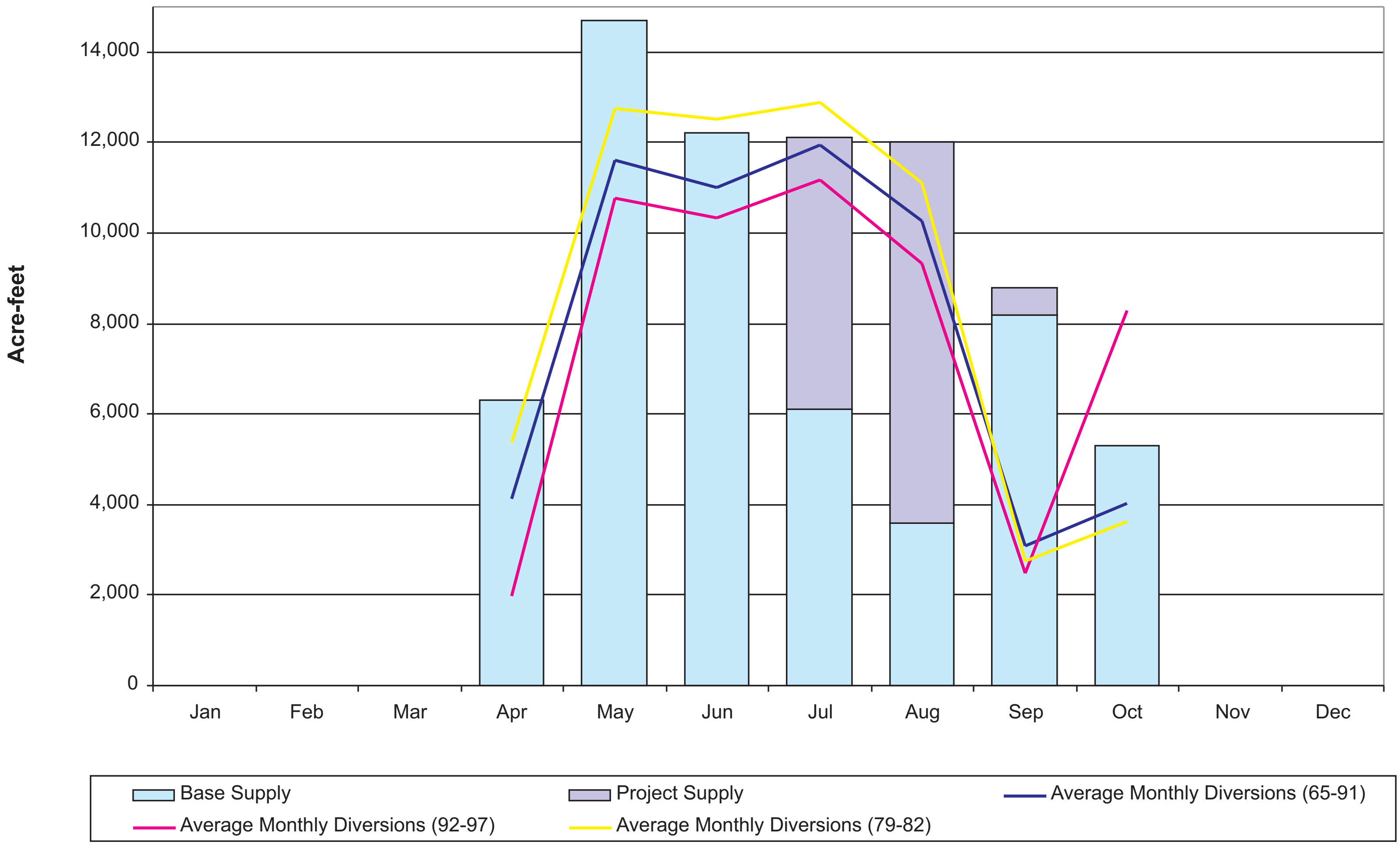
- 1965 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

As shown on Figure 24, the average diversions (1965 to 1991) made by the District are less than their contract entitlements during all irrigation months. The largest monthly diversions occur during May and July. However, the District has diverted less than 50 percent of their entitlement during the critical month of September. Even with the relatively small September diversions, RD 1004 has diverted a portion of Project Water during critical months (July, August, and September) every year since 1965, as shown on Figure 25.

Non-contract Period (November – March). In addition to the contract water, RD 1004 has filed for entitlements to pump water during the non-contract period for wetlands and rice straw decomposition. The methods and quantities of diversions in the past have varied.

Other Surface Water Sources

Butte Creek is located along the eastern edge of the RD 1004 service area, and Butte Slough is located on the southwestern edge. RD 1004 has established water rights to both Butte Creek and Butte Slough, and has permits to divert water from these sources, as shown in Table 19.



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (65-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 24
RECLAMATION DISTRICT NO. 1004
MONTHLY CONTRACT SUPPLY AND AVERAGE
MONTHLY SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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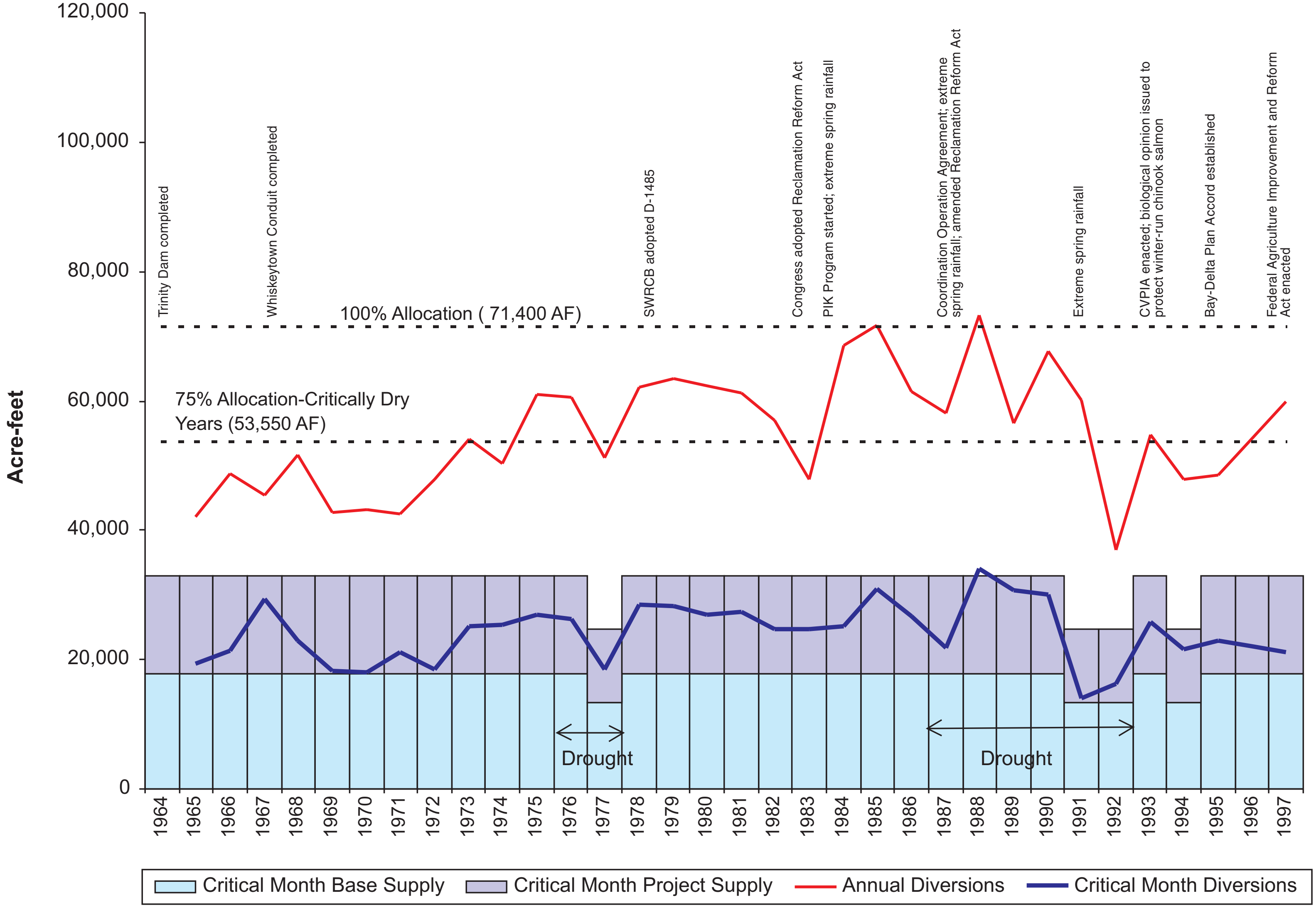
MBK

W032003010RDD_859_TM 3 (5/7/03)



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 25
RECLAMATION DISTRICT 1004
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY AND SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Sutter Sub-basin

- **Meridian Farms Water Company**
- **Tisdale Irrigation and Drainage Company**
- **Sutter Mutual Water Company**
- **Pelger Mutual Water Company**

Sutter Sub-basin

The Sutter Sub-basin, shown on Figure 26, is south of Butte Sub-basin (described above) and is located on the east side of the Sacramento Valley floor. This sub-basin is bounded on the west and south by the Sacramento River, on the north and northeast by Butte Creek and Butte Slough, and on the east by the Sutter Bypass west levee. The participating SRSCs within this sub-basin include the following:

- MFWC
- TIDC
- SMWC
- PMWC

Inflows to the sub-basin include diversions from the east bank of the Sacramento River, Butte Slough, and Sutter Bypass West Borrow Channel. Outflows occur through the RD 1500 pumping plant and pumping plants operated by RD 70 and RD 1660. Surplus water from precipitation and return flows from irrigation are rediverted in portions of the sub-basin for further irrigation of crop lands. In particular, drain flows from “rim landers” (landowners not within Company boundaries) located along the west edge of the southern portion of the sub-basin are reused by adjacent companies before being pumped out of the sub-basin.

In addition to the participating SRSCs, there are numerous short-form SRSCs, riparian diverters, groundwater users, and other irrigation companies with water rights on Butte Creek and Butte Slough. There are no State Water Project contractors in the sub-basin.

Meridian Farms Water Company

MFWC (or Company) is located on the west side of the Sacramento River east of the community of Meridian and directly southwest of the Sutter Buttes. The Company is located in Sutter County, west of the Sutter Bypass. The Sacramento River serves as the principal water source for the Company. The Company has water rights to the Sacramento River as shown in Table 21. The following discussion describes this source and its historical use, and other sources such as groundwater and drainwater reuse/recycling.

Sacramento River Supply

Settlement Contract Entitlements. The MFWC surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0838A (Contract No. 0838A). This contract provides for an agreement between MFWC and the United States on MFWC’s diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 0838A provides for a maximum total of 35,000 ac-ft/yr, of which 23,000 ac-ft is considered to be Base Supply and 12,000 ac-ft is CVP water (Project Supply), as shown in Table 22. The contract also provides that additional Project Water can be purchased if surplus water is available.

TABLE 21
Meridian Farms Water Company: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A001074B (9/10/18)	000591 (6/10/19)	004676B (8/6/57)	Mar 1 to Nov 1	138
RD 70 Main Drain, Long Lake, and Lateral Drain No. 4	A009737	005935 (3/12/42)	007160 (3/10/65)	Apr 1 to Oct 1	100

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

TABLE 22
Meridian Farms Water Company: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	6,500	12,000
Non-critical Months	16,500	0
Total Annual	23,000	12,000

The contract specifies the total quantity of water that may be diverted by MFWC each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 27. The monthly Base Supply ranges from a minimum of 1,100 ac-ft in August to a maximum of 6,200 ac-ft in May. Although the contract period is April through October, no Base or Project Supply is allocated for the month of October. However, Base and Project Supply, can be shifted between non-critical months. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 5,000, 5,000, and 2,000 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 6,500 ac-ft, and the total Project Supply is 12,000 ac-ft, as shown in Table 22.

Settlement Contract Historical Diversions. MFWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 28. During drought conditions in the late 1980s and early 1990s, annual diversions declined. From 1987 to 1997, annual diversions declined every year in comparison with the previous year except for in 1994 (critically dry year) and 1997. The reduction in diversions during this period is primarily related to changes in cropping patterns and irrigated acreage.

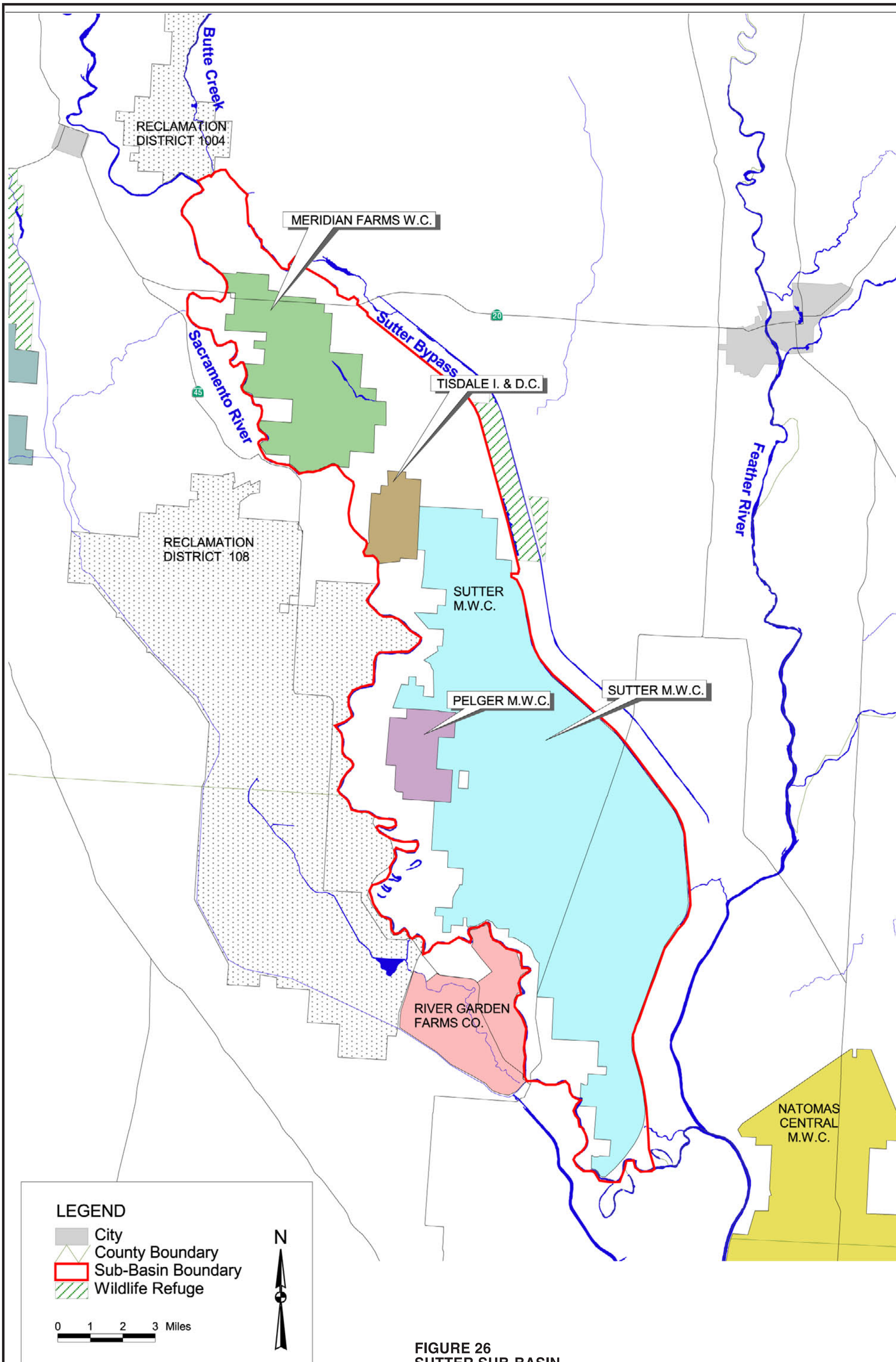
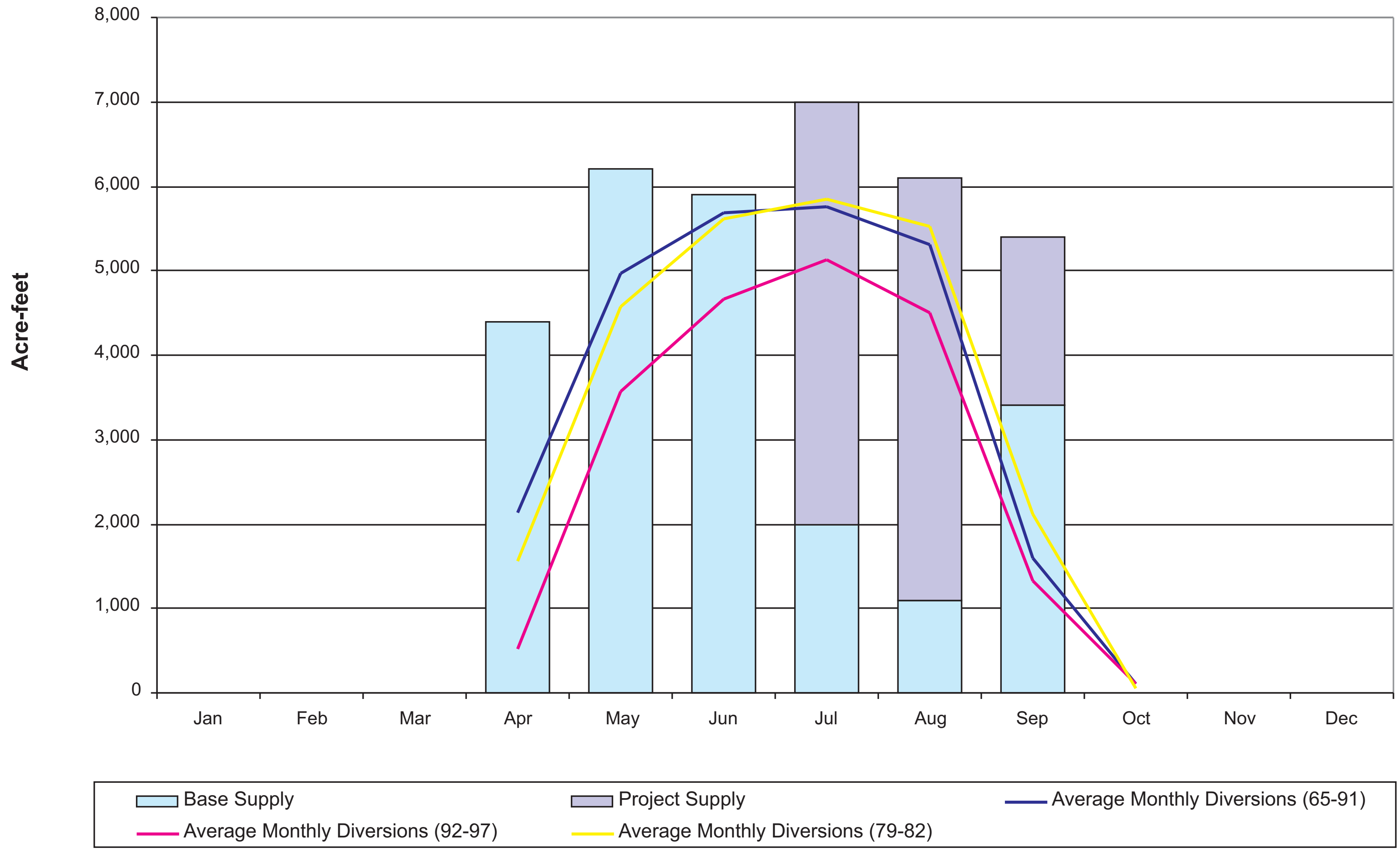


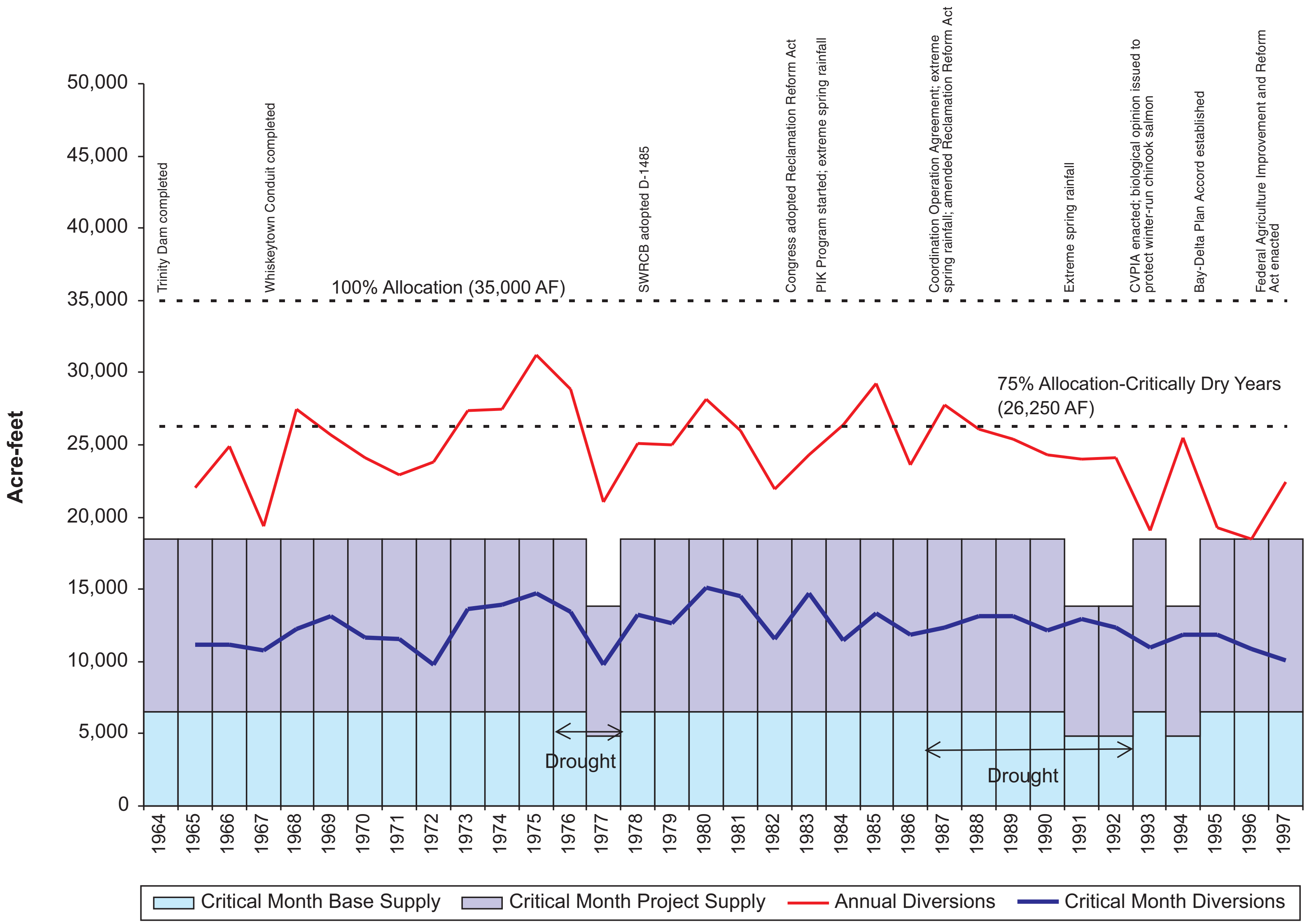
FIGURE 26
SUTTER SUB-BASIN AND PARTICIPATING SACRAMENTO RIVER SETTLEMENT CONTRACTORS



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (65-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 27
MERIDIAN FARMS WATER COMPANY
MONTHLY CONTRACT SUPPLY AND AVERAGE
MONTHLY SACRAMENTO RIVER DIVERSIONS



Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 28
MERIDIAN FARMS WATER COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS

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Figure 27 shows the historical monthly average diversions for the following three periods:

- 1965 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- From 1965 to 1991, MFWC diverted over 80 percent of their contract amounts from May to August.
- From 1965 to 1997, MFWC has diverted all of their Base Supply and approximately 69 percent of their Project Supply entitlement during critical months (also see Figure 28).
- During the critically dry years, MFWC has used nearly all of its entitlement water (Base and Project Supply) during the critical months (also see Figure 28). Critical month water use and annual diversions have remained constant whether the allocation was 100 percent or reduced to 75 percent.
- The distribution of the monthly average diversion for the three periods is similar for most months.

Non-contract Period (November – March). Contract No. 0838A does not limit MFWC from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. MFWC has historically irrigated in months prior to April (pre-irrigation), especially for grain crops, tomatoes, and orchards. Additional water is also diverted from the Sacramento River prior to April 1 to prime the Company's conveyance and distribution facilities, including Long Lake. MFWC does not divert water for rice decomposition purposes because of limited pump capacity to pump drainwater back into the Sacramento River at the southern end of the Company.

Other Surface Water Sources

The Sacramento River is the only existing surface water sources for MFWC. No additional surface water sources are available to MFWC.

Tailwater and Reuse/Recirculation

MFWC has relied heavily upon recirculation/recycling to supplement its Sacramento River entitlement. In the past, MFWC pursued an aggressive drainwater recapture program. MFWC's current policy on return flow is to use all as fully as possible (Murray, Burns, and Kienlen, 1994). Approximately 40 percent of the acreage within the Company is irrigated with recirculated water. MFWC has permits to pump 100 cfs from its own main drain.

MFWC uses eight relift pumps throughout the system in order to efficiently reuse drain-water. MFWC has the capability of pumping water from the bottom of the service area back up to the upper portion of Long Lake for reuse. Long Lake is within MFWC's boundaries and functions as a regulatory reservoir; Long Lake is an integral part of the tailwater recovery system. The capacity of Long Lake is not significant from a water supply standpoint but is essential from a regulatory and tailwater reuse standpoint.

MFWC does not actively pump tailwater from sources outside of the Company boundaries. MFWC receives minor quantities of tailwater, approximately 15,000 ac-ft, from the lands that lie north of the Company along the Sacramento River.

Groundwater

One privately owned well and three Company-owned wells are located within the Company's boundaries. MFWC operates and maintains the privately owned well, which has a capacity of approximately 9 cfs. The three Company-owned wells have a combined capacity of approximately 16 cfs. Groundwater is used to supplement surface water supplies during peak demand and drought periods (DWR, 1978).

Tisdale Irrigation and Drainage Company

Tisdale Irrigation and Drainage Company (TIDC or Company) is situated between the Sacramento River to the west and the Sutter Bypass to the east. TIDC is located in Sutter County and lies southwest of the Sutter Buttes. The Sacramento River serves as the principal water source for the Company. The Company has water rights to the Sacramento River as shown in Table 23. The following discussion describes this source and its historical use, and reliance on groundwater and drainwater reuse/recycling.

Sacramento River Supply

Settlement Contract Entitlements. TIDC holds a water right, under pre-1914 postings, to divert water from the natural flow of the Sacramento River. The TIDC surface water supply entitlement is currently addressed in a contract with Reclamation entered into in 1964, Contract No. 14 16-200-2781A (Contract No. 2781A). This contract provides for an agreement between TIDC and the United States on TIDC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 2781A provides for a maximum total of 9,900 ac-ft/yr, of which 7,900 ac-ft is considered to be Base Supply and 2,000 ac-ft is CVP water (Project Supply), as shown in Table 24. The contract also provides that additional Project Supply can be purchased if surplus water is available.

The contract specifies the total quantity of water that TIDC that may divert each month during the period April through October each year. The monthly Base Supply ranges from a minimum of 200 ac-ft in October to a maximum of 2,000 ac-ft in May. CVP water (Project Supply) is available during the months of July and August with entitlements of 800 and 1,200 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 2,600 ac-ft, and the total Project Supply is 2,000 ac-ft, as shown in Table 24.

TABLE 23
Tisdale Irrigation and Drainage Company: Water Rights

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River	A000742 (7/26/17)	000382 (1/3/18)	001211 (6/24/32)	Mar 15 to Oct 15	29.25
Sacramento River	A016985 (4/3/56)	013868 (2/15/63)	009335 (4/23/70)	May 1 to Jun 15	15

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:
- A – Appropriative right
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

TABLE 24
Tisdale Irrigation and Drainage Company: Settlement Contract Supply

	Base Supply (ac-ft)	**Project Supply (ac-ft)**
Critical Months	2,600	2,000
Non-critical Months	5,300	0
Total Annual	7,900	2,000

Settlement Contract Historical Diversions. Monthly and annual diversion data were unavailable.

Non-contract Period (November – March). Contract No. 2781A does not limit TIDC from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. In response to increasingly stringent limitations on burning, many of the Company's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose.

Other Surface Water Sources

Excluding Sacramento River water rights/contract entitlements, TIDC does not hold water rights to any other surface water sources, as shown in Table 23.

Tailwater and Reuse/Recirculation

Detailed information regarding tailwater use and recirculation was unavailable for TIDC.

Groundwater

Detailed information regarding groundwater use was unavailable for TIDC.

Sutter Mutual Water Company

Sutter Mutual Water Company (SMWC or Company) is located approximately 22 miles northwest of Sacramento and is bordered by three levee systems totaling 55 miles. Sutter

Bypass is located along the eastern and southern edges of the Company, and the Sacramento River is located to the west of the Company. SMWC encompasses approximately 50,000 acres and serves 150 landowners. The Sacramento River serves as the principal water source for the Company. The Company has water rights to the Sacramento River as shown in Table 25. The following discussion describes this source and its historical use.

TABLE 25
Sutter Mutual Water Company: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A000581 (2/1/17)	000287 (5/8/17)	002817 (3/6/46)	Mar 1 to Oct 31	45
Sacramento River	A000878 (1/3/18)	000419 (4/4/18)	002818 (3/6/46)	Mar 1 Oct 31	116.72
Sacramento River	A000879 (1/3/18)	000420 (4/4/18)	002819 (3/6/46)	Mar 1 to Oct 31	25.25
Sacramento River	A000880A (1/3/18)	000421 (4/4/18)	002820A (3/6/46)	Mar 1 to Oct 31	404.82
Sacramento River	A001160 (1/24/19)	000569 (5/9/19)	002822 (3/6/46)	Mar 1 to Oct 31	40.5
Sacramento River	A001758 (4/9/20)	001103 (7/26/22)	000552 (11/5/26)	Apr 1 to Oct 31	1.5
Sacramento River	A001763 (4/9/20)	001108 (7/31/22)	001110 (9/15/31)	Apr 15 to Sep 15	3
Sacramento River	A001769 (4/9/20)	001117 (8/9/22)	000547 (6/22/26)	Apr 1 to Oct 31	7.67
Sacramento River	A001772 (4/9/20)	001120 (8/10/22)	000657 (1/31/28)	May 1 to Oct 1	0.31
Sacramento River	A003195 (12/27/22)	002169 (7/25/25)	000882 (11/30/29)	Apr1 to Oct 31	1.38
Sacramento River	A007886 (3/29/34)	004354 (7/3/34)	002240 (6/19/41)	Mar 1 to Oct 1	7.32
Sacramento River	A009760 (11/3/39)	005510 (4/1/40)	002821 (3/6/46)	Jan 1 to Dec 31	250
Sacramento River	A010658 (6/16/43)	006189 (10/14/43)	002823 (3/6/46)	Mar 1 to Oct 31	7.52
Sacramento River, West Borrow Pit Sutter Bypass	A011953 (6/23/47)	007194 (10/25/48)	004562 (2/25/57)	Apr 1 to Oct 1	7.5
Sacramento River	A012470A (4/13/48)	0072687A (12/17/49)	008547A (8/16/95)	Apr 1 to Nov 1	35.9
Sacramento River	A016677 (10/20/55)	013867 (2/15/63)	008220 (9/7/67)	Primary: Apr 1 to Jun 15 Secondary: Sep 1 to Oct 31	7.5

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).
[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.
[c]The type of water right is indicated by the first letter in the Application reference, as follows:
A – Appropriative right
J – Adjudication
S – Statement of Water Diversion and Use
Z – Section 12 filings
[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.
[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Sacramento River Supply

Settlement Contract Entitlements. SMWC, formed in 1919, holds a water right to divert water from the natural flow of the Sacramento River. The SMWC surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-0815A (Contract No. 0815A). This contract provides for an agreement between SMWC and the United States on SMWC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 0815A provides for a maximum total of 267,900 ac-ft/yr, of which 172,900 ac-ft is considered to be Base Supply and 95,000 ac-ft is CVP water (Project Supply), as shown in Table 26. The contract also provides that additional Project Water can be purchased if surplus water is available.

The contract specifies the total quantity of water that may be diverted by SMWC each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 29. The monthly Base Supply ranges from a minimum of 5,200 ac-ft in August to a maximum of 52,800 ac-ft in May. CVP water (Project Supply) is available during the months of June, July, August, and September with entitlements of 15,000, 35,000, and 10,000 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 44,000 ac-ft, and the total Project Supply is 80,000 ac-ft, as shown in Table 26.

TABLE 26
Sutter Mutual Water Company: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	44,000	80,000
Non-critical Months	128,900	15,000
Total Annual	172,900	95,000

Note:

The SMWC proposed renewal contract is for 226,000 ac-ft (169,500 ac-ft of Base Supply and 56,500 ac-ft of Project Water).

Settlement Contract Historical Diversions. SMWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract. The Company's total annual diversions from the Sacramento River can be characterized into two time periods, 1964 to 1982 and 1983 to 1997 (shown on Figure 30). From 1964 to 1982, annual diversions fluctuated between a minimum of 189,000 ac-ft in 1977 (critically dry year) to a maximum of 258,700 ac-ft in 1975. From 1983 to 1997, there has been a gradual reduction in annual diversions. During this period, annual diversions fluctuated between a minimum of 150,300 ac-ft in 1983 to a maximum of 209,700 ac-ft in 1984. Several factors contributed to the change in diversions between these two periods, including changes in cropping patterns, rice varieties, cultural practices, and farm machinery technology. Cropping patterns within SMWC, specifically a reduction in rice acreage due to government programs, occurred between these periods. From 1964 to 1982, an average of 20,900 acres of rice was irrigated in comparison to 16,200 acres between 1983 to 1997. The variety of rice planted during these periods also changed from a taller stalked, slow maturing variety to a short stalked, fast maturing variety. In addition, improvement in farm machinery technology and the development of the laser land leveler allowed for greater precision in leveling rice fields. The development of this technology reduced the quantity of water required to obtain uniform minimum water depths on the rice fields.

Figure 29 shows the historical monthly average diversions for the following three periods:

- 1964 to 1982: Long-term period of record from beginning of recording period to changes in crop pattern, rice varieties, cultural practices, and farm machinery technology.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1983 to 1997: The period following the changes in crop pattern, rice varieties, cultural practices, and farm machinery technology.

The following observations are noted:

- A reduction in diversions occurred during all months was observed during the recent period (1984 to 1997) in comparison to the previous period (1964 to 1982). The reduction in diversions is attributed to changes in crop pattern, rice varieties, cultural practices, and farm machinery technology.
- From 1964 to 1982, SMWC diverted over 90 percent of their contract amounts from May through August.
- Every year during critical months, from 1964 to 1997, SMWC has diverted all of their Base Supply and a majority of their Project Supply.

The distribution of the monthly average diversions for the three periods is similar for most months. However, during the recent period (1983 to 1997), diversions were reduced relative to the other periods during the months of April, May, and June.

- On average, monthly diversions by SMWC from 1964 to 1982 peaked during June. During the recent period (1983 to 1997), monthly diversions peak in July.

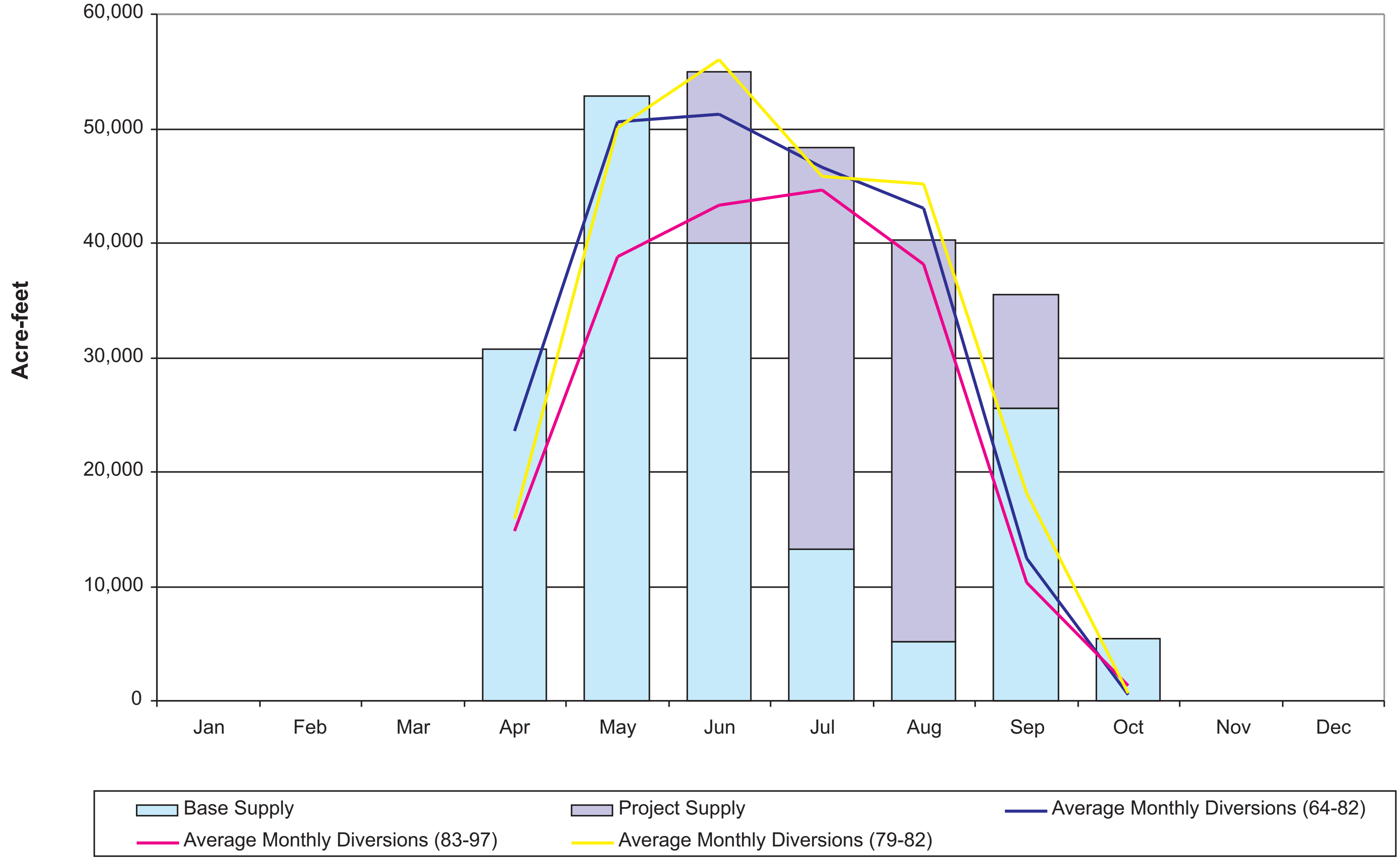
Non-contract Period (November – March). In addition to the contract water, SMWC has entitlements to pump water during the non-contract period for other uses including rice straw decomposition given appropriative rights during the non-contract months. These entitlements allow for a maximum diversion of 250 cfs. Approximately 3,000 to 4,000 acres have been flooded in the past for rice straw decomposition. Due to flood control and drainage restrictions, the maximum acreage that may be flooded at this time is approximately 5,000 acres.

Other Surface Water Sources

Excluding Sacramento River water rights/contract entitlements, SMWC does not hold water rights to any other surface water sources.

Tailwater and Reuse/Recirculation

SMWC presently uses approximately 10,000 to 15,000 ac-ft/yr of drainage water from sources both inside and outside of the Company. Private landowners pump an additional 5,000 to 15,000 ac-ft from these sources. The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These rimlanders are not within Company boundaries, but contribute drainwater that may be reused by Company farmers. SMWC uses a portion of the rimlanders' tailwater that they may not otherwise use within their systems. Company operations are coordinated with RD 1500 and PMWC. RD 1500 manages drainage in the service area, while SMWC delivers water to the majority of water users in the basin area.



Notes:
1. Critically dry year 1977 is omitted from Average Monthly Diversions (64-82).
2. Critically dry years 1991, 1992 and 1994 are omitted from Average Monthly Diversions (83-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 29
SUTTER MUTUAL WATER COMPANY MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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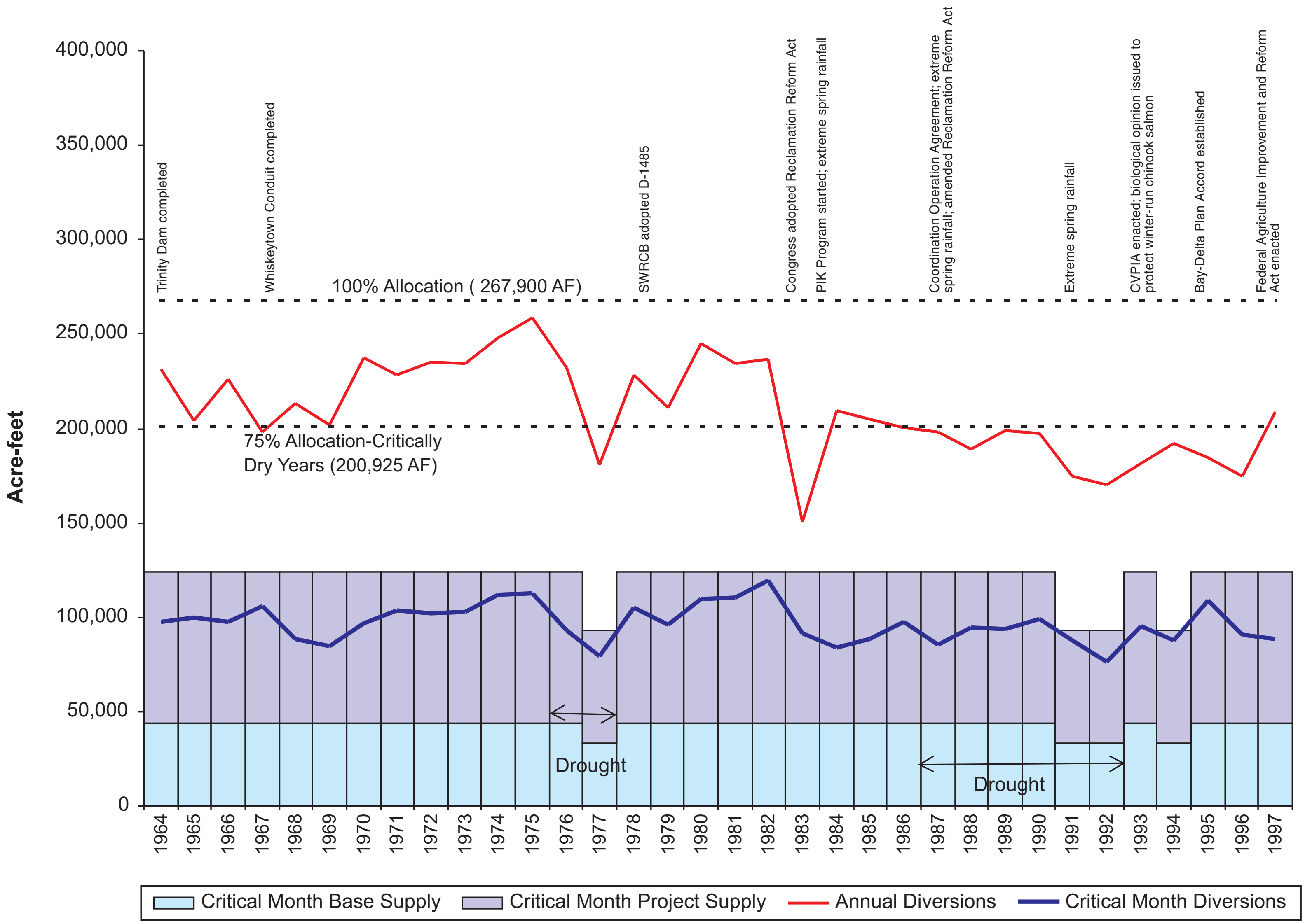

Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 30
SUTTER MUTUAL WATER COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS

TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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SMWC currently operates five booster pumps and one internal recirculation system (ML 10, which has three booster pumps) with a total combined capacity of 190 cfs. These facilities are used for drainwater reuse and are located in the central and northeast portions of the Company. SMWC is interlaced with drainage ditches that carry water towards the main drain and eventually out of the service area at the southern end of the Company. Drainage ditches in the eastern portion of the Company intercept naturally occurring saline groundwater, called "connate water." This salt-laden groundwater seeps into the drain ditches and causes an increase in salinity in the drains. Irrigation practices using Sacramento River water and drainage systems have allowed the Company and other districts/landowners to maintain suitable crop yields and keep the connate water below the crop root zones. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability.

Groundwater

A mound of artesian connate water has been identified within the boundaries of SMWC. This saline groundwater tends to be most prevalent toward the eastern portion of the Company associated with artesian pressure through the Sutter Basin Fault. Salinity concentrations tend to increase with depth (U.S. Department of Agriculture/Natural Resources Conservation Service, 1996).

SMWC has relatively high water tables caused by subsurface inflows from the river, subsurface interbasin flow from surrounding areas, and rising connate water under artesian pressure. DWR has identified approximately 38 wells within the Company boundaries (DWR, Central District). Most of these wells have been abandoned due to high salinity levels as discussed above (DWR, 1978).

Pelger Mutual Water Company

Pelger Mutual Water Company (PMWC or Company) is located northwest of Sacramento. PMWC is bordered on three sides (northern, eastern, and southern boundaries) by SMWC. The Sacramento River, located west of the Company, serves as the principal water source for the Company. The Company has water rights to the Sacramento River as shown in Table 27. The following discussion describes this sources and its historical use.

TABLE 27
Pelger Mutual Water Company: Water Rights

Water Rights[a,b]					
Source	Application[c] (Priority Date)[d]	Permit (Date)	License (Date)	Diversion Season	Maximum Quantity[e] (cfs)
Sacramento River	A001765A (4/9/20)	001111 (8/2/22)	000613A (3/13/72)	Apr 1 to Oct 31	4
Sacramento River	A012470 (4/13/48)	007268 (2/17/49)	008547 (3/18/68)	Apr 1 to Nov 1	89.4
Sacramento River	A012470B (4/13/48)	007268B (2/17/49)	008547B (8/16/95)	Apr 1 to Nov 1	53.5
Sacramento River	A030410 (11/2/94)	020933 (9/16/97)	Pending	Sep 15 to Mar 31	60

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

- A – Appropriative right
- J – Adjudication
- S – Statement of Water Diversion and Use
- Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Sacramento River Supply

Settlement Contract Entitlements. PMWC holds water rights to divert water from the natural flow of the Sacramento River. The PMWC surface water supply entitlement is currently addressed in a contract entered into with Reclamation in 1964, Contract No. 14-06-200-2073A (Contract No. 2073A). This contract provides for an agreement between PMWC and the United States on PMWC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

Contract No. 2073A provides for a maximum total of 8,860 ac-ft/yr, of which 7,110 ac-ft is considered to be Base Supply and 1,750 ac-ft is CVP water (Project Supply), as shown in Table 28. The contract also provides that additional Project Water can be purchased if surplus water is available.

TABLE 28
Pelger Mutual Water Company Settlement: Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	920	1,750
Non-critical Months	6,190	0
Total Annual	7,110	1,750

The contract specifies the total quantity of water that may be diverted by PMWC each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 31. The monthly Base Supply ranges from a minimum of 40 ac-ft in August to a maximum of 3,250 ac-ft in May. CVP water (Project Supply) is available during the months of July, August, and September with entitlements of 700, 950, and 100 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 920 ac-ft, and the total Project Supply is 1,750 ac-ft, as shown in Table 28.

Settlement Contract Historical Diversions. PMWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 32. From 1964 to 1970, diversions decreased from one year to the next. Total annual diversions in 1964 were 9,200 ac-ft in comparison to approximately 1,200 ac-ft in both 1969 and 1970. Between 1970 and 1983, the diversions went through two cycles where diversions generally increased for several years, then decreased for several years. Since 1983, diversions have continued to fluctuate; however, the overall trend has been an increase in annual diversions.

The fluctuations in Sacramento River diversions are attributed to several factors, including changes in cropping patterns, acreage farmed, and increased usage of alternative water sources (groundwater and drainwater) during drought years. The cropping pattern within PMWC is diverse, and typically the acreage of a specific crop varies from year to year. For example, a maximum of 1,565 acres of rice was planted in 1980 in comparison to zero acres in 1977[3]. Such variations in cropping patterns correspond to fluctuations in the total water requirements for the Company and resulting Sacramento River diversions. The total irrigated acreage has also fluctuated during the period of 1977 to 1997 from a minimum of 2,675 acres in 1995 to maximum of 3,985 in 1981.

Figure 31 shows the historical monthly average diversions for the following three periods:

- 1964 to 1991: Long-term period of record from beginning of recording period to just prior to the listing of winter-run Chinook salmon as an endangered species in 1992.
- 1979 to 1982: A period of near normal hydrologic and water use conditions.
- 1992 to 1997: The period following the listing of the winter-run Chinook salmon to present.

The following observations are noted:

- Although the annual diversions varied greatly from 1964 to 1997, the monthly distribution for different time periods were relatively similar.
- Every year since 1991, PMWC has diverted some portion of their contract entitlement during critical months.
- For all three periods, the maximum diversions occurred during the month of May.

[3] Surface water diversions form PMWC were zero in 1977, a critically dry year with drought conditions throughout California.

Non-contract Period (November – March). In addition to the contract water, PMWC has entitlements to pump water during the non-irrigation season for wetlands and rice straw decomposition. In response to increasingly stringent limitations on burning, some of the Company's rice growing landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. Approximately 1,000 acres have been flooded in the past, a trend that is expected to continue or increase in the future. PMWC also has an agreement with U.S. Fish and Wildlife Service to provide winter water for waterfowl.

Other Surface Water Sources

Excluding Sacramento River water rights/contract entitlements, PMWC does not hold water rights to any other surface water sources.

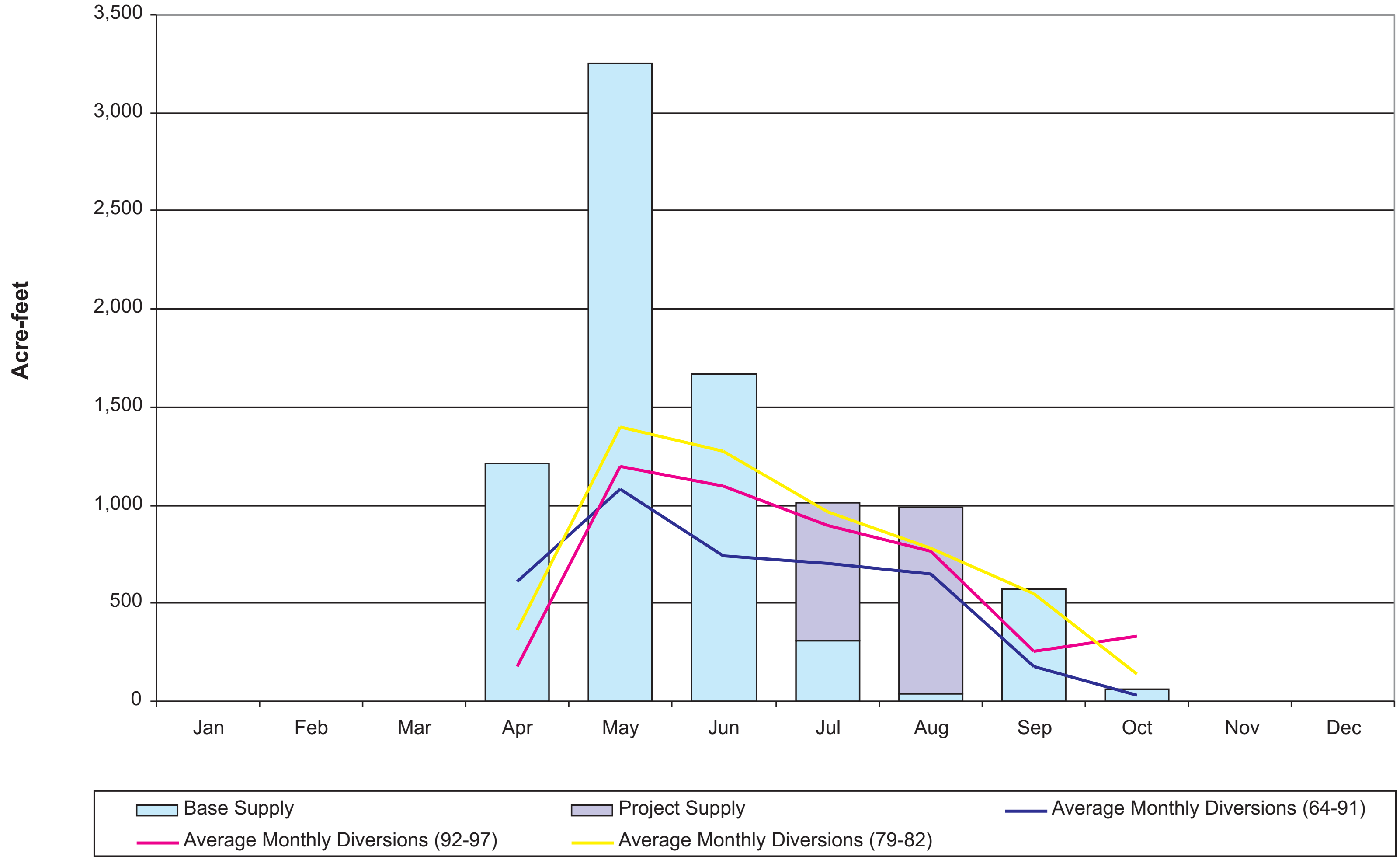
Tailwater and Reuse/Recirculation

The western edge of the Company abuts a number of independent farmers with individual contracts with Reclamation. These rimlanders are not within PMWC boundaries, but contribute drainwater that may be reused by Company farmers. In recent years, PMWC has relied heavily upon tailwater from both inside and outside of the Company to supplement its Sacramento River entitlement. Since the mid-1970s, the majority of irrigation water requirements have been meet by drainwater use (approximately 29 to 78 percent depending on year). On average, drainwater use accounted for 55 percent of the irrigation water requirements from 1977 to 1997. In comparison, diversions from the Sacramento River accounted for 42 percent of the irrigation requirements during this period.

Groundwater

PMWC is surrounded on three sides by SMWC and coordinates water deliveries with SMWC and drain usage with RD 1500. While portions of neighboring SMWC have low-quality groundwater as a result of connate water upwelling (Laugenour and Meikle, 1997), PMWC has usable groundwater resources within its boundaries and uses groundwater as a normal part of its resource mix.

Since 1990, approximately 0 to 28 percent of the annual water requirements for the Company have been met by groundwater sources. Approximately three privately owned wells are located within the Company's boundaries. These wells are used in conjunction with the river pumps and drainwater recycling pump to meet irrigation needs during drought periods. The total capacity of the three privately owned wells is approximately 26 cfs. PMWC does not own/operate any wells.



Notes:

1. Critically dry years 1977 and 1991 are omitted from Average Monthly Diversions (64-91).
2. Critically dry years 1992 and 1994 are omitted from Average Monthly Diversions (92-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 31
PELGER MUTUAL WATER COMPANY
MONTHLY CONTRACT SUPPLY AND AVERAGE
MONTHLY SACRAMENTO RIVER DIVERSIONS

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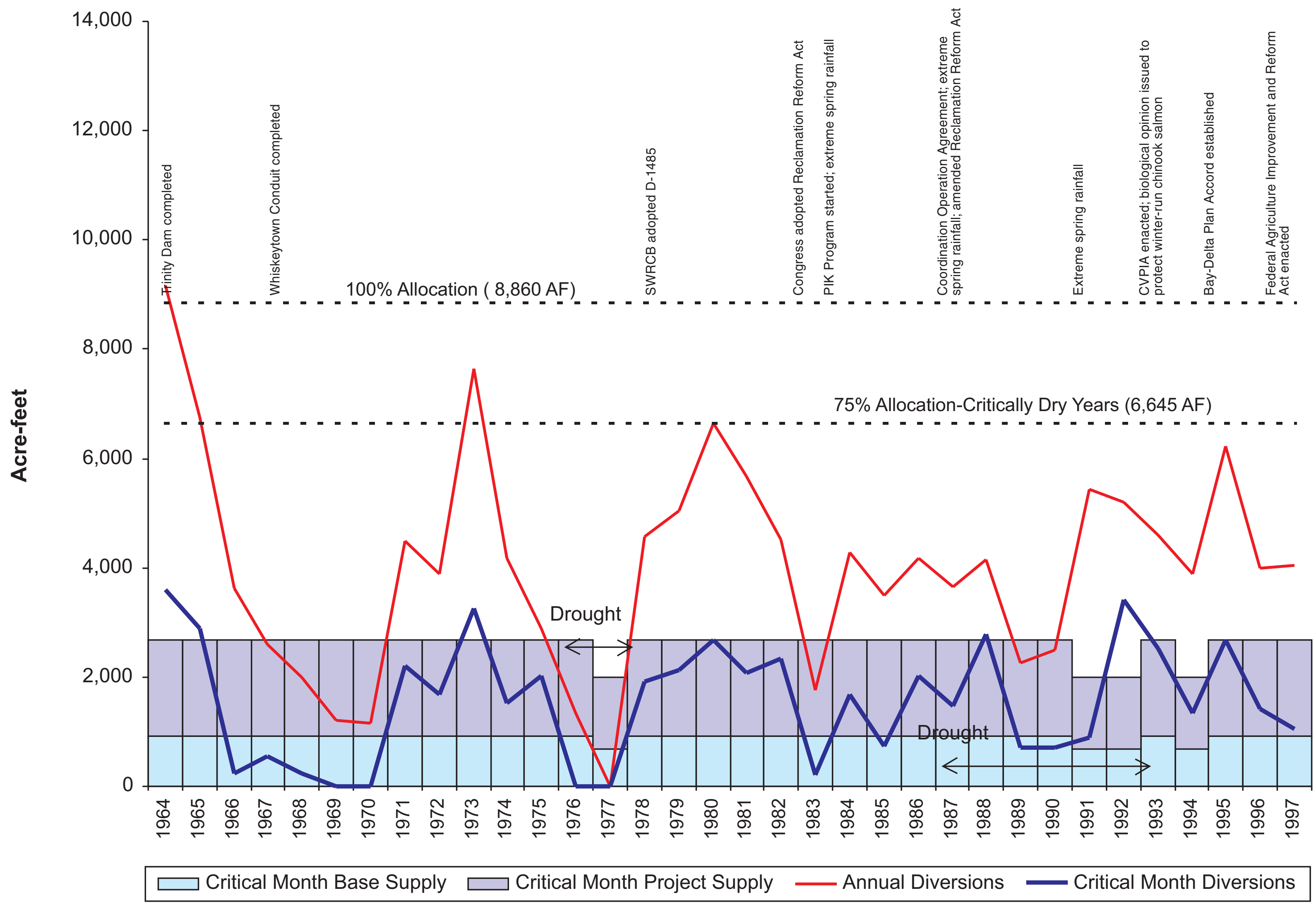

Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 32
PELGER MUTUAL WATER COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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American Sub-basin

- Natomas Central Mutual Water Company

American Sub-basin

The American Sub-basin, shown on Figure 33, is bounded on the west by the Sacramento and Feather Rivers, on the north by the Bear River, and on the south and southeast by the American River. The eastern boundary is defined as the edge of the Valley floor. Like the Redding Sub-basin, this sub-basin is unique in that a large proportion of municipal users are present throughout the area, including parts of the City and County of Sacramento and urban centers in Placer County, such as the City of Roseville. Most of the area is served with surface water or a combination of surface water and groundwater. NCMWC is the participating SRSC within this sub-basin.

Other Sacramento River Settlement Contracts include Pleasant Grove-Verona Mutual Water Company and numerous short-form SRSCs. Other major water users in the sub-basin include various CVP contractors associated with the American River; South Sutter Water District; Nevada Irrigation District; riparian diverters associated with the Sacramento, American, Feather, and Bear rivers; and groundwater users. There are no State Water Project contractors in the sub-basin.

Inflows to the sub-basin include diversions from the Sacramento, Feather, Bear, and American rivers, and imported water from canals and tributaries originating in the foothills to the east. Outflows occur through the RD 1000 pumping plants (four) to the Sacramento River, and RD 1001 plant to Natomas Cross Canal. Surplus precipitation and return flows from irrigators is rediverted in portions of the sub-basin for further irrigation of crop lands.

Natomas Central Mutual Water Company

NCMWC (or Company) is located on the east side of the Sacramento River in southern Sutter and northwestern Sacramento Counties. The Natomas Cross Canal is located along the northern border of the Company. The Sacramento River serves as the principal water source for the Company. The Company has water rights to the Sacramento River and several other surface water sources as shown in Table 29. The following discussion describes these sources and their historical use.

Sacramento River Supply

Settlement Contract Entitlements. The NCMWC surface water supply entitlement is currently addressed in a contract with Reclamation entered into in 1964, Contract No. 14-16-200-0885A (Contract No. 0885A). This contract provides for an agreement between NCMWC and the United States on NCMWC's diversion of water from the Sacramento River during the period April 1 through October 31 of each year. This contract will remain in effect until March 31, 2006.

TABLE 29
Natomas Central Mutual Water Company: Water Rights

Water Rights[a,b]					
Source	**Application[c] (Priority Date)[d]**	**Permit (Date)**	**License (Date)**	**Diversion Season**	**Maximum Quantity[e] (cfs)**
Sacramento River, Natomas Cross Canal	A000534 (12/13/16)	000247 (3/16/17)	001050 (5/28/31)	Apr 1 to Oct 1	42.18 cfs
Sacramento River, Natomas Cross Canal	A001056 (8/22/18)	000511 (11/27/18)	002814 (2/18/46)	Mar 15 to Oct 15	38 cfs
Sacramento River, Natomas Cross Canal	A001203 (3/5/19)	000580 (6/10/19)	003109 (9/28/50)	May 1 to Oct 31	160 cfs
Sacramento River, Natomas Cross Canal	A001413 (8/27/19)	001129 (8/16/22)	003110 (9/28/50)	May 1 to Oct 1	120 cfs
Sacramento River, Natomas Cross Canal	A015572 (10/8/53)	015015 (8/26/66)	009794 (5/26/71)	Apr 1 to Jun 30	131 cfs
RD 1000 East Drain, RD 1000 Main Drain, RD 1000 West Drain	A022309 (10/8/65)	015314 (2/21/67)	009989 (1/26/73)	Primary: Mar 1 to Jun 30 Secondary: Sep 1 to Oct 31	14 cfs
Sacramento River, Natomas Cross Canal, RD 1000 East Drain, RD 1000 Main Drain, RD 1000 West Drain	A025727 (5/1/78)	019400 (2/7/85)	Pending	Oct 1 to Apr 1	168 cfs 10,000 ac-ft/yr

[a]Source – SWRCB; Division of Water Rights (www.waterrights.ca.gov).

[b]N/A – Priority Dates and License/Permit Information are not applicable for some types of water rights.

[c]The type of water right is indicated by the first letter in the Application reference, as follows:

A – Appropriative right

J – Adjudication

S – Statement of Water Diversion and Use

Z – Section 12 filings

[d]The Priority Date is the basis for defining the seniority of the water right, and is based on the Application date.

[e]The amount of water diverted under the water right will be in accordance with the principles of reasonable and beneficial use.

Contract No. 0885A provides for a maximum total of 120,200 ac-ft/yr, of which 98,200 ac-ft is considered to be Base Supply and 22,000 ac-ft is CVP water (Project Supply), as shown in Table 30. The contract also provides that additional Project Supply can be purchased if surplus water is available.

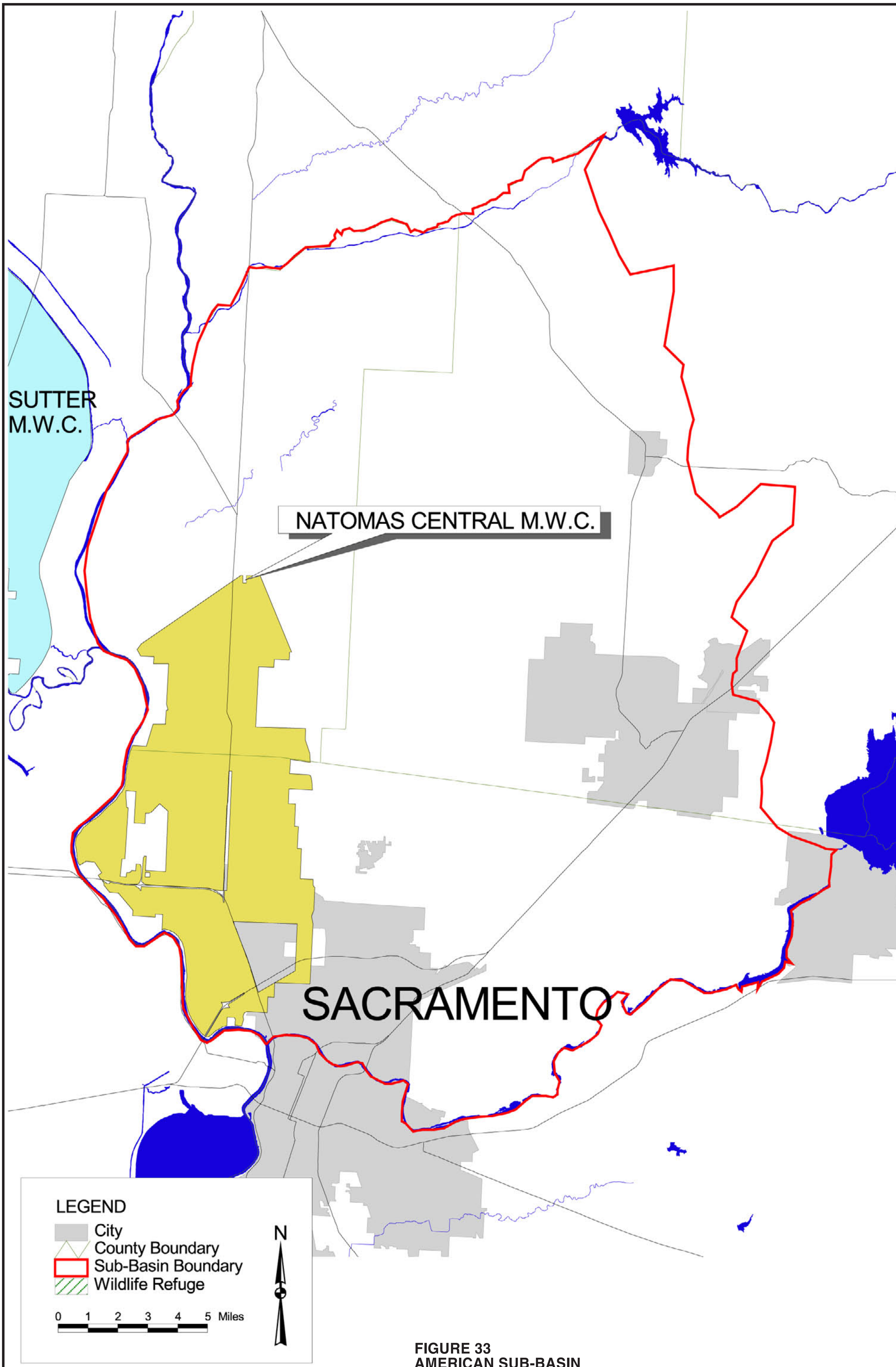

FIGURE 33
AMERICAN SUB-BASIN
AND PARTICIPATING SACRAMENTO
RIVER SETTLEMENT CONTRACTORS

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MBK

W062004006RDD_52_TM 3 (9/29/04)

TABLE 30
Natomas Central Mutual Water Company: Settlement Contract Supply

	Base Supply (ac-ft)	Project Supply (ac-ft)
Critical Months	31,500	22,000
Non-critical Months	66,700	0
Total Annual	98,200	22,000

The contract specifies the total quantity of water by NCMWC that may be diverted each month during the period April through October each year. The monthly distribution of the Base and Project Supply is shown on Figure 34. The monthly Base Supply ranges from a minimum of 2,000 ac-ft in October to a maximum of 27,700 ac-ft in May. CVP water (Project Supply) is available during the months of July and August with entitlements of 7,200 and 14,800 ac-ft, respectively. The contract identifies July, August, and September as the critical months. For the critical months, the total Base Supply is 31,500 ac-ft, and the total Project Supply is 22,000 ac-ft, as shown in Table 30.

Settlement Contract Historical Diversions. NCMWC's total annual diversions from the Sacramento River have fluctuated since the initiation of the entitlement contract, as shown on Figure 35. From 1964 to 1971, annual diversions were relatively constant (the exception being 1968). The average annual diversion during this period was approximately 75 percent of the total contract allocation. Between 1972 and 1984, annual diversions increased relative to the earlier time period. With the exception of 1983, annual diversions during this period were consistently above 85 percent of the total contract allocations. Furthermore, NCMWC purchased additional Project Supply above the 22,000 ac-ft in the years 1974 to 1976, 1979 to 1982, and 1984. Beginning in the mid-1980s, annual diversions dropped to below the 75 percent level and have remained at this level through 1997. In 1986, NCMWC implemented a water recycling program, thus reducing their diversions from the Sacramento River.

Referring again to Figure 34, average monthly diversions are depicted for the following three periods:

- 1975 to 1981: Period of full acreage farmed and prior to closed system operations.
- 1979 to 1982: Period of near normal hydrologic and water use conditions.
- 1986 to 1997: Period following the closed system operations.

The following observations are noted:

- During the recent period, diversions in April, May, and June show the greatest decline relative to the other two period averages. The primary two factors that contributed to these reductions are increased recirculation of drainwater and changes in cropping patterns. During the later time period (1986 to 1997), the crops shifted from wheat, barley, oats, and other "early" irrigated crops to sugar beets and other "late" irrigated crops.
- During all three periods, diversions were greatest during July; however, the largest contract allocation is in the month of May.

- Every year from 1964 to 1997 NCMWC has diverted some portion of their Project Supply during the critical months (also see Figure 35).
- During critically dry years, NCMWC has used over 95 percent of its entitlement water (Base and Project Supply) during the critical months (also see Figure 35).
- Between 1964 and 1997, NCMWC has purchased additional Project Supply in 9 of the 34 years (also see Figure 35).
- Average monthly diversions in October have increased under recent conditions in comparison to conditions prior to 1992. This is a result of flooding fields to decompose rice stubble.
- Increased use of the RD 1000 drainage system as a conduit to a larger number of acres has increased the water use efficiency of NCMWC.
- "Closing" the basin (restricting return flows to the river) has allowed NCMWC to use, not only its own drainwater, but also the drainwater from other river diverters and groundwater users in the sub-basin—this includes the City of Sacramento and Sacramento International Airport.
- During "high river" levels, NCMWC can capture groundwater inflow that occurs along its western border with the Sacramento River.
- As the Company has increased its ability to deliver water in a timely manner to more acres in the northern area, the basin's rice production has become more concentrated in that area. This concentration has helped to improve "flooding times."

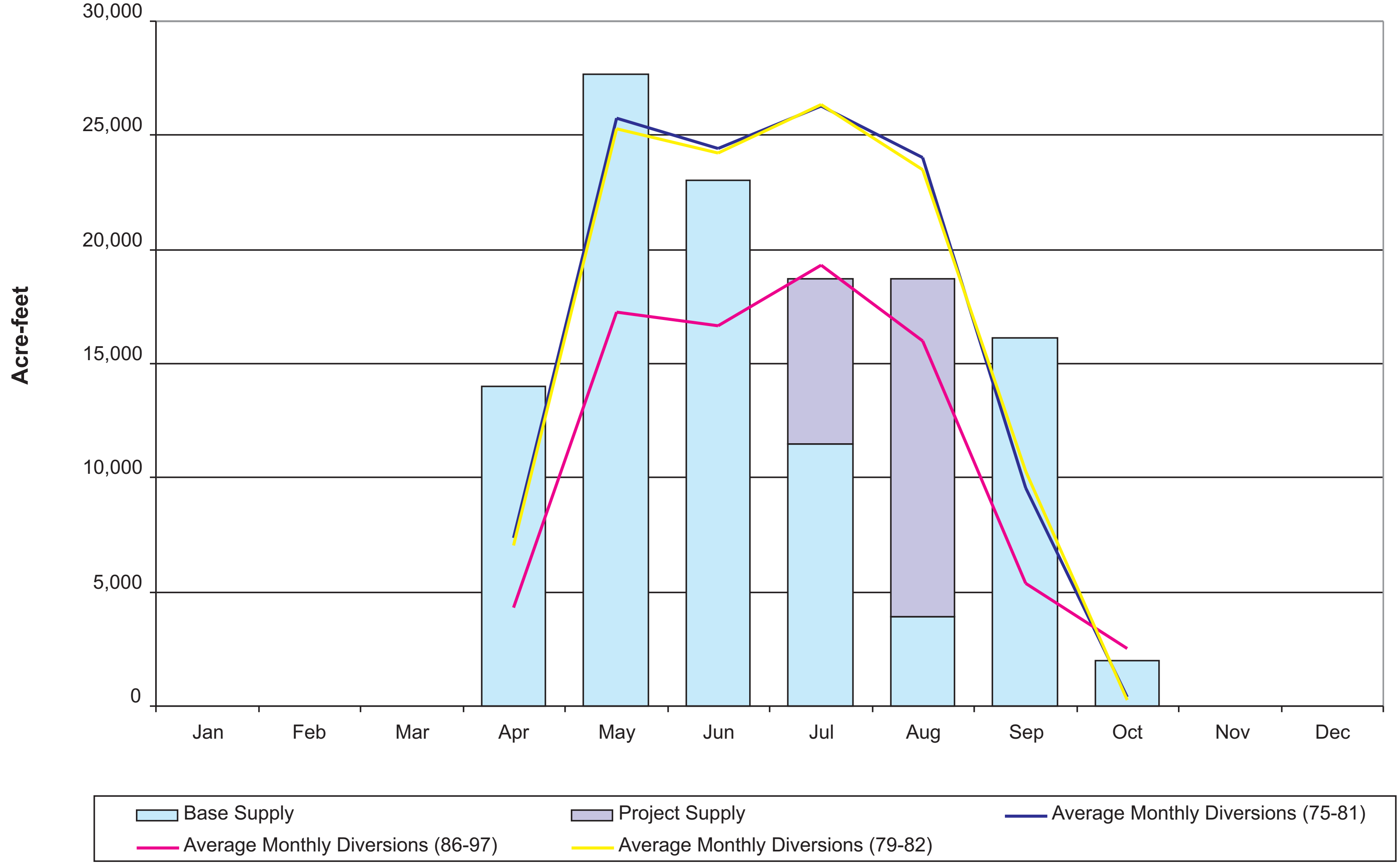
Non-contract Period (November – March). Contract No. 0885A does not limit NCMWC from diverting water for beneficial use during the months of November through March, to the extent authorized under California law. In response to increasingly stringent limitations on burning, many of the Company's landowners flood a portion of their fields to clear their land of leftover rice straw by allowing the rice stubble to decompose. The number of flooded acres has consistently increased since 1994. In 1994, 500 acres were flooded in comparison to 4,000 acres in 1998.

Other Surface Water Sources

NCMWC has water rights to several of the drainage facilities located within or bordering the Company including RD 1000 East Drain, RD 1000 West Drain, and the RD 1000 Main Drain. The use of this drainage water is discussed below in Tailwater and Reuse/ Recirculation.

Tailwater and Reuse/Recirculation

In recent years, NCMWC has relied heavily upon tailwater as an alternate supply to its Sacramento River entitlement. The source of this tailwater has been primarily from inside of the Company, although some tailwater is available from the lands on the western edge of the Company which are adjacent to the Sacramento River (approximately 7,000 acres). High groundwater levels in much of the Company service area also contribute inflow to the drains. Approximately 60,000 ac-ft of tailwater are used annually. Continued reuse and recycling efforts are expected to be influenced by an increasing need to manage salinity and other constituents that affect crop productivity and sustainability.



Notes:

1. Critically dry year 1977 is omitted from Average Monthly Diversions (75-81).
2. Critically dry years 1991, 1992, and 1994 are omitted from Average Monthly Diversions (86-97).
3. Monthly diversions based on contract period for April to October.

FIGURE 34
NATOMAS CENTRAL MUTUAL WATER COMPANY MONTHLY CONTRACT SUPPLY AND AVERAGE MONTHLY SACRAMENTO RIVER DIVERSIONS
TM 3 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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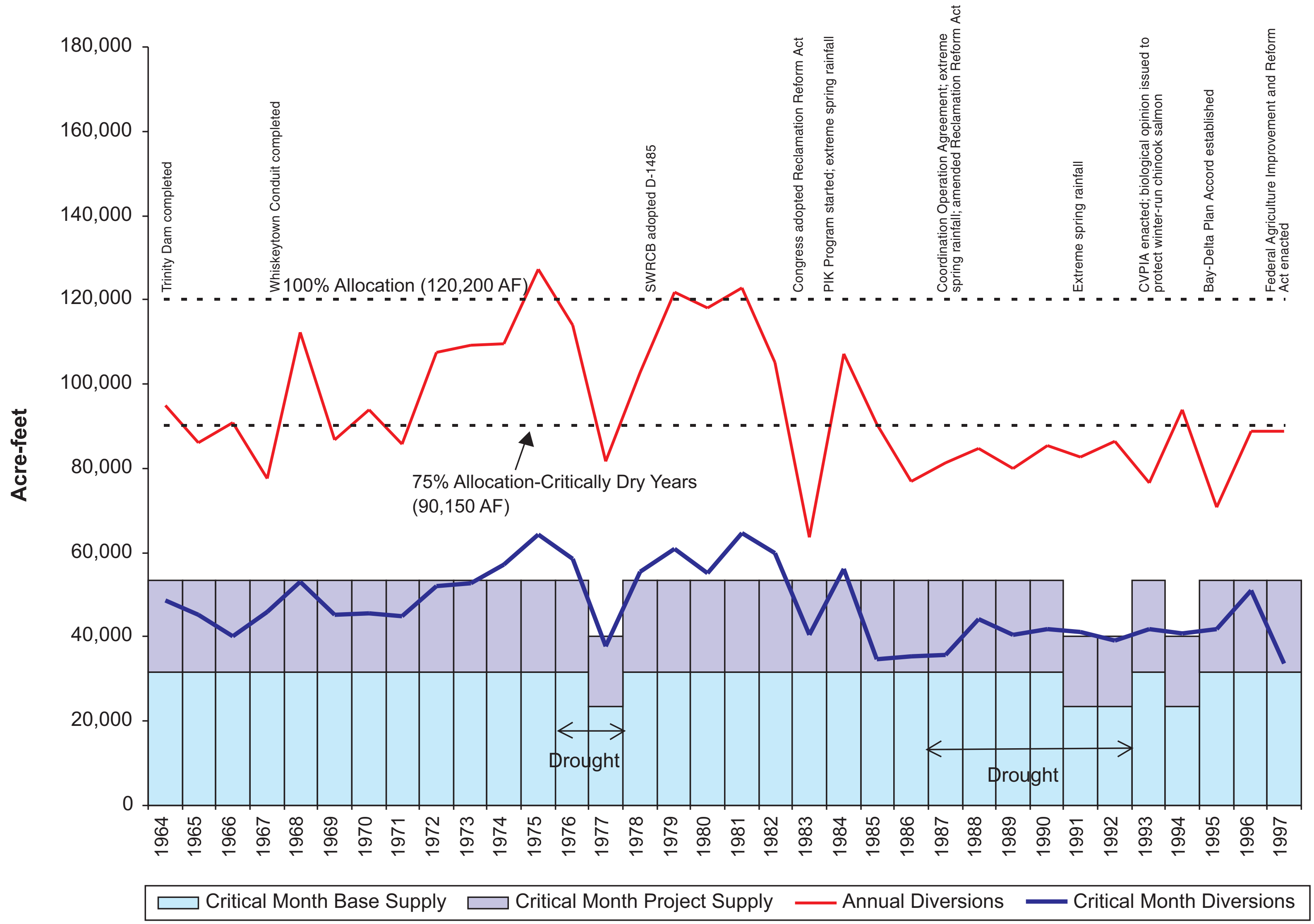

Note: Annual quantities are based on contract period from April to October; Critical Months include July, August, and September.

FIGURE 35
NATOMAS CENTRAL MUTUAL WATER COMPANY
ANNUAL AND CRITICAL MONTH CONTRACT SUPPLY
AND SACRAMENTO RIVER DIVERSIONS

The Company completed the installation of a recirculation system in 1986, to improve water quality for the City of Sacramento and increase overall efficiency within the Company boundaries. The recirculation system has since provided for the following benefits:

- Improve water quality discharge from RD 1000 pumping plants into the Sacramento River.
- Reduce pumping during the summer months by RD 1000, thus reducing their operation costs.
- Increase water availability to parts of service area with a history of "poor service."
- Reduce costs to customers (drain rate) who install drain pumps to receive tailwater exclusively.
- Reduce diversions and water costs paid (Restoration Fund) for Project Water.
- Improve water conservation practices through the installation and operation of a Companywide recycling program.
- Improve rice yields by reducing the "holding time" for herbicides on the field level.
- Allow greater flexibility for growers in method and timing of water application and crop selection without the institution of a metered water charge system.

The recirculation system includes 30 pumping stations at various locations that recapture water for reuse either directly into fields or back into the main irrigation canals. During a normal irrigation season, no agricultural drainage water returns to the Sacramento River until after the end of the rice irrigation season (between August 15 and September 1).

Groundwater

Approximately 51 privately owned wells and one Company-owned well are known to be located within the Company's service area (DWR, Central District). These wells are used in conjunction with the river pumps and drainwater recycling pump to meet irrigation needs on an as-needed basis. The Company-owned well is used to provide additional capacity in a small area at the southern end of the Company. In addition, a privately owned well near the Sacramento International Airport is operated and maintained by NCMWC, and is used for landscaping purposes at the airport. The other privately owned wells are used independent of NCMWC operations and are predominantly used for duck clubs or during drought situations. These wells are predominately used for duck clubs or during drought situations. As described previously, shallow groundwater also contributes to supplies in the drains (available for diversion). Indirect groundwater use also occurs through "sub-irrigation" in areas where shallow groundwater levels reach the root zones of managed crops.

Sacramento Valley Wildlife Refuges

Refuge Water Supply Entitlements

The following five Sacramento Valley refuges are entitled to receive water from the CVP (amounts are listed in Table 31):

- Sacramento
- Delevan
- Colusa
- Sutter (all national wildlife refuges owned and operated by the U.S. Fish and Wildlife Service)
- Gray Lodge Wildlife Management Area (owned and operated by the Department of Fish and Game)

TABLE 31
Contractual Water Supply Entitlements[a] for Each Sacramento Valley Wildlife Refuge

Refuge	Level 2 (ac-ft)	Incremental Level 4 (ac-ft)	Total Level 4 (ac-ft)
Sacramento	46,400	3,600	50,000
Delevan	20,950	9,050	30,000
Colusa	25,000	0	25,000
Sutter	23,500	6,500	30,000
Gray Lodge	35,400	8,600	44,000
Totals	151,250	27,750	179,000

[a]Based on Exhibit B of the water service contracts with Reclamation.

Level 2 and Level 4 water supplies are the Level 2 and Level 4 amounts, respectively, from the "Dependable Water Supply Needs" table for those habitat areas as set forth in the Refuge Water Supply Report and two-thirds of the water supply needed for full habitat development for those habitat areas identified in the San Joaquin Action Plan/Kesterson Mitigation Action Plan Report prepared by Reclamation.

Level 2 water is provided from the yield of the CVP. The U.S. Department of the Interior's Water Acquisition Program provides Incremental Level 4 water to the refuges. Water is acquired by transfer from willing sellers, generally on an annual basis. The Sacramento Valley wildlife refuges have a combined Incremental Level 4 entitlement of 27,750 ac-ft (19,150 ac-ft for the National Wildlife Refuges and 8,600 ac-ft for Gray Lodge Wildlife Management Area). Reclamation has acquired 6,300 ac-ft of Incremental Level 4 water on a long-term basis by assignment of a portion of three CVP (Corning Canal) contracts. No other long-term Incremental Level 4 water has been acquired in the Sacramento Valley.

Recent Refuge Deliveries

Deliveries to the Sacramento Valley wildlife refuges from 1999 through 2003 were somewhat less than their contract entitlements (see Table 32). The lower demand for water was the result of several factors, including hydrologic conditions, lands not developed (habitat or water service), and changes in refuge land management practices such as reduced acreage of rice food plots and more efficient irrigation practices.

TABLE 32
Water Deliveries for Each Sacramento Valley Wildlife Refuge[a]

Refuge	Level 2 (ac-ft)	Incremental Level 4 (ac-ft)	Total Level 4 (ac-ft)
Sacramento	30,969	1,531	32,500
Delevan	18,433	1,493	19,926
Colusa	15,214	0	15,214
Sutter	15,694	185	15,878
Gray Lodge	31,873	258	32,131
Total	112,183	3,467	115,649

[a]Average annual values for 1999 through 2003.

Currently, water management plan criteria are being developed for wildlife refuges. Each refuge with a water service contract will be required to have an acceptable water management plan and provide 5-year updates similar to the agricultural water management plans under the Standard Criteria.

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Appendix A
District Exhibit A's to the Sacramento River Settlement Contracts

Exhibit A

Glenn-Colusa Irrigation District
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	100,000	0	100,000
May	140,000	0	140,000
June	150,000	0	150,000
July	130,000	55,000	185,000
August	90,000	50,000	140,000
September	65,000	0	65,000
October	45,000	0	45,000
Total	720,000	105,000	825,000

Points of Diversion: 154.7R, 154.8R

Dated:

Contract No. 14-06-200-856A-R-1

Exhibit A

Provident Irrigation District
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	7,210	0	7,210
May	10,830	0	10,830
June	12,920	0	12,920
July	6,300	3,500	10,000
August	2,500	1,000	3,500
September	7,400	500	7,900
October	2,570	0	2,570
Total	49,730	5,000	54,730

Points of Diversion: 123.9R, 154.8R

Dated:

Exhibit A

Maxwell Irrigation District
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	1,990	0	1,990
May	3,520	0	3,520
June	2410	0	2410
July	220	2,000	2,220
August	30	2,000	2,030
September	710	2,000	2,710
October	3,100	0	3,100
Total	11,980	6,000	17,980

Points of Diversion: 103.8R, 104.1R

Dated:

Contract No. 14-06-200-849A-R-1

Exhibit A

Princeton-Codora-Glenn Irrigation District
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	10,800	0	10,800
May	13,500	0	13,500
June	12,790	400	13,190
July	6,740	6,000	12,740
August	2,780	8,400	11,180
September	4,800	200	5,000
October	1,400	0	1,400
Total	52,810	15,000	67,810

Points of Diversion: 123.9R, 154,8R

Dated:

Contract No. 14-06-200-876A-R-1

Exhibit A

Reclamation District No. 108
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	34,000	0	34,000
May	50,500	0	50,500
June	49,000	0	49,000
July	31,500	16,000	47,500
August	16,500	15,000	31,500
September	16,000	2,000	18,000
October	1,500	0	1,500
Total	199,000	33,000	232,000

Points of Diversion: 43.1R, 43.3R, 51.1R, 56.4R, 59.15R, 61.05R, 61.2R, 62.3R, 63.2R, 70.4R

Dated:

Contract No. 14-06-200-890A-R-1

Exhibit A

Reclamation District No. 1004
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	6,300	0	6,300
May	14,700	0	14,700
June	12,200	0	12,200
July	6,100	6,000	12,100
August	3,600	8,400	12,000
September	8,200	600	8,800
October	5,300	0	5,300
Total	56,400	15,000	71,400

Points of Diversion: 84.28L, 85.3L, 89.12L,111.8L

Dated:

Contract No. 14-06-200-838A-R-1

Exhibit A

Meridian Farms Water Company
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	4,400	0	4,400
May	6,200	0	6,200
June	5,900	0	5,900
July	2,000	5,000	7,000
August	1,100	5,000	6,100
September	3,400	2,000	5,400
October	0	0	0
Total	23,000	12,000	35,000

Points of Diversion: 71.1L, 74.8L, 80.0L

Dated:

Contract No. 14-06-200-856A-R-1

Exhibit A

Sutter Mutual Water Company
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	20,000	0	20,000
May	42,500	0	42,500
June	48,000	0	48,000
July	28,500	25,000	53,500
August	20,000	24,000	44,000
September	5,000	7,500	12,500
October	5,500	0	5,500
Total	169,500	56,500	226,000

Points of Diversion: 32.4L, 40.6L, 63.75L

Dated:

Contract No. 14-06-200-2073A-R-1

Exhibit A

Pelger Mutual Water Company
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	1,210	0	1,210
May	3,250	0	3,250
June	1,670	0	1,670
July	310	700	1010
August	40	950	990
September	570	100	670
October	60	0	60
Total	7110	1750	8860

Points of Diversion: 56.96L,

Dated:

Exhibit A

Natomas Central Mutual Water Company
Sacramento River

SCHEDULE OF MONTHLY DIVERSIONS OF WATER

	Base Supply (acre-feet)	Project Water (acre-feet)	Contract Total (acre-feet)
April	14,000	0	14,000
May	27,700	0	27,700
June	23,000	0	23,000
July	11,500	7,200	18,700
August	3,900	14,800	18,700
September	16,100	0	16,100
October	2,000	0	2,000
Total	98,200	22,000	120,200

Points of Diversion: 2.15L, 6.1L, 7.5L, 14.1L, 16.0L, 19.6L (Cross Canal 1.0S & 2.0S)

Dated:

Technical Memorandum No. 4

Sacramento River Basinwide Water Management Plan District Water Requirement and CVP Supply/Sub-basin Water Balances

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

October 2004

Contents

Contents, Continued

Acronyms and Abbreviations

ac-ft	acre-feet
ACID	Anderson-Cottonwood Irrigation District
BWMP	Basinwide Water Management Plan
CVP	Central Valley Project
DWR	California Department of Water Resources
ETAW	evapotranspiration of applied water
GCID	Glenn-Colusa Irrigation District
M&I	municipal and industrial
MFWC	Meridian Farms Water Company
MID	Maxwell Irrigation District
NCMWC	Natomas Central Mutual Water Company
PCGID	Princeton-Codora-Glenn Irrigation District
PID	Provident Irrigation District
PMWC	Pelger Mutual Water Company
RD 1004	Reclamation District No. 1004
RD 108	Reclamation District No. 108
Reclamation	U.S. Bureau of Reclamation
SMWC	Sutter Mutual Water Company
SRSC	Sacramento River Settlement Contractor
SWP	State Water Project
taf/yr	thousand acre-feet per year
TM	Technical Memorandum

District Water Requirement and CVP Supply/ Sub-basin Water Balances

Introduction

Technical Memorandum (TM) No. 4 addresses two elements of the Basinwide Water Management Plan (BWMP)—the definition and quantification of the district water requirement with respect to Central Valley Project (CVP) supplies for each participating Sacramento River Settlement Contractor (SRSC) and a basinwide water use balance. The first section of TM 4 addresses what proportion of a given SRSC's total water requirement is met through Base Supplies, and briefly discusses how each SRSC is able to fill the gap above their respective Base Supplies to meet their total water requirements. The second section presents a water use balance for each of the hydrologic sub-basins that comprise the BWMP study area.

Reclamation prepared water needs assessments to evaluate future water needs for each of the SRSCs in support of the recently completed CVP contract negotiations. In all but two cases (Anderson-Cottonwood Irrigation District [ACID] and Sutter Mutual Water District [SMWC]), the needs analysis identified water needs exceeding or equal to the current total contract amount. The approach used to determine water needs varied from the approach described below to identify water requirements in normal and dry/drought years. The water needs assessments prepared by U.S. Bureau of Reclamation (Reclamation) for each of the participating SRSCs and are available from Reclamation by request.

SRSC Water Requirement and CVP Supply

Definition and Context

The district water requirement is defined and quantified in TM 2, *Current and Future Water Requirements*. The district water requirement is the total quantity of water supply required by the SRSC to meet on-field water requirements for specific crop types and acreage, and necessary operational losses including conveyance leakage, operational spills, and incidental minor losses such as evaporation. The on-field water requirements are based on 1995 land use data and normalized climate data, and represent an "average" water requirement only. It is expected that actual district water requirements for any single calendar month may vary significantly year-to-year because of actual climate conditions for the year.

The quantity and monthly distribution of each SRSC's Base Supply and Project Water supply are specified in Exhibit A of the water Settlement Contracts with Reclamation. See TM 3, *Water Resources Characterization*, for details on each SRSC's Base Supply and Project Water supply contracts. Appendix A to TM 3 includes Exhibit A's of the SRSCs.

TM 2 presents graphs showing both an annual total and a monthly distribution of each SRSC's district water requirement, and the monthly distribution of each SRSC's Base and

Project Water Supplies. The data are presented for both normal and drought/critical years. These graphs are presented in Appendix A. The key differences for a drought/critical year include an increased water requirement due to lower moisture content at the beginning of the irrigation season, and a decrease in Base Supply from the 25 percent cutback provision for critical years. See TM 2 for further discussion of the methodology and key assumptions related to the district water requirement analysis.

Use of Nonbase Supply Water Sources to Meet District Water Requirements

A review of the TM 2 monthly distribution graphics shows in many cases a significant gap, or deficit, between the SRSC's district water requirement and the available Base Supply. This additional increment of supply is generally met with some combination of one or more of the following supplemental water sources:

- Project Water Supply—Water supply available to each SRSC under contract with Reclamation through the CVP facilities
- Drainwater—Water supply that may be incidentally available within each SRSC's service area's drainage ditches through a combination of field runoff and regional drainage
- Groundwater—Water pumped from the underlying aquifer within each SRSC's service area
- Miscellaneous Surface Water Supply—Water supply available to individual SRSCs based on water rights held on Sacramento River tributaries

Each SRSC uses these supplemental water sources differently, based on a complex combination of factors that vary from year to year. See TM 3 for an analysis of the historical water source use patterns for each SRSC. The primary factors influencing the mix of water sources used include the following:

- Water-year type (normal, wet, drought)
- Crop types and irrigation methods
- The availability of supplemental supplies (both timing and quantity)
- Water quality and associated impacts on crop yields
- The SRSC's supply and drainage infrastructure layout
- Impacts on operational efficiency and flexibility
- Economic considerations such as the cost of Sacramento River pumping

The SRSC operations and management staff strive to balance these factors in the most efficient manner as necessary to provide a water supply that is adequate and of sufficient quality for their service area. Additional detail is provided in TM 6.

Summary Analysis of Water Requirement and Base Supply

Table 1 summarizes the increment of total district water requirement not met by Base Supply for each SRSC and sub-basin, by critical and non-critical months for both normal and drought/critical years. Appendix A shows the data used to derive the estimated need. The quantities are based on the TM 2 monthly water supply requirement data and Base

Supply contract quantities from TM 3. The critical months are contractually specified as July, August, and September for most SRSCs. For ACID and GCID, the critical months are specified as July and August. The data from Table 1 are also presented graphically on Figures 1 through 11. The summary of total district water requirements not met by Base Supply data into the non-critical and critical months was done based on the significant differences between these two periods in terms of the general supply and demand conditions faced by each SRSC, and the resulting influence on the water management decisions made by the SRSCs.

TABLE 1
Increment of Total District Water Requirement not Met by Base Supply[a,b,c,d] – Critical and Non-critical Months

	Normal		Drought	
Sub-basin	**Non-critical Months (ac-ft)**	**Critical Months (ac-ft)**	**Non-critical Months (ac-ft)**	**Critical Months (ac-ft)**
Redding Sub-basin				
Anderson-Cottonwood Irrigation District (ACID)	-44,900	1,000	900	22,700
Subtotal	*-44,900*	*1,000*	*900*	*22,700*
Colusa Sub-basin				
Glenn-Colusa Irrigation District (GCID)	-69,400	97,800	101,800	187,000
Provident Irrigation District (PID)	16,600	31,800	29,800	40,500
Princeton-Codora-Glenn Irrigation District (PCGID)	-4,600	18,600	8,400	25,400
Maxwell Irrigation District (MID)	5,300	14,500	9,700	16,300
Reclamation District No. 108 (RD 108)	-21,900	36,400	23,700	62,900
Subtotal	*-74,000*	*199,100*	*173,400*	*332,100*
Butte Sub-basin				
Reclamation District No. 1004 (RD 1004)	6,600	30,500	20,500	39,500
Subtotal	*6,600*	*30,500*	*20,500*	*39,500*
Sutter Sub-basin				
Meridian Farms Water Company (MFWC)	7,000	15,700	13,000	19,100
Sutter Mutual Water Company (SMWC)	-7,900	74,800	34,600	95,900
Pelger Mutual Water Company (PMWC)	-1,900	5,600	-100	6,200
Subtotal	*-2,800*	*96,100*	*47,500*	*121,200*
American Sub-basin				
Natomas Central Mutual Water Company (NCMWC)	16,200	44,900	36,800	56,300
Subtotal	*16,200*	*44,900*	*36,800*	*56,300*
Total	**-98,900**	**371,600**	**279,100**	**571,800**

[a]Negative values indicate surplus quantities (i.e., total district requirement is less than the Base Supply during these months/conditions).

[b]Table is based on the 1995 normalized information presented in TM 2.

[c]Values are based on the existing contract set to expire in 2006 for SMWC.

[d]Values in this table might not be consistent with the accounting methodology that Reclamation has re-established for determining use of Base Supply during each month of each SRSC's contract period.

Note:
ac-ft = acre-feet

The differences in the two periods are significant for three reasons. First, the critical months period is typically the period of greatest irrigation demand due to crop development and climate patterns in the Sacramento Valley. Secondly, the critical month Base Supply is typically much less than the non-critical month Base Supply, according to contract conditions, because the average natural flow in the system is lower during the critical months. The third important factor is the contractual restrictions placed on the movement of Base and Project Supplies between the non-critical and critical months, which prevents moving “surplus” Base or Project Supplies from the non-critical months to address a deficit in the critical months.This situation is exacerbated during drought/critical years. The water requirement goes up during drought conditions, while contract supplies may be reduced 25 percent under the contract terms in a critical year. These general patterns are shown clearly on the figures.

District Water Requirement Compared to the Proposed Renewal Contracts

The SRSCs have negotiated renewal contracts in 2003 that reduce the “Take or Pay” provisions to allow the districts to pay for 75 percent of their Project Water and only pay the remaining 25 percent prorated according to actual use. Table 2 summarizes the increment of total district water requirement not met by Base Supply and 75 percent Project Water for each SRSC and sub-basin, by critical and non-critical months for both normal and drought/critical years. The district water requirement is based on the data from TM 2, and the Base Supply and 75 percent Project Water are based on the negotiated quantities for the renewal contracts. Negotiations with ACID are currently underway to determine the future total contract quantities; therefore, the existing contract quantities, due to expire in 2006, were used in Table 2.

TABLE 2
Total District Water Requirement Not Met by Base Supply and 75 Percent Project Water[a,b,c,d,e]

	Normal		Drought	
Sub-basin	**Non-critical Months (ac-ft)**	**Critical Months (ac-ft)**	**Non-critical Months (ac-ft)**	**Critical Months (ac-ft)**
Redding Sub-basin				
ACID	-44,900	-6,500	900	15,200
Subtotal	**-44,900**	**-6,500**	**900**	**15,200**
Colusa Sub-basin				
GCID	-69,400	19,050	101,800	108,250
PID	16,600	28,050	29,800	36,750
PCIGD	-4,600	7,350	8,400	14,150
MID	5,300	10,000	9,700	11,800
RD108	-21,900	11,650	23,700	38,150
Subtotal	**-74,000**	**76,100**	**173,400**	**209,100**
Butte Sub-basin				
RD 1004	6,600	19,250	20,500	28,250
Subtotal	**6,600**	**19,250**	**20,500**	**28,250**

TABLE 2
Total District Water Requirement Not Met by Base Supply and 75 Percent Project Water[a,b,c,d,e]

	Normal		Drought	
Sutter Sub-basin				
MFWC	7,000	6,700	13,000	10,100
SMWC	-7,900	3,550	34,600	24,650
PMWC	-1,900	4,288	-100	4,888
Subtotal	-2,800	14,538	47,500	39,638
American Sub-basin				
NCMWC	16,200	28,400	36,800	39,800
Subtotal	**16,200**	**28,400**	**36,800**	**39,800**
TOTAL	**-98,900**	**131,788**	**279,100**	**331,988**

[a]Negative values indicate surplus quantities (i.e., total district requirement is less than the Base Supply and 75 percent Project Water during these months/conditions).

[b]Table is based on the 1995 normalized information presented in TM 2.

[c]Values are based on the existing contract set to expire in 2006 for SMWC.

[d]Values in this table may not be consistent with the accounting methodology that Reclamation has re-established for determining the use of Base Supply during each month of each SRSC's contract period.

[e]75 percent Project Water is based on the Renewal Contract's Take or Pay provisions.

Sub-basin Water Use Balances

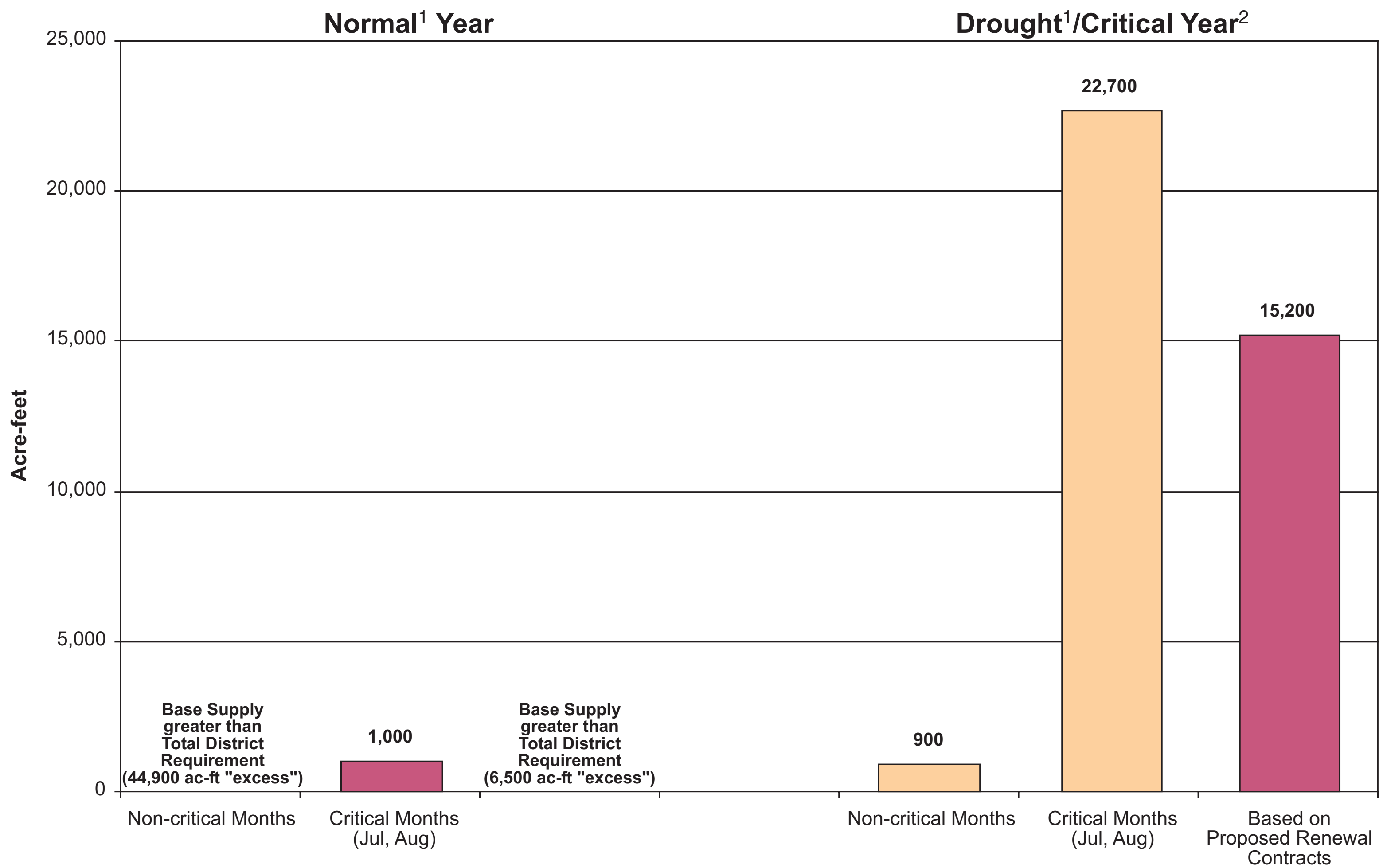
As identified in TM 3, the following sub-basins were developed to assist in analyzing basinwide water supplies and demand:

- Redding
- Colusa
- Butte
- Sutter (composed of north and south)
- American

In addition to inflow and outflow through each sub-basin, sub-basin water requirements are identified for agricultural, municipal and industrial (M&I), and environmental uses. Supplies available within each sub-basin are grouped into the following general categories:

- Sacramento River riparian supplies (i.e., riparian)
- SRSC supplies (separated by Base and Project Supplies)
- CVP agricultural water service contract supplies
- Local surface water supplies
- Groundwater pumping

Water use balances for each of the sub-basins listed above were developed from information obtained from the California Department of Water Resources (DWR) and Reclamation. This is the same DWR data defined and used in the development of TM 3. DWR develops detailed water use balances at a county level to support various water resources planning efforts. With assistance from DWR, this county-level information was summarized by sub-basins as shown on Figure 12. Each of the sub-basin water use balances identifies the water supplies (surface water, groundwater, and agricultural drainage inflow), demands (agricultural, M&I, and environmental), and outflow (return flow to the river, deep percolation from applied water and from leakage from conveyance facilities, and irrecoverable losses). The quantities, expressed as thousand acre-feet per year (taf/yr), represent average annual conditions as projected for the year 2020. A water use balance is also presented for drought conditions as projected under 2020.

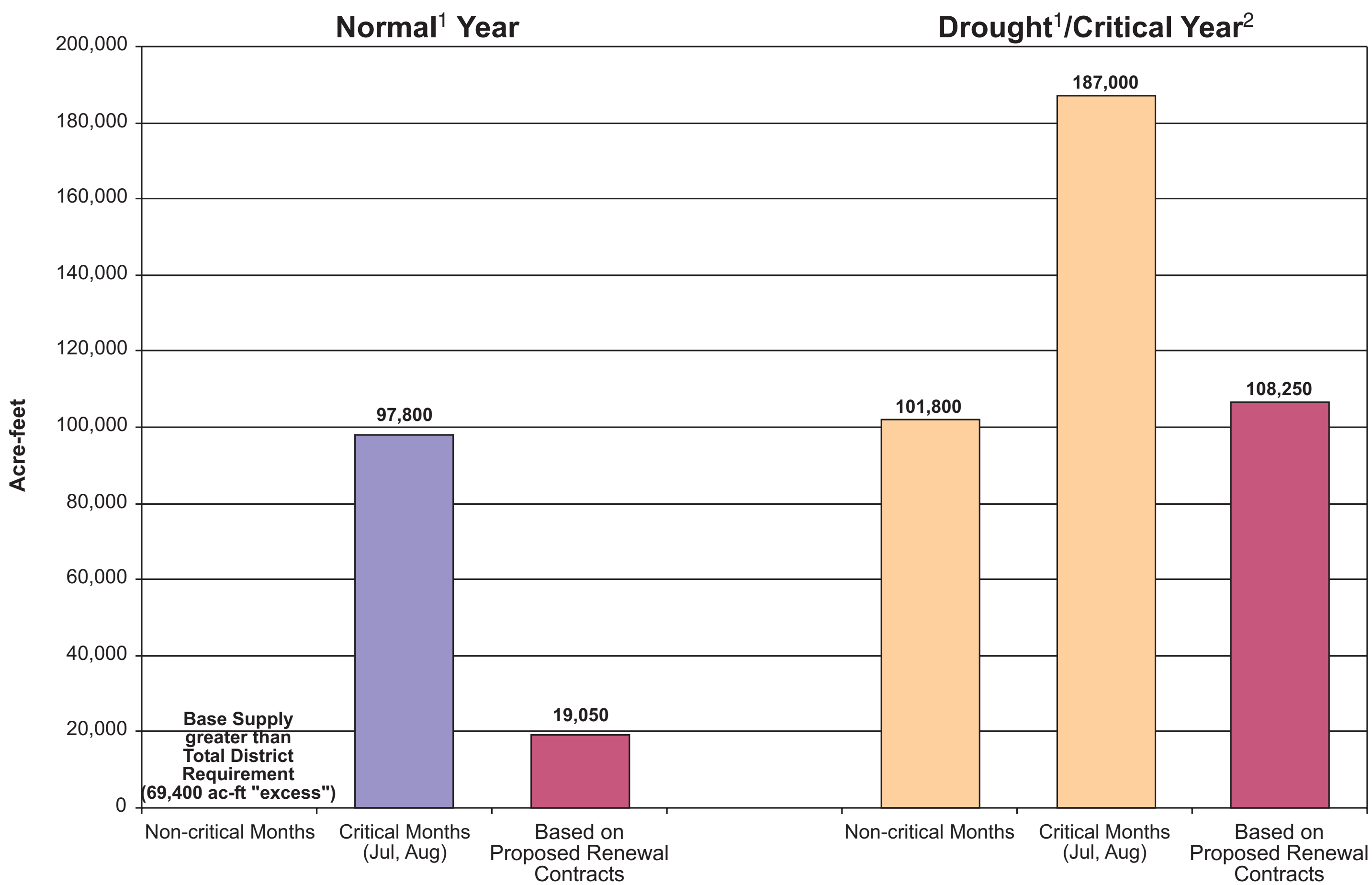


[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 1
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, ANDERSON-COTTONWOOD IRRIGATION DISTRICT
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK

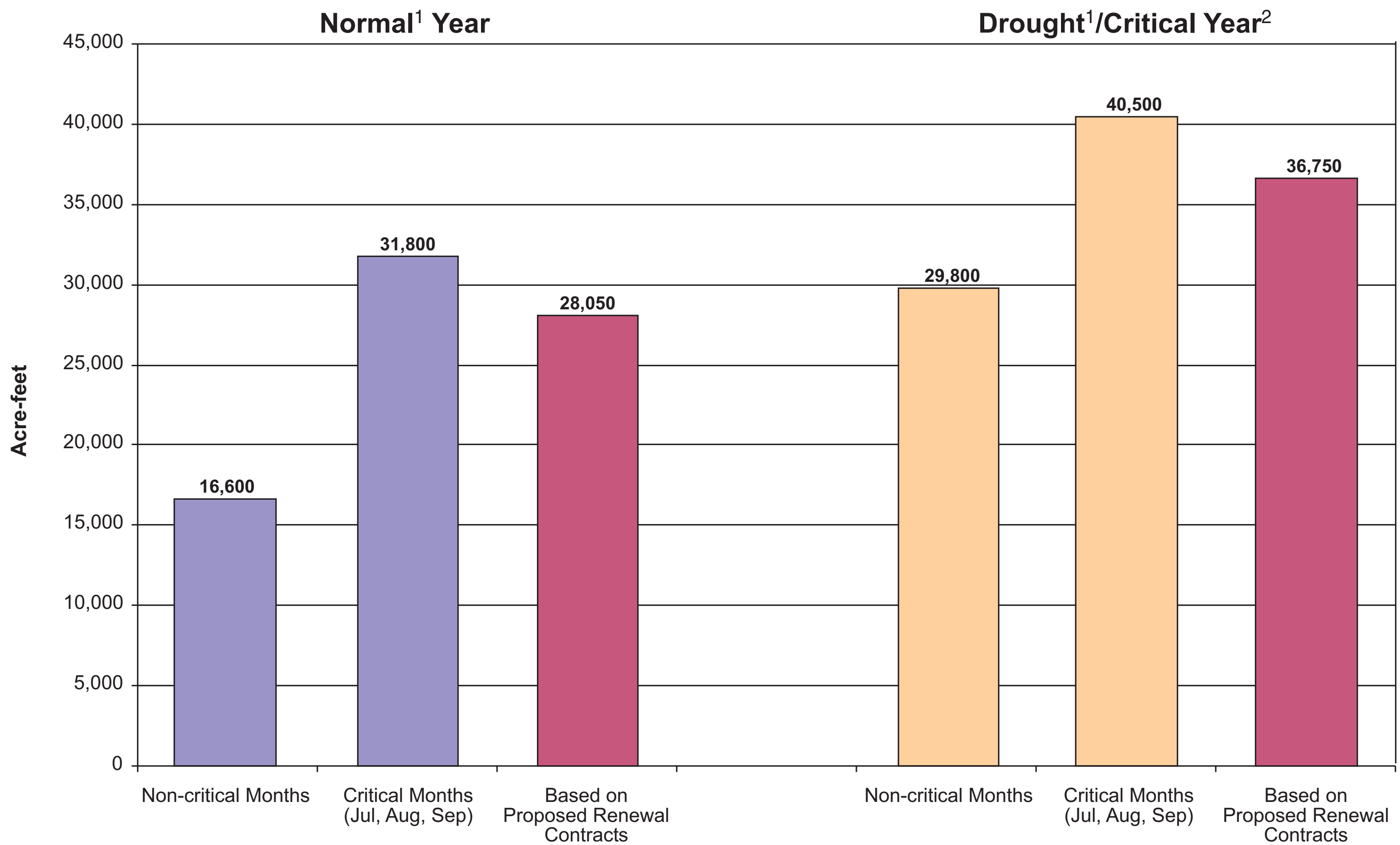


[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 2
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, GLENN-COLUSA IRRIGATION DISTRICT
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

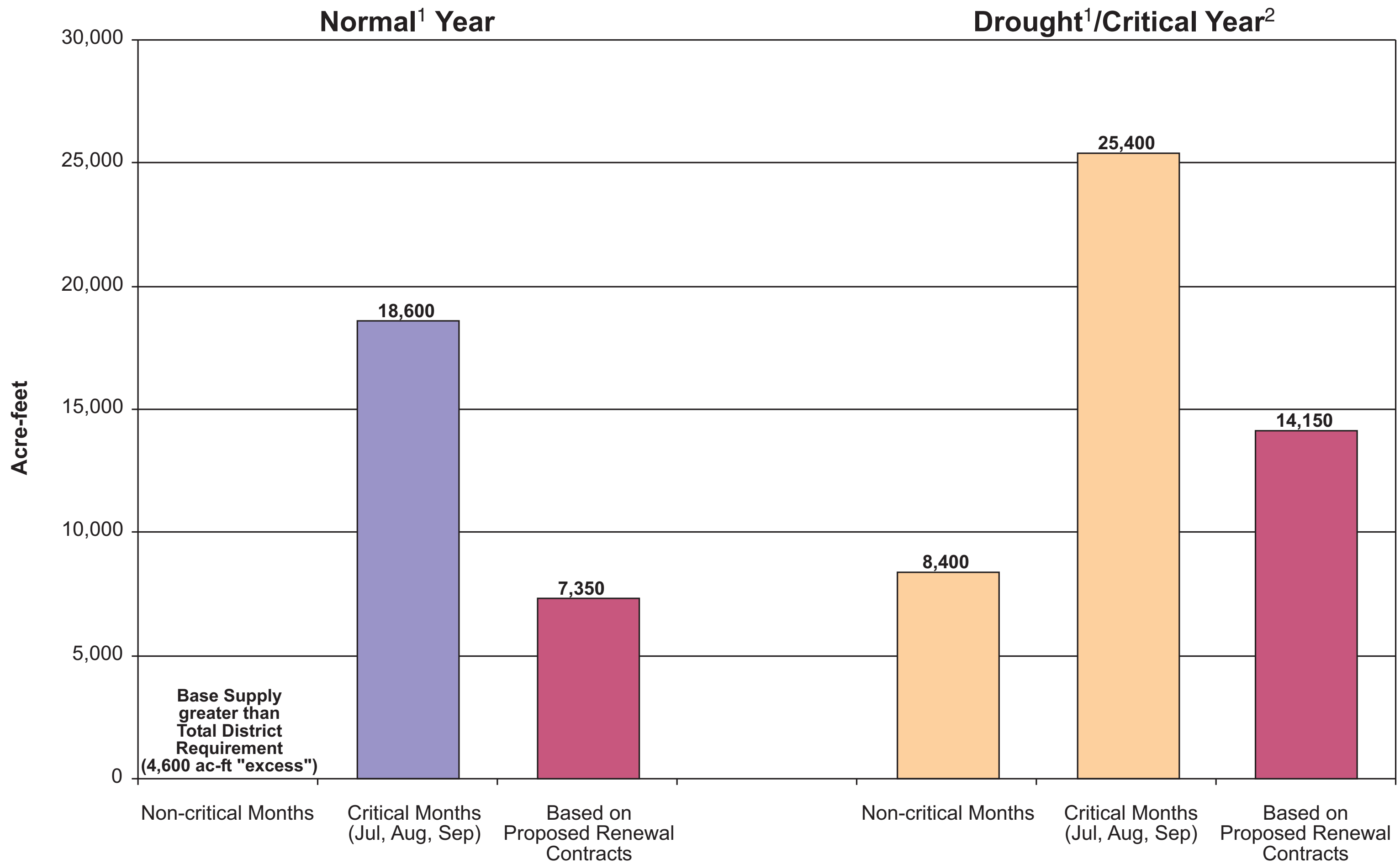


[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 3
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, PROVIDENT IRRIGATION DISTRICT
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK



[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 4
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, PRINCETON-CODORA-GLENN IRRIGATION DISTRICT
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
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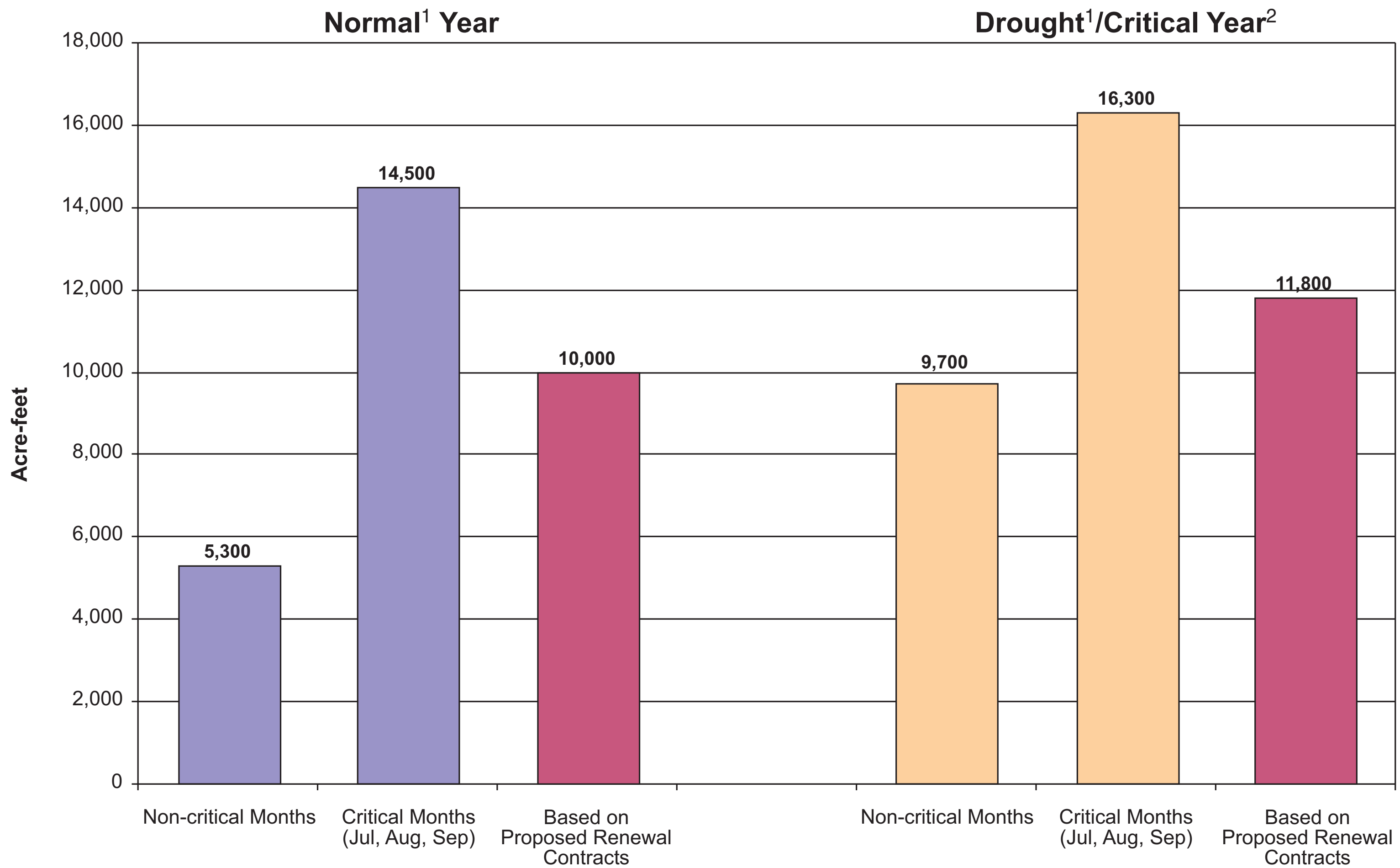
W062004006RDD_45_TM 4 (7/26/04)

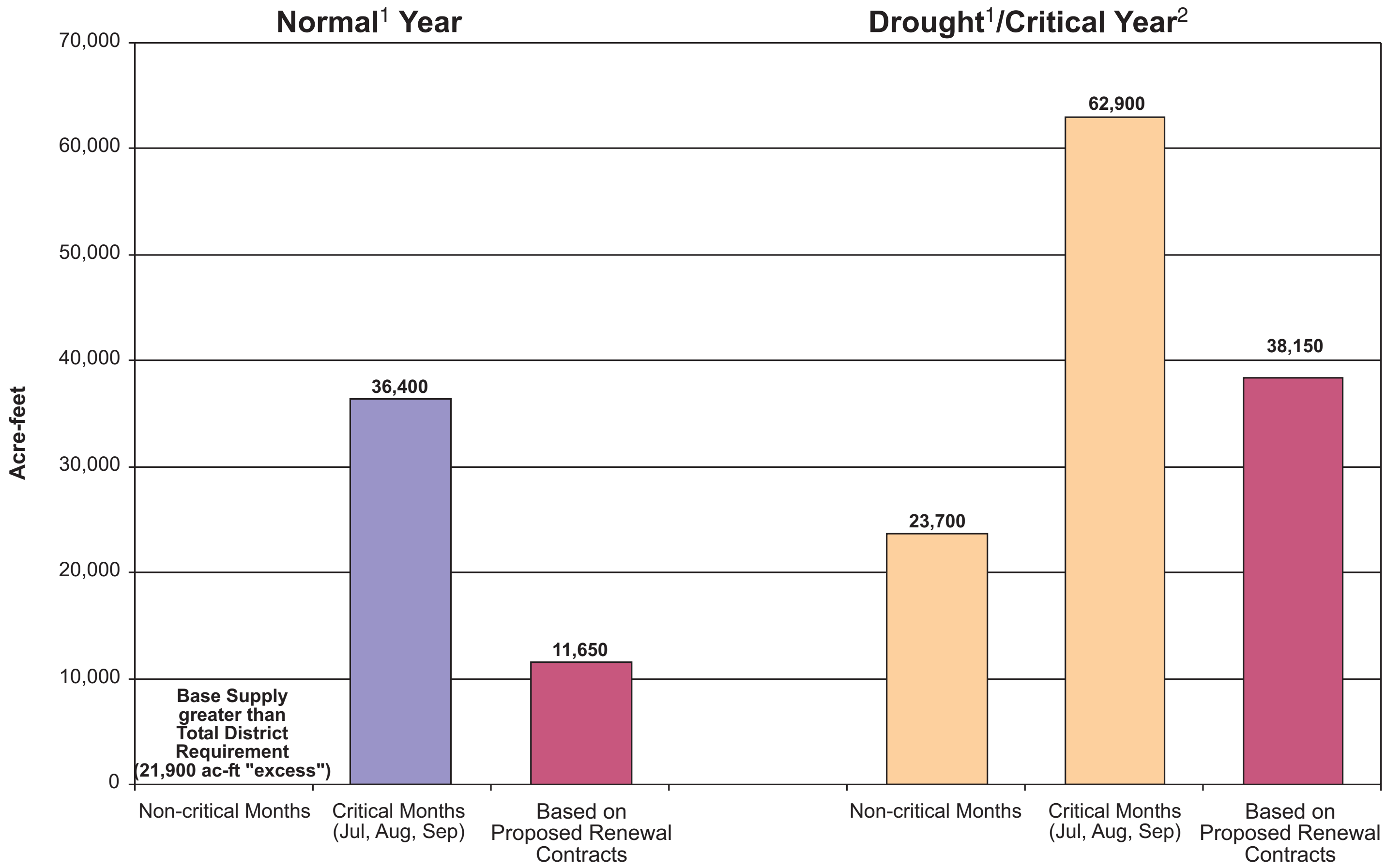


[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 5
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, MAXWELL IRRIGATION DISTRICT
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK



[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 6
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, RECLAMATION DISTRICT NO. 108
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
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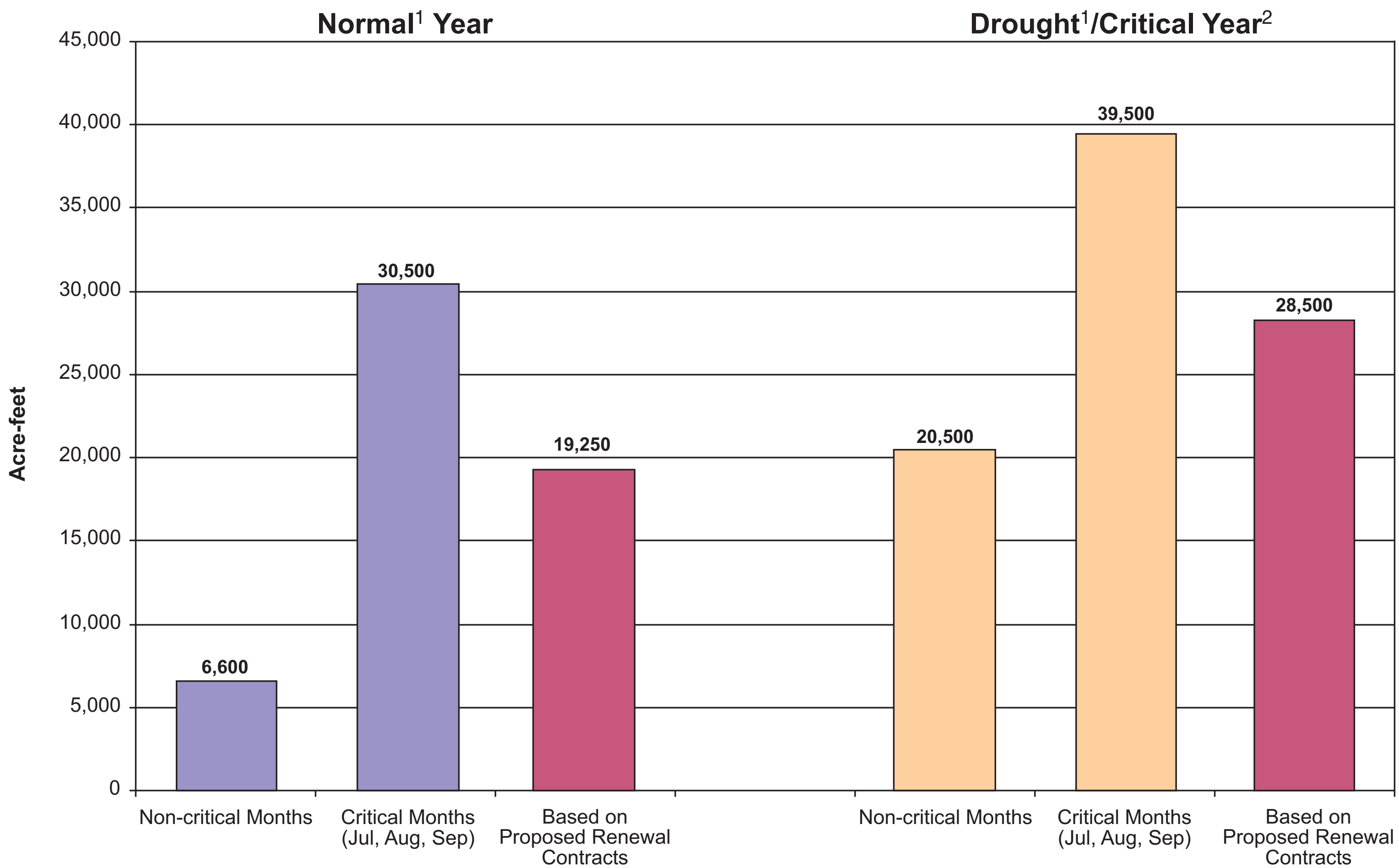
MONTGOMERY WATSON HARZA
MBK



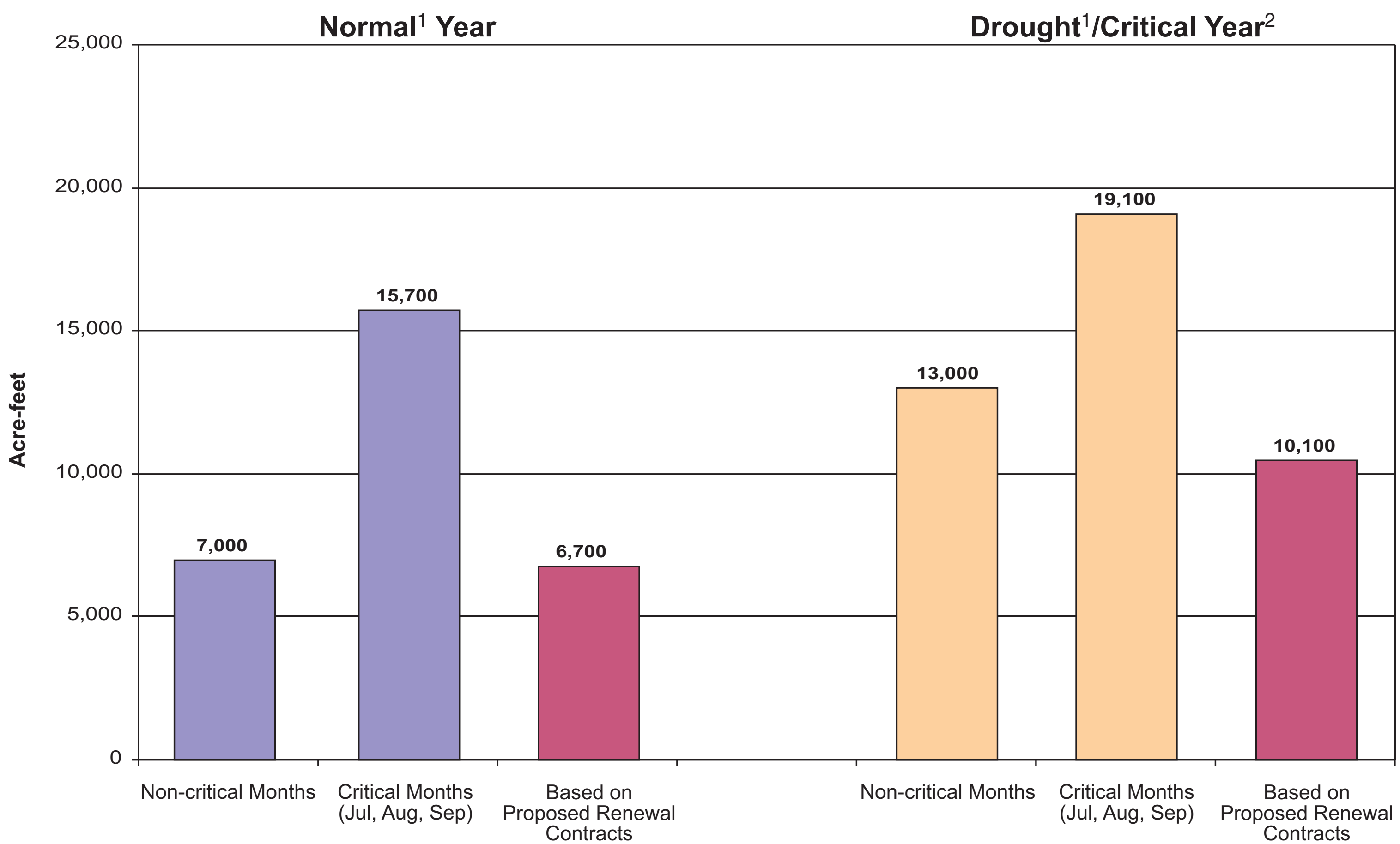
[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 7
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, RECLAMATION DISTRICT NO. 1004
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK

W062004006RDD_47_TM 4 (7/26/04)



[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 8
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, MERIDIAN FARMS WATER COMPANY
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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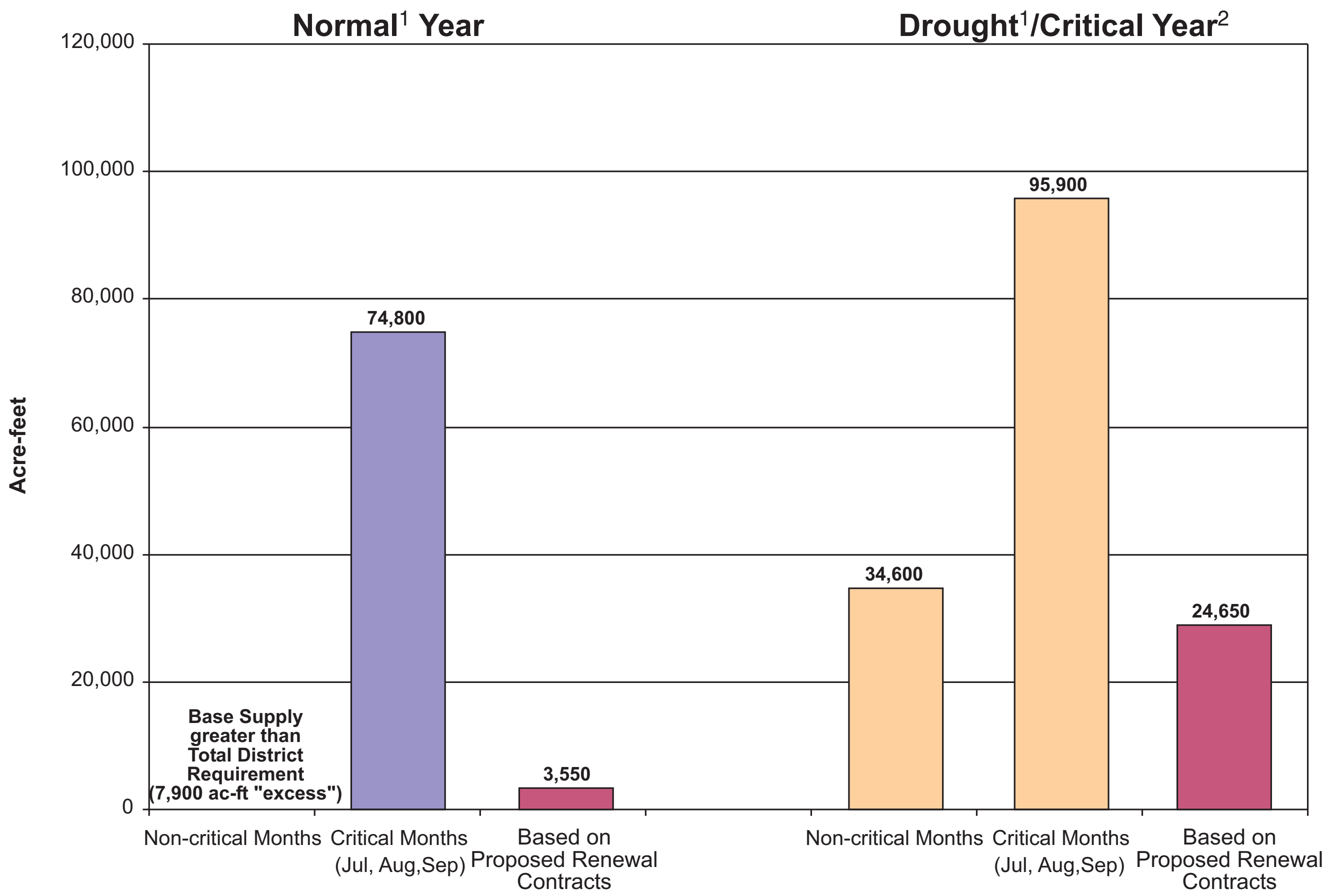
W062004006RDD_48_TM 4 (7/26/04)

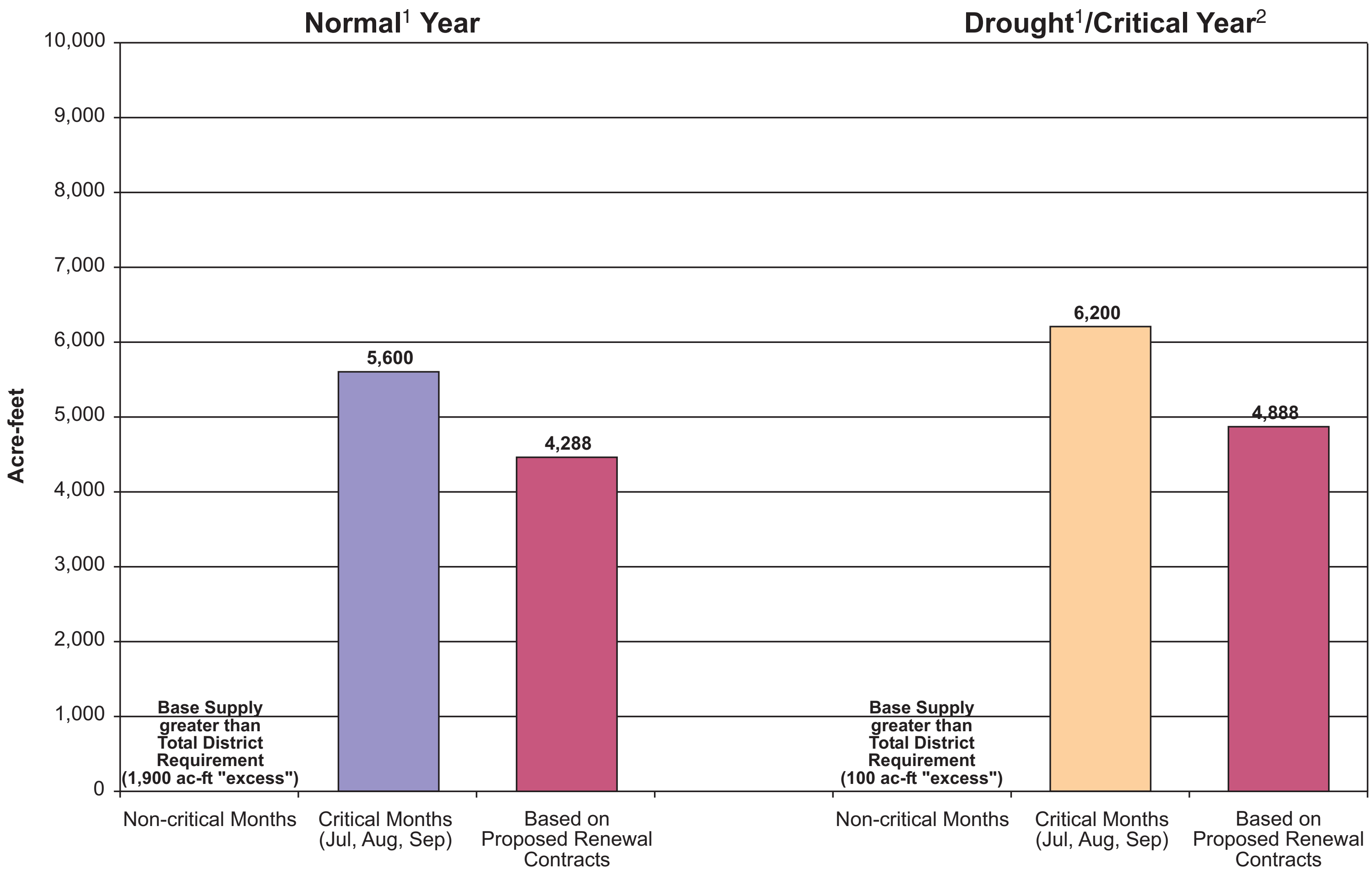


[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 9
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, SUTTER MUTUAL WATER COMPANY

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK



[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 10
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, PELGER MUTUAL WATER COMPANY
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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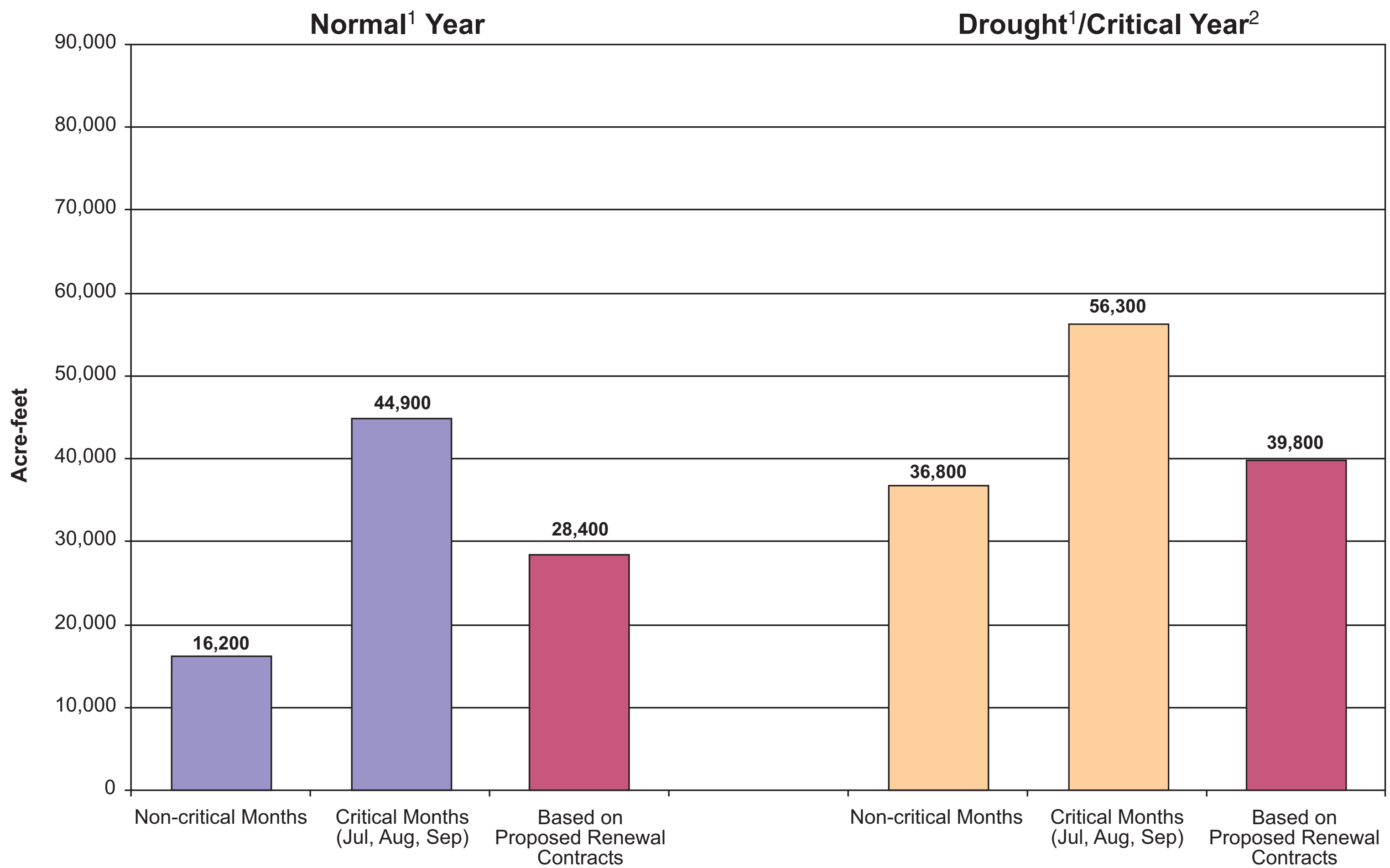
W062004006RDD_49_TM 4 (7/26/04)



[1]Normal and drought requirements per DWR 1995 projections.

[2]"Critical" refers to years designated as critical by Reclamation per Shasta Inflow index resulting in 25 percent curtailment provisions.

FIGURE 11
DISTRICT WATER REQUIREMENTS AND CVP SUPPLY, NATOMAS CENTRAL MUTUAL WATER COMPANY
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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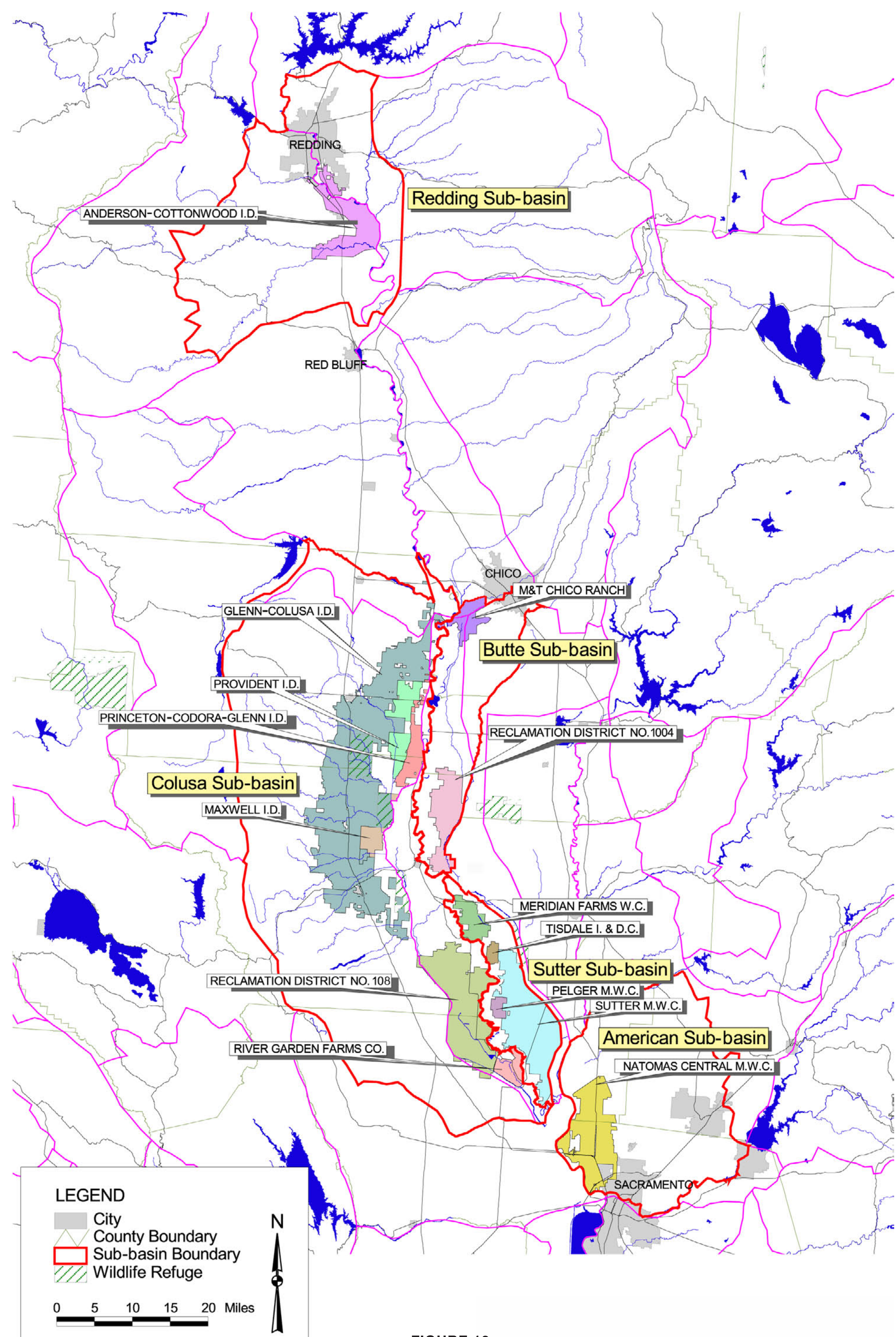


FIGURE 12
SUB-BASINS IN THE SACRAMENTO RIVER BASIN

W062004006RDD_04_TM 4 (7/13/04)

Redding Sub-basin

- ❑ **Anderson-Cottonwood Irrigation District**

Redding Sub-basin

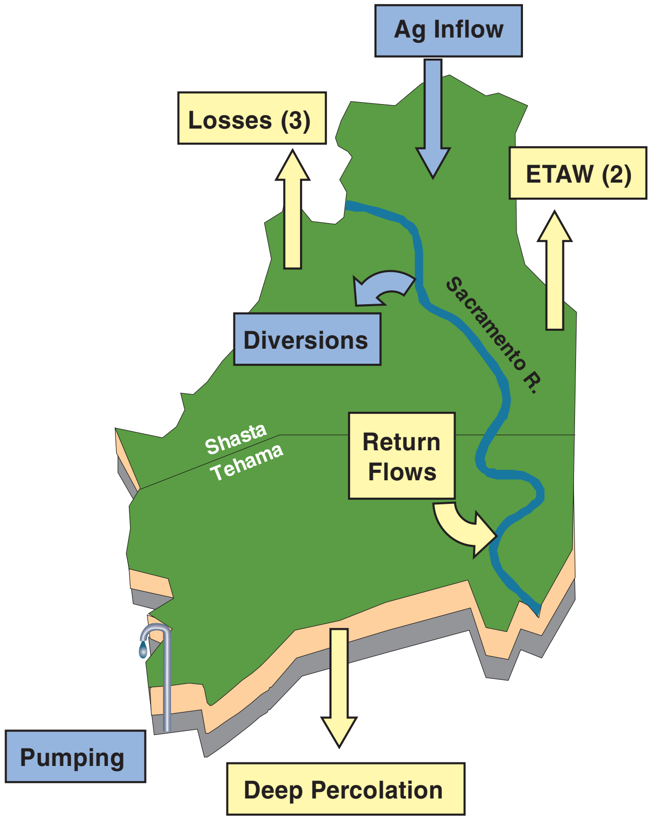
The Redding Sub-basin, as shown on Figure 13, is located in the northern section of the Sacramento Valley floor. It covers the segment of the Sacramento River from Shasta Dam to just north of Red Bluff. This sub-basin consists of significant urban areas, including the cities of Redding, Anderson, and Shasta Lake, and the community of Cottonwood. ACID is the only SRSC within this sub-basin. No State Water Project (SWP) contractors are in the sub-basin.

Relative to the sub-basins in the central and southern end of the study area, the Redding Sub-basin receives approximately twice as much annual rainfall, and the rainy season may extend further into the spring months, delaying the demand for irrigation water. Numerous water users along the Sacramento River divert water for agricultural and M&I uses, and numerous water users hold riparian and appropriative rights to Sacramento River water and associated tributaries in the sub-basin. Also unique to this sub-basin is the large percentage of irrigated pasture relative to other crop types. For example, over 75 percent of irrigated lands in the ACID service area are pasture.

A water use balance for the Redding Sub-basin for the 2020 average-year conditions is presented on Figure 13. Under 2020 average conditions for the sub-basin, the following projections are made:

- On average, surface water and groundwater pumping will be approximately 80 percent and 20 percent of the total water supply, respectively.
- For the negotiated agreements, the total diversions could range from 125,000 acre-feet per year (taf/yr) to 175 taf/yr, depending on hydrologic conditions and other outstanding issues. (The lower bound corresponds to average diversions for critically dry years 1977, 1991, 1992, and 1994; the upper bound corresponds to full Base and Project Supplies.)
- Relative to other sub-basins in this technical memorandum, a larger portion of most diversions returns back to the sub-basin water system as system leakage or deep percolation, that enters the groundwater system.Once in the groundwater system, a portion remains in storage, and the rest of this water flows as subsurface flow until reaching the Sacramento River or another part of the surface water system.

Figure 14 presents a water use balance for Redding Sub-basin under 2020 critical-year conditions.



WATER USE (1)

ETAW (2):	Agricultural	=	66
	M&I	=	41
Fall Flooding		=	0
Wildlife Refuges		=	0
SUBTOTAL		=	107
Other:	Losses (3)	=	14
	Deep Perc	=	42
	Return Flows	=	120
TOTAL		=	283

WATER SUPPLY (4)

Surface Water Diversions:		
Riparian	=	1
Settlement Contracts:		
Base Supply	=	163
Project Supply	=	5
CVP Water Service Contracts (5)	=	45
Local Surface Water	=	17
SUBTOTAL	=	231
Agricultural Drainage Inflow	=	0
Groundwater Pumping	=	46
TOTAL	=	277

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Annual average for the 1980 to 1989 period, unless otherwise specified.
(5) ACID Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 13
REDDING SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS

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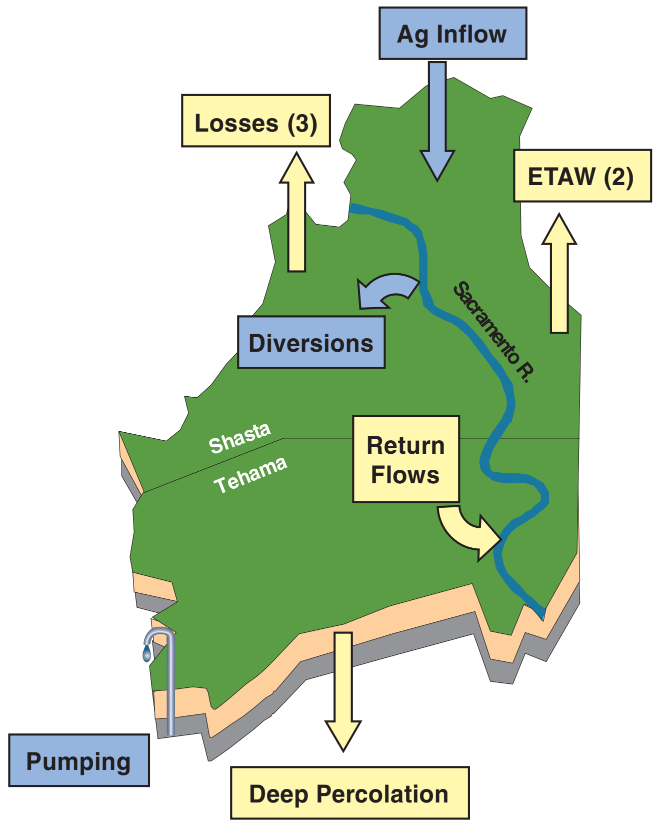


WATER USE (1)

ETAW (2):	Agricultural	= 81
	M&I	= 42
Fall Flooding		= 0
Wildlife Refuges		= 0
SUBTOTAL		= 124
Other:	Losses (3)	= 13
	Deep Perc	= 28
	Return Flows	= 100
TOTAL		= 265

WATER SUPPLY

Surface Water Diversions:	
Riparian	= 1
Settlement Contracts:	
Base Supply	= 137
Project Supply	= 9
CVP Water Service Contracts (4)	= 48
Local Surface Water	= 17
SUBTOTAL	= 212
Agricultural Drainage Inflow	= 0
Groundwater Pumping	= 57
TOTAL	= 269

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) ACID Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 14
REDDING SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS

Colusa Sub-basin

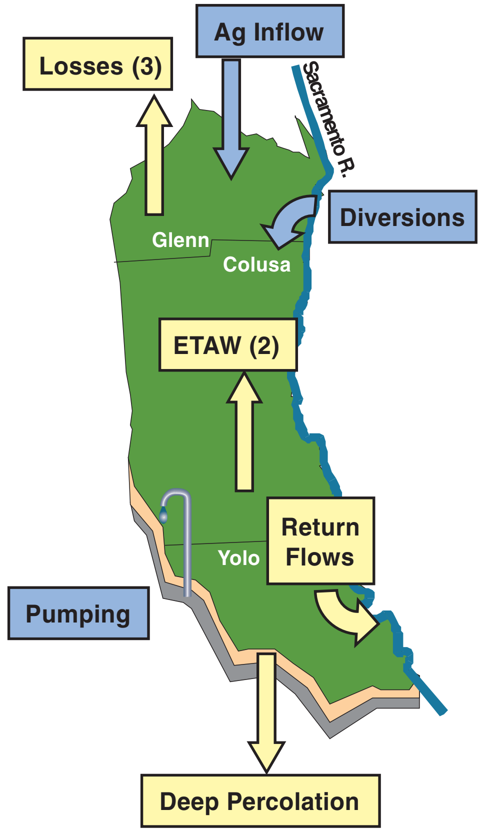
- **Glenn-Colusa Irrigation District**
- **Provident Irrigation District**
- **Princeton-Codora-Glenn Irrigation District**
- **Maxwell Irrigation District**
- **Reclamation District No. 108**
- **River Garden Farms Company**

Colusa Sub-basin

The Colusa Sub-basin, shown on Figure 15, encompasses six SRSCs participating in the BWMP. Combined, these six contractors make up more than 50 percent of the SRSC entitlements. Three other metered SRSCs are in the sub-basin, as well as numerous short-form SRSCs. Other water users in the basin include CVP contractors (i.e., Tehama-Colusa Canal districts, Sacramento River riparian diverters, and groundwater users). No SWP contractors are in the sub-basin.

- A water use balance for the Colusa Sub-basin for 2020 average-year conditions is presented on Figure 15. Under 2020 average conditions for this sub-basin, the following projections are made:
- On average, surface water and groundwater pumping will be approximately 76 percent and 24 percent of the total water supply, respectively. The SRSC diversions will make up approximately two-thirds of the surface water supply. This proportion could be even larger given the uncertainty in potential deficiencies in CVP agricultural water service contractor deliveries under 2020 conditions.
- For the negotiated agreement's average 2020 diversion of 990 taf/yr, 870 taf/yr (or 88 percent of this total diversion) is Base Supply and 120 taf/yr (or 12 percent of this total diversion) is Project Supply. These Project Supply diversions occur during the critical months of July, August, and September (July and August only for GCID).
- The SRSC diversions could range from 800 taf/yr to 1,225 taf/yr, depending upon hydrologic conditions and other outstanding issues (the lower bound representing 75 percent of contract delivery quantities, and the upper bound representing maximum diversions of current Base and Project Supply entitlements).
- Given the relative proportion and potential range of supplies available to the SRSCs in the Colusa Sub-basin, several management options designed to improve water supply reliability for users within the sub-basin, and possibly enhance CVP operations system-wide, could be considered. In addition, given the uncertainty associated with Project Supplies, another possibility would be to explore how a given management option might accommodate or replace the Project Supply portion of the current negotiated agreements (averaging 120 taf/yr in this sub-basin). This information will be used to explore these and other possible options further in TM 5.

Figure 16 presents a water use balance for Colusa Sub-basin under 2020 critical-year conditions.



WATER USE (1)

ETAW (2):	Agricultural	=	1306
	M&I	=	7
Fall Flooding		=	67
Wildlife Refuges		=	43
SUBTOTAL		=	1,423
Other:	Losses (3)	=	87
	Deep Perc	=	128
	Return Flows (4)	=	285
TOTAL		=	1,923

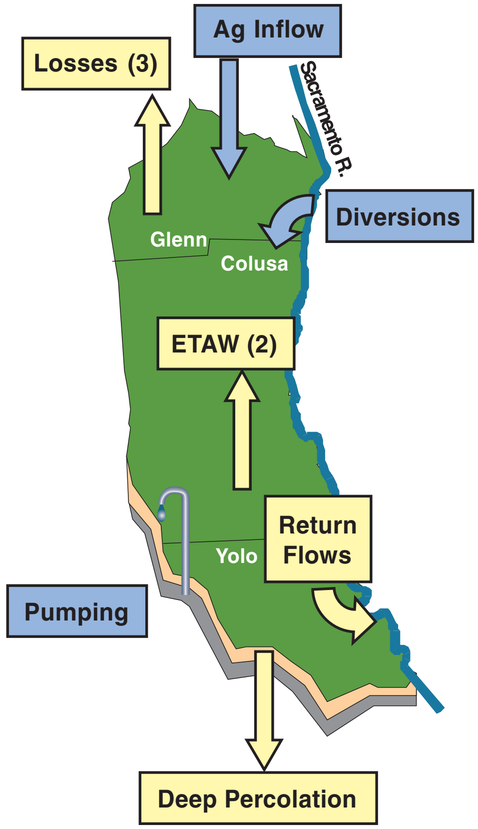
WATER SUPPLY (5)

Surface Water Diversions:		
Riparian	=	126
Settlement Contracts:		
Base Supply	=	929
Project Supply	=	120
CVP Water Service Contracts (6)	=	235
CVP Wildlife Refuges	=	129
Local Surface Water	=	7
SUBTOTAL	=	1,546
Agricultural Drainage Inflow	=	0
Groundwater Pumping	=	363
TOTAL	=	1,909

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 20 percent of the sum of ETAW, fall flooding, and wildlife refuges).
(5) Annual average for the 1980 to 1989 period, unless otherwise specified.
(6) Tehama-Colusa Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 15
COLUSA SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS



WATER USE (1)

ETAW (2):	Agricultural	= 1,374
	M&I	= 7
Fall Flooding		= 55
Wildlife Refuges		= 42
SUBTOTAL		= 1,478
Other:	Losses (3)	= 80
	Deep Perc	= 137
	Return Flows (4)	= 148
TOTAL		= 1,843

WATER SUPPLY

Surface Water Diversions:	
Riparian	= 126
Settlement Contracts:	
Base Supply	= 788
Project Supply	= 67
CVP Water Service Contracts (5)	= 136
CVP Wildlife Refuges	= 129
Local Surface Water	= 7
SUBTOTAL	= 1,253
Agricultural Drainage Inflow	= 0
Groundwater Pumping	= 477
TOTAL	= 1,730

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 10 percent of the sum of ETAW, fall flooding, and wildlife refuges).
(5) Tehama-Colusa Canal deliveries within the sub-basin.

Note:
Units = 1,000 acre-feet per year.

FIGURE 16
COLUSA SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS

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Butte Sub-basin

- M&T Chico Ranch
- Reclamation District No. 1004

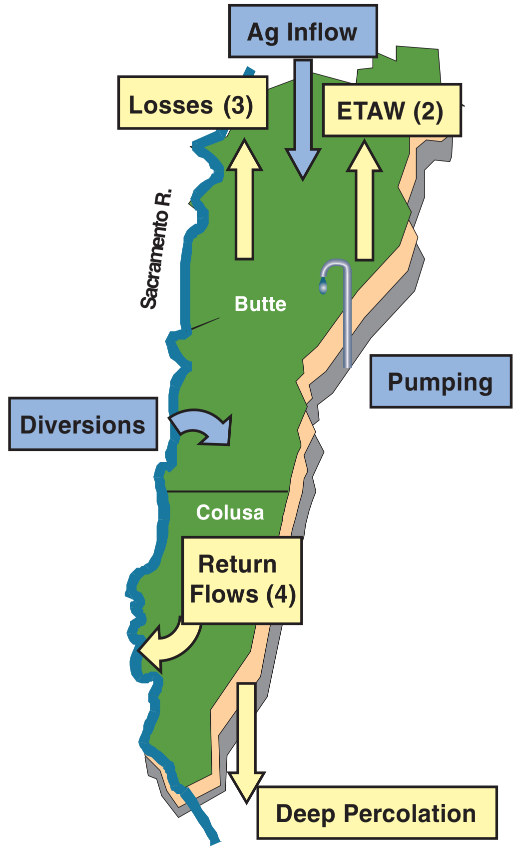
Butte Sub-basin

The Butte Sub-basin, shown on Figure 17, is located on the east side of the Sacramento Valley floor and is bounded on the west by the Sacramento River, on the north by Big Butte Creek, on the east by Butte Creek and Butte Slough, and on the south by the Sacramento River and Butte Slough. The participating SRSCs within this sub-basin include M & T Chico Ranch and RD 1004. Several short-form SRSCs and numerous small riparian diverters are also located in the Butte Sub-basin. No SWP contractors are in the sub-basin.

A water use balance for Butte Sub-basin for 2020 average-year conditions is presented on Figure 17. Under 2020 average conditions for this sub-basin, the following projections are made:

- On average, surface water will provide for approximately 50 percent of the total water supply. Groundwater pumping will represent 30 percent of the total water supply, and reuse of agricultural drainage flow originating from outside the sub-basin will account for 20 percent of the total water supply.
- The participating SRSC's Base and Project Supplies will make up approximately 25 percent of the surface water supply, and just 15 percent of the total water supply.
- Portions of surplus water from precipitation and drainage flows from irrigation flow to Butte Slough are typically rediverted for irrigation before leaving the basin. The sub-basin water balance shows the portion of drainage flow that originates outside the sub-basin, hence providing an additional supply to area. For 2020 average conditions, this supply is approximately 90 taf/yr or approximately 30 percent of the total supply to the region.

Figure 18 presents a water use balance for Butte Sub-basin under 2020 critical-year conditions.



WATER USE (1)

ETAW (2):	Agricultural	=	423
	M&I	=	8
Fall Flooding		=	53
Wildlife Refuges		=	0
SUBTOTAL		=	484
Other:	Losses (3)	=	46
	Deep Perc	=	49
	Return Flows (4)	=	143
TOTAL		=	722

WATER SUPPLY

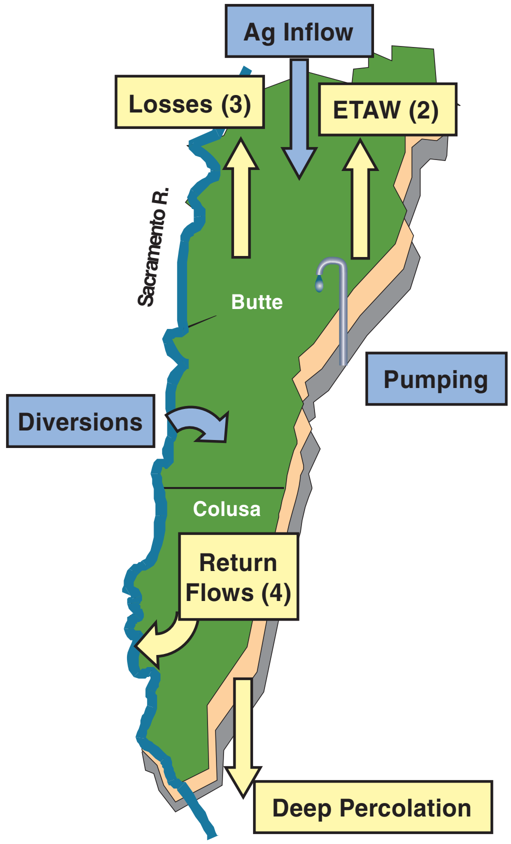
Surface Water Diversions:		
Riparian	=	38
Settlement Contracts:		
Base Supply	=	91
Project Supply	=	16
CVP Water Service Contracts	=	0
Local Surface Water	=	272
SUBTOTAL	=	417
Agricultural Drainage Inflow	=	70
Groundwater Pumping	=	228
TOTAL	=	715

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 20 percent of TOTAL water supply).

Notes:

Includes Detailed Analysis Unit 167 (Butte and Colusa Counties) and Butte County Detailed Analysis Unit 166.
Units = 1,000 acre-feet per year.

FIGURE 17
BUTTE SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS



WATER USE (1)

ETAW (2):	Agricultural	=	471
	M&I	=	8
Fall Flooding		=	53
Wildlife Refuges		=	0
SUBTOTAL		=	532
Other:	Losses (3)	=	41
	Deep Perc	=	47
	Return Flows (4)	=	68
TOTAL		=	690

WATER SUPPLY

Surface Water Diversions:		
Riparian	=	36
Settlement Contracts:		
Base Supply	=	67
Project Supply	=	12
CVP Water Service Contracts	=	0
Local Surface Water	=	252
SUBTOTAL	=	367
Agricultural Drainage Inflow	=	57
Groundwater Pumping	=	255
TOTAL	=	679

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) Estimated (assumed 10 percent of TOTAL water supply).

Notes:

Includes Detailed Analysis Unit 167 (Butte and Colusa Counties) and Butte County Detailed Analysis Unit 166.
Units = 1,000 acre-feet per year.

FIGURE 18
BUTTE SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS

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Sutter Sub-basin

- **Meridian Farms Water Company**
- **Tisdale Irrigation and Drainage Company**
- **Sutter Mutual Water Company**
- **Pelger Mutual Water Company**

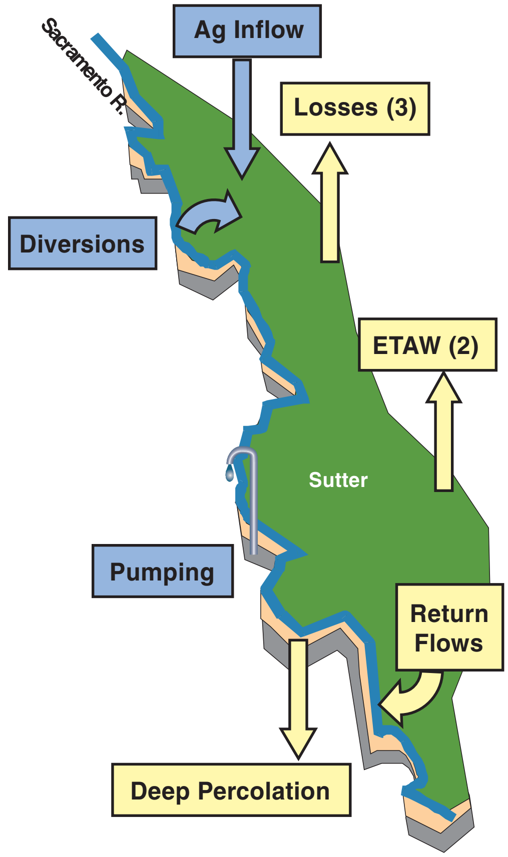
Sutter Sub-basin

For the purposes of the basinwide water use balance, North and South Sutter Sub-basins have been combined to form Sutter Sub-basin, as shown on Figure 19. This combined area encompasses four SRSCs participating in the BWMP. These four SRSCs represent approximately 15 percent of the total SRSC entitlements valleywide. In addition to the participating SRSCs, numerous short-term SRSCs and riparian diverters are located in the Sutter sub-basin. No SWP contractors are in the sub-basin, and groundwater pumping is typically very minor, largely because of the poor-quality groundwater in much of the sub-basin.

A water balance for the Sutter Sub-basin for 2020 average-year conditions is presented on Figure 19. Under 2020 average conditions for this sub-basin, the following projections are made:

- The SRSC Base and Project Supplies will make up approximately 90 percent of the total supplies to this region.
- For the negotiated agreement's average diversion of 284 taf/yr, 211 taf/yr (or 75 percent of this total diversion) is Base Supply, and 73 taf/yr (or 25 percent of the total diversion) is Project Supply. The Project Supply diversions occur during the critical months of July, August, and September.
- The SRSC diversions could range from 240 taf/yr to 360 taf/yr, depending on hydrologic conditions and other outstanding issues (the lower bound representing a combination of 75 percent Base Supply deliveries and approximately 45 percent of Project Supply deliveries, computed from average Project Supply deliveries during critically dry years 1977, 1991, 1992, and 1994; the upper bound represents maximum diversion of current Base and Project Supply entitlements).
- Given the limited use of groundwater in the sub-basin, dry-year reductions in diversion are likely made up by increased reuse within the sub-basin, increased reliance on agricultural drainage inflows originating from outside the sub-basin, purchase of water from sources outside the sub-basin, and changes in crop types and acreages.

Figure 20 presents a water use balance for Sutter Sub-basin under 2020 critical-year conditions.



WATER USE (1)

ETAW (2):	Agricultural	=	180
	M&I	=	5
Fall Flooding		=	12
Wildlife Refuges		=	1
SUBTOTAL		=	198
Other:	Losses (3)	=	16
	Deep Perc	=	31
	Return Flows	=	69
TOTAL		=	314

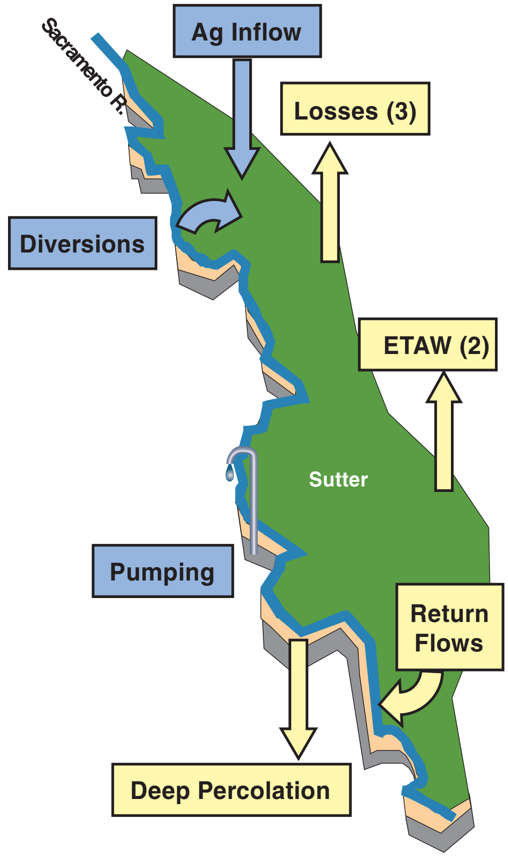
WATER SUPPLY

Surface Water Diversions:		
Riparian	=	9
Settlement Contracts:		
Base Supply	=	211
Project Supply	=	73
CVP Water Service Contracts	=	0
Local Surface Water	=	1
SUBTOTAL	=	294
Agricultural Drainage Inflow	=	21
Groundwater Pumping	=	3
TOTAL	=	318

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.

Note:
Units = 1,000 acre-feet per year.

FIGURE 19
SUTTER SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS



WATER USE (1)

ETAW (2):	Agricultural	=	205
	M&I	=	7
Fall Flooding		=	12
Wildlife Refuges		=	1
SUBTOTAL		=	225
Other:	Losses (3)	=	11
	Deep Perc	=	22
	Return Flows	=	27
TOTAL		=	285

WATER SUPPLY

Surface Water Diversions:		
Riparian	=	9
Settlement Contracts:		
Base Supply	=	175
Project Supply	=	66
CVP Water Service Contracts	=	0
Local Surface Water	=	1
SUBTOTAL	=	251
Agricultural Drainage Inflow	=	21
Groundwater Pumping	=	5
TOTAL	=	277

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.

Note:
Units = 1,000 acre-feet per year.

FIGURE 20
SUTTER SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS

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American Sub-basin

- ❑ **Natomas Central Mutual Water Company**

American Sub-basin

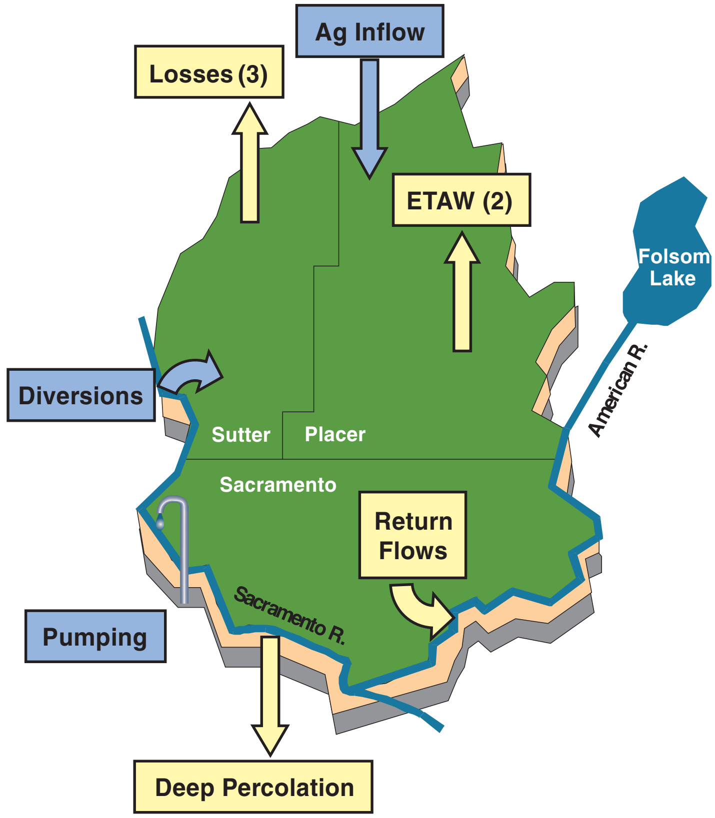
The American Sub-basin, shown on Figure 21, is bounded on the west by the Sacramento and Feather Rivers, on the north by the Bear River, and on the south and southeast by the American River. The eastern boundary is defined as the edge of the Sacramento Valley floor. Like the Redding Sub-basin, this sub-basin is unique in that a large proportion of municipal users are present throughout the area, including parts of the City and County of Sacramento, and urban centers in Placer County, such as the City of Roseville. Most of the area is served with surface water or a combination of surface water and groundwater.

NCMWC is the only participating SRSC within this sub-basin. Other Sacramento River negotiated agreements include Pleasant Grove-Verona Mutual Water Company and numerous short-form SRSCs. Other major water users in the sub-basin include various CVP contractors associated with the American River, South Sutter Water District, Nevada Irrigation District; riparian diverters associated with the Sacramento, American, Feather, and Bear Rivers; and groundwater users. No SWP contractors are in the sub-basin.

A water balance for the American Sub-basin for 2020 average-year conditions is presented on Figure 21. Under 2020 average conditions for this sub-basin, the following projections are made:

- On average, surface water and groundwater pumping will be approximately 60 percent and 40 percent of the total water supply, respectively.
- The SRSC diversions make up approximately one-half of the surface water supply, the balance being associated with local supplies.
- For the SRSC's average 2020 diversions of 165 taf/yr, 145 taf/yr (or 70 percent of this total diversion) is Base Supply, and the remainder is Project Supply. These Project Supply diversions occur during the months of July, August, and September.
- The SRSC diversions could range from 210 taf/yr to 350 taf/yr, depending on hydrologic conditions and other outstanding issues.

Figure 22 presents a water use balance for American Sub-basin under 2020 critical-year conditions.



WATER USE (1)

ETAW (2):	Agricultural	=	261
	M&I	=	175
Fall Flooding		=	9
Wildlife Refuges		=	45
SUBTOTAL		=	490
Other:	Losses (3)	=	40
	Deep Perc	=	118
	Return Flows	=	150
TOTAL		=	798

WATER SUPPLY

Surface Water Diversions:		
Riparian (4)	=	120
Settlement Contracts:		
Base Supply	=	145
Project Supply	=	20
CVP Water Service Contracts	=	56
Local Surface Water	=	142
SUBTOTAL	=	483
Agricultural Drainage Inflow	=	19
Groundwater Pumping	=	295
TOTAL	=	798

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) American River Water Rights diversions.

Note:
Units = 1,000 acre-feet per year.

FIGURE 21
AMERICAN SUB-BASIN
AVERAGE-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS

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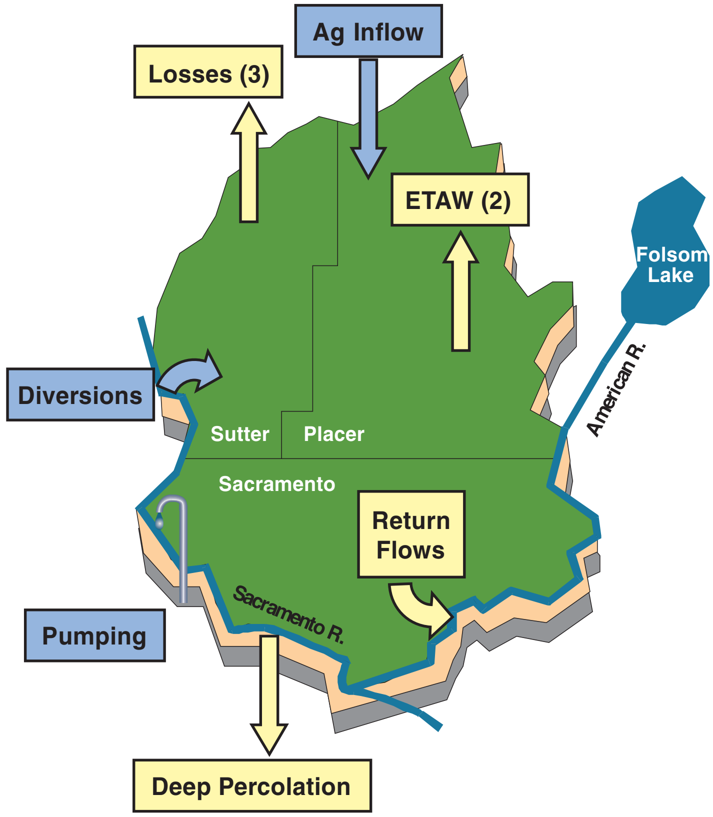
MBK



WATER USE (1)

ETAW (2):	Agricultural	=	305
	M&I	=	201
Fall Flooding		=	9
Wildlife Refuges		=	45
SUBTOTAL		=	560
Other:	Losses (3)	=	34
	Deep Perc	=	111
	Return Flows	=	37
TOTAL		=	743

WATER SUPPLY

Surface Water Diversions:			
	Riparian (4)	=	92
Settlement Contracts:			
	Base Supply	=	118
	Project Supply	=	18
CVP Water Service Contracts		=	42
Local Surface Water		=	128
SUBTOTAL		=	398
Agricultural Drainage Inflow		=	19
Groundwater Pumping		=	295
TOTAL		=	712

(1) Net of effective precipitation.
(2) ETAW = Evapotranspiration of Applied Water. Source: DWR Bulletin 160-98.
(3) Losses consist of evaporation from conveyance facilities and riparian vegetation.
(4) American River Water Rights diversions.

Note:
Units = 1,000 acre-feet per year.

FIGURE 22
AMERICAN SUB-BASIN
CRITICAL-YEAR WATER USE BALANCE
2020 PROJECTED CONDITIONS

Definition of Terms Used in the Sub-basin Water Use Balances

Water Supply

Surface Water: Surface water supplied to the area for agricultural, M&I, and environmental purposes. The supply may be from a single source, or a combination of several sources. Sources may include riparian diversions from the Sacramento River, Sacramento River SRSC diversions, Central Valley Project Agricultural Water Service Contractor diversions, State Water Project diversions, and local stream diversions.

Groundwater: Total groundwater pumped in the area for agricultural and M&I purposes.

Drainage: Total drainage water originating from adjacent areas outside the sub-basin and used in the sub-basin for agricultural purposes.

Depletion/Outflow

ETAW (Evapotranspiration of Applied Water) - Agricultural: the portion (acre-feet [ac-ft] per acre) of the total evapotranspiration [ET] that is provided by irrigation; thus, ETAW = actual ET minus the ET met by precipitation [effective precipitation]). The portion of crop consumptive use met by applied water.

ETAW – M&I: The portion of M&I consumptive use (i.e., outdoor use) met by applied water.

Environmental Requirements: The portion of environmental requirements (such as refuge requirements) met by applied water.

Other Requirements: The portion of applied water consumed for other uses such as rice flooding.

Losses: Conveyance system evaporation, riparian evapotranspiration (also referred to as ET), and miscellaneous agricultural evapotranspiration.

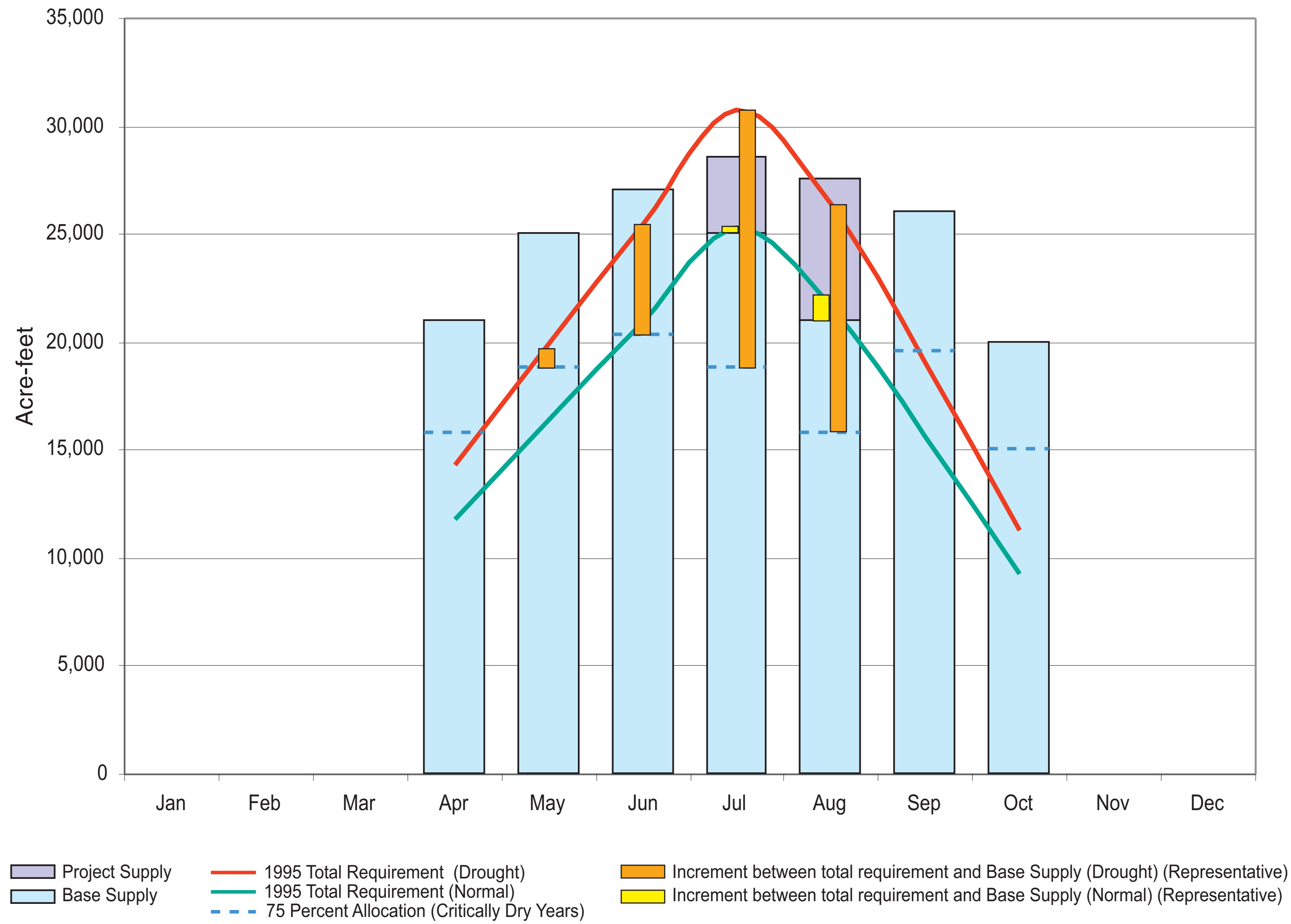
Return Flow: Total surface water returned to the river.

Deep Percolation: Percolation to groundwater from applied water and from conveyance system leakage.

NOTES

1. The sub-basin water use balance depicts average annual supplies, depletions, and outflows associated with land and water use under 2020 projected level of demand (average-year conditions).
2. The sub-basin water use balance does not depict of all the components of the hydrologic cycle. For example, subsurface groundwater inflow, stream-aquifer gains and losses, or flood flows are not part of the water use balance.
3. The data were derived from DWR water budget tables developed for Detailed Analysis Unit/County subareas. Certain data items from these tables were aggregated into common groups to simplify the presentation of the sub-basin water use balance. These simplifications may result in slight discrepancies from the DWR water budget tables.

Appendix A
Monthly Water Requirement Curves



Assumptions: Seepage = 27 percent (of canal supply)
Operational Spills = 20 percent (of canal supply)

FIGURE A-1
ANDERSON-COTTONWOOD IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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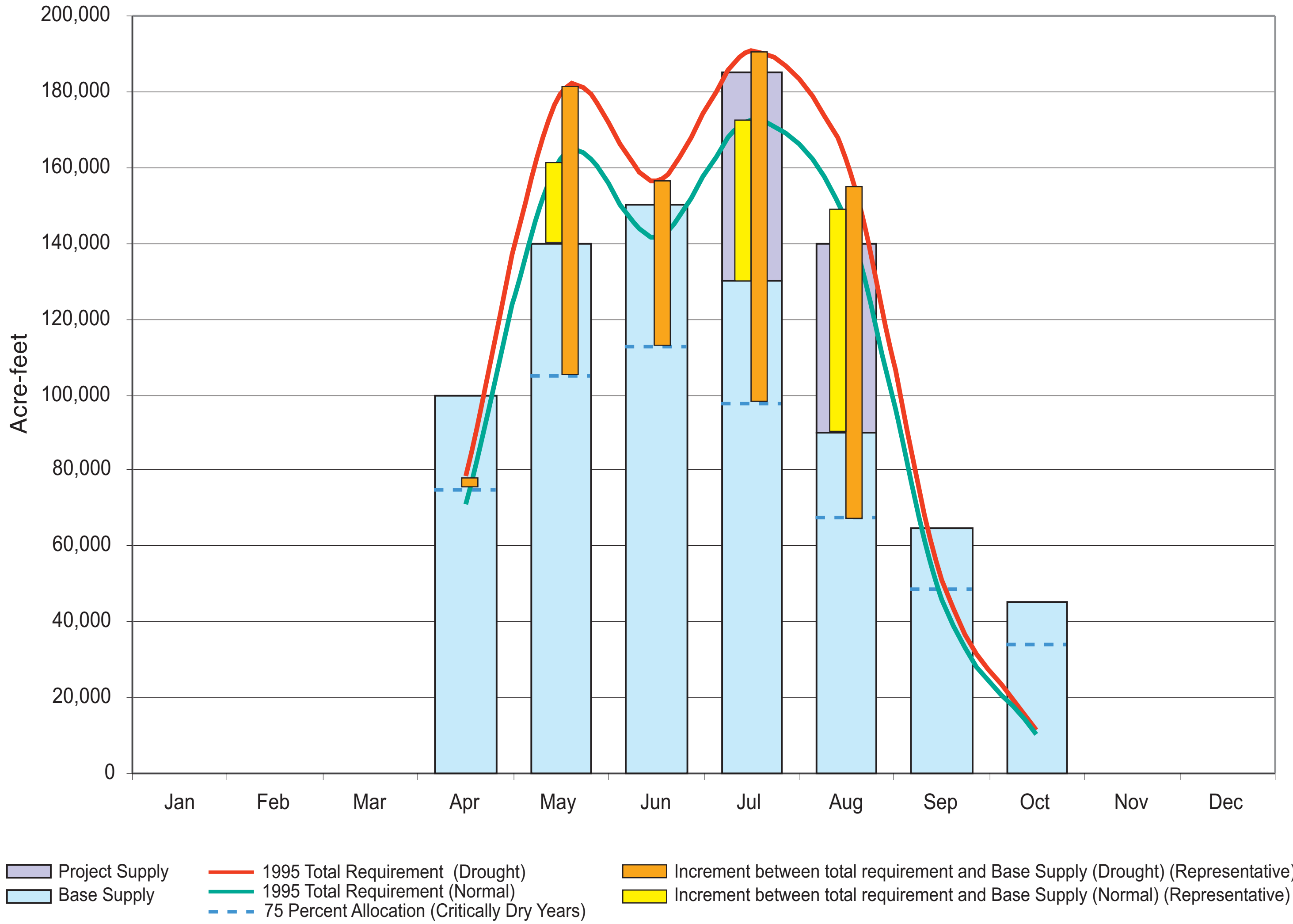
MBK



Assumptions: Seepage = 13 percent (of canal supply)
Operational Spills = 5 percent (of canal supply)

FIGURE A-2
GLENN-COLUSA IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

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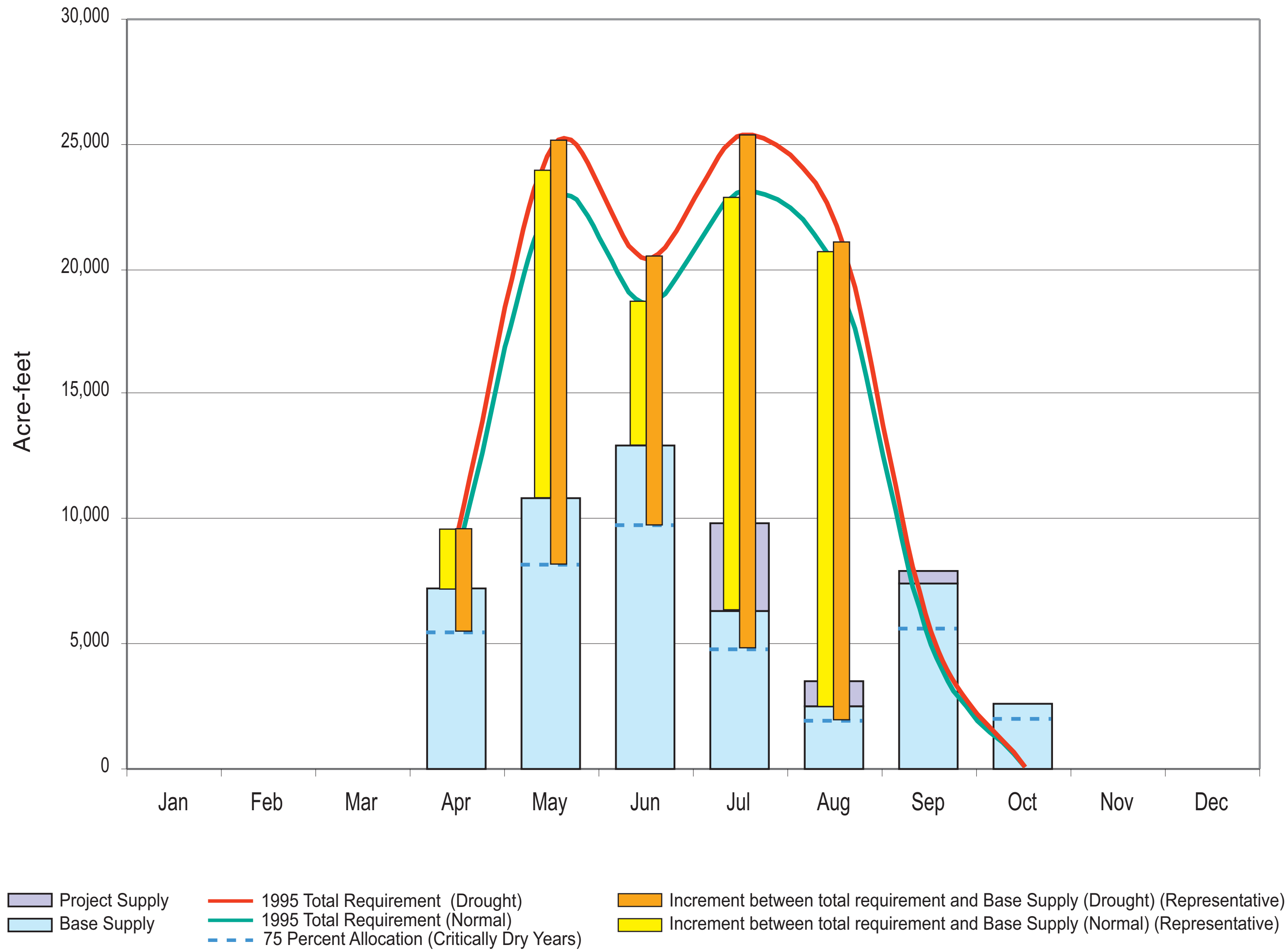
MBK
W062004006RDD_32_TM 4 (7/29/04)



Assumptions: Seepage = 12 percent (of canal supply)
Operational Spills = 10 percent (of canal supply)

FIGURE A-3
PROVIDENT IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

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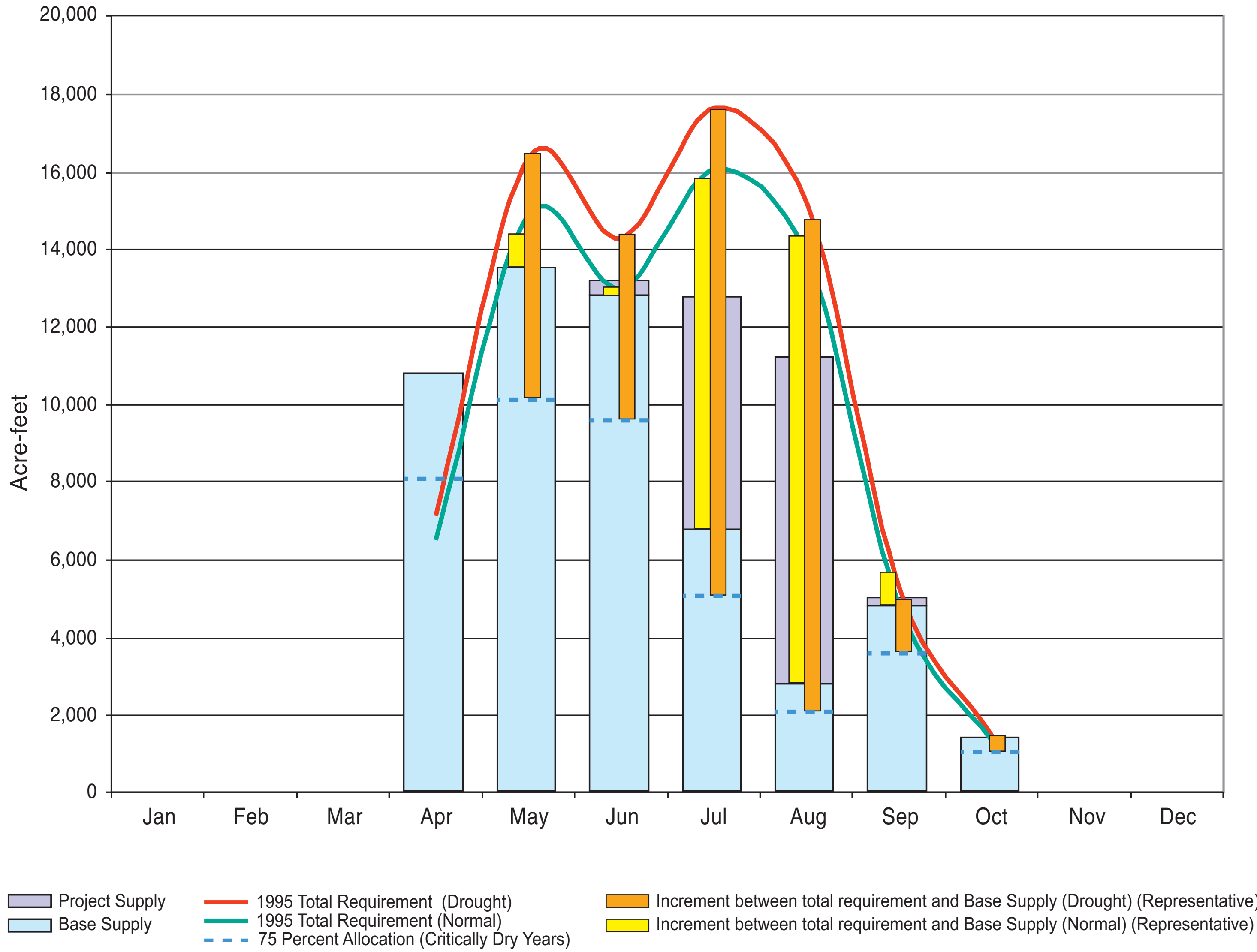
MBK

W062004006RDD_35_TM 4 (7/29/04)



Assumptions: Seepage = 20 percent (of canal supply)
Operational Spills = 10 percent (of canal supply)

FIGURE A-4
PRINCETON-CORORA-GLENN IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

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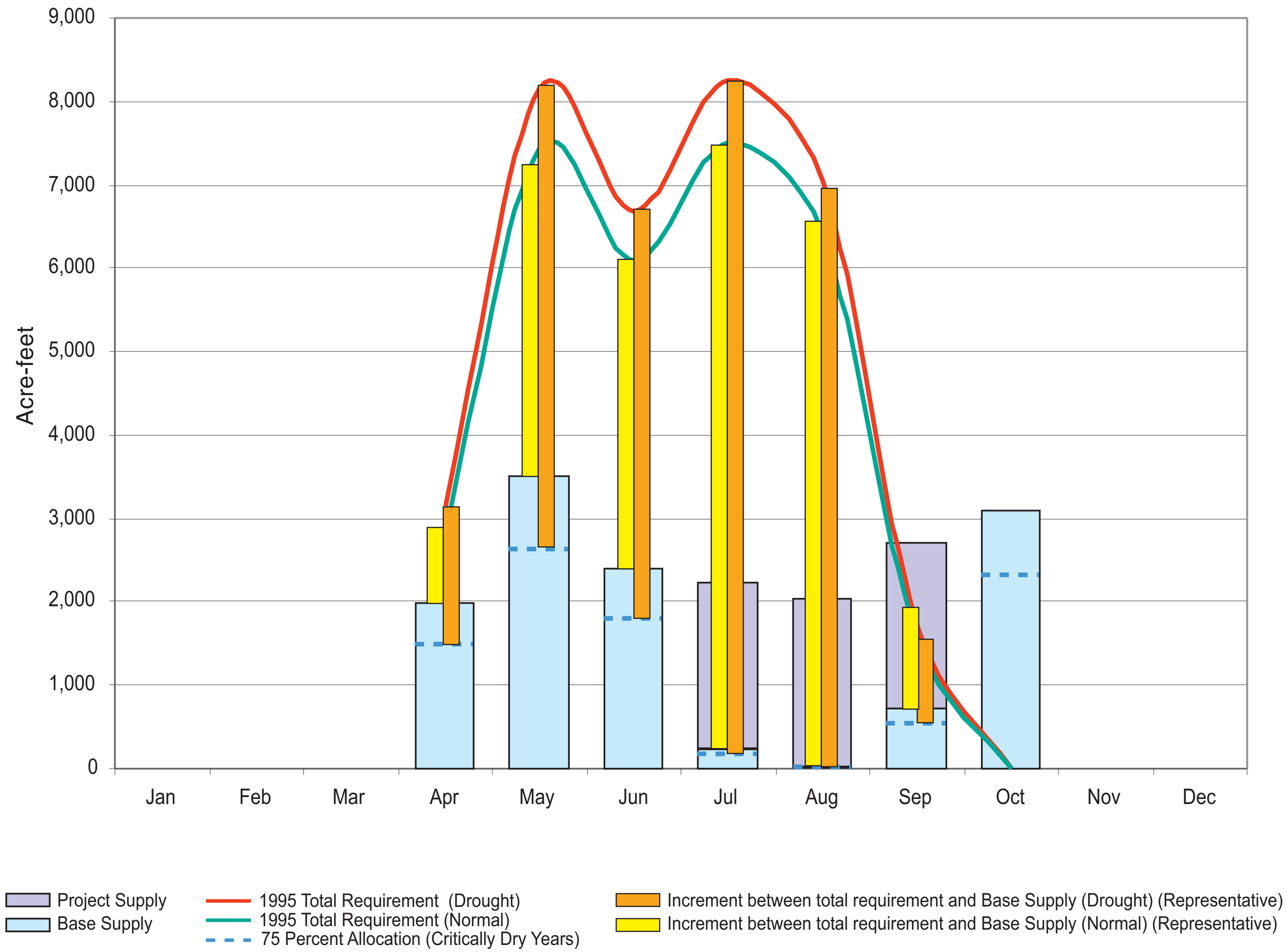
MBK



Assumptions: Seepage = 15 percent (of canal supply)
Operational Spills = 5 percent (of canal supply)

FIGURE A-5
MAXWELL IRRIGATION DISTRICT
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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in association with
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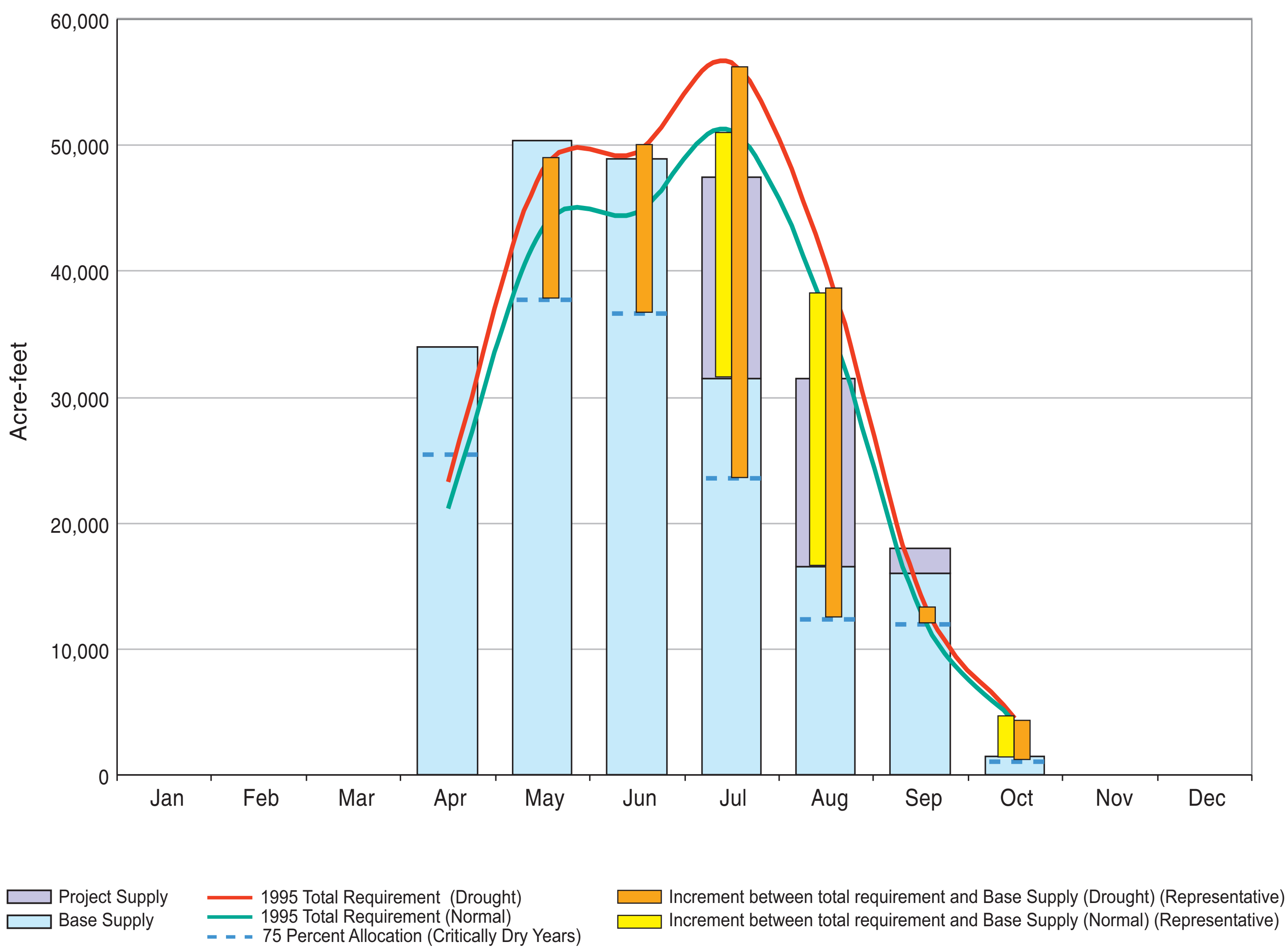

Assumptions: Seepage = 10 percent (of canal supply)
Operational Spills = 5 percent (of canal supply)

FIGURE A-6
RECLAMATION DISTRICT NO. 108
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

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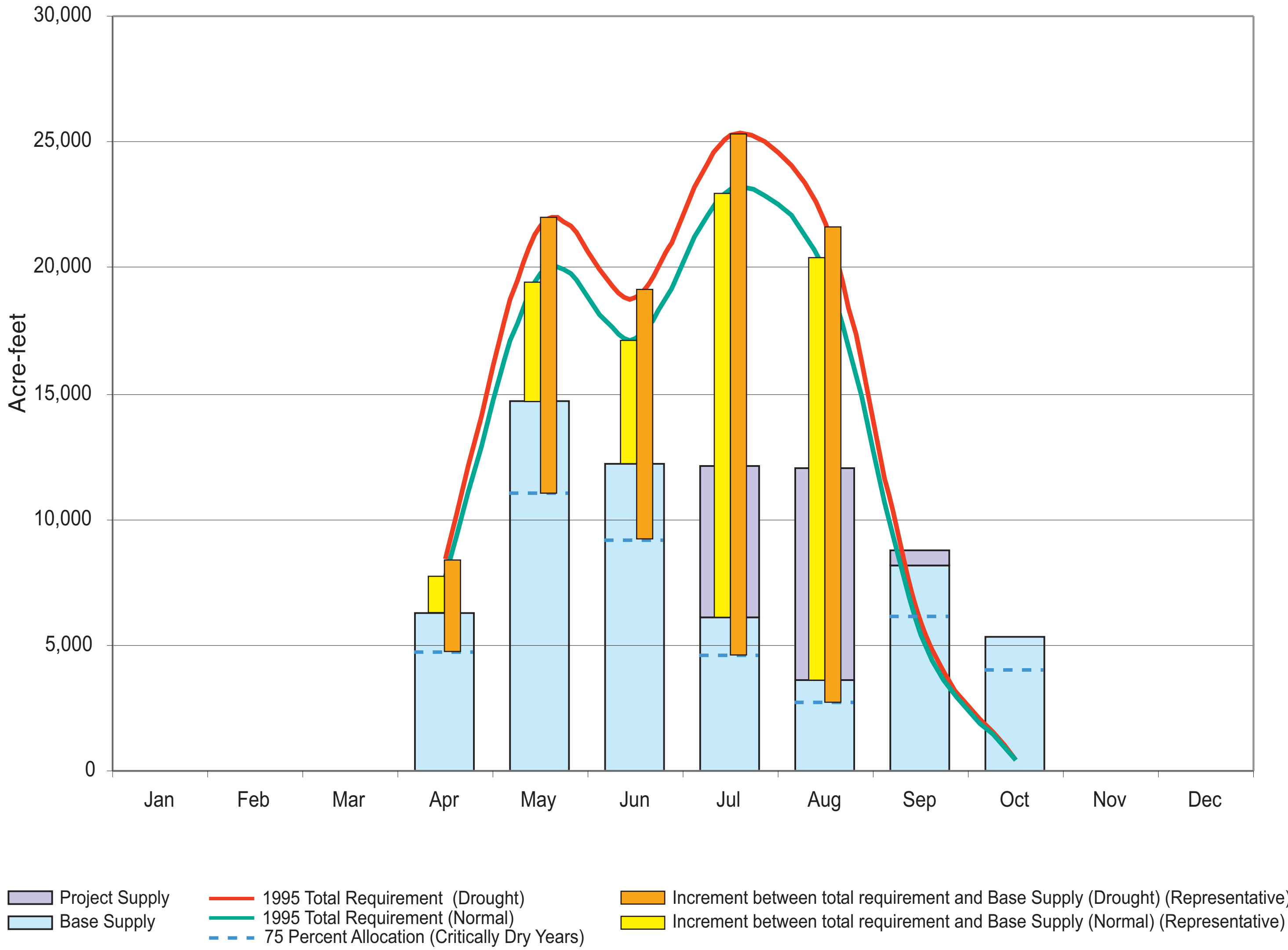

Assumptions: Seepage = 15 percent (of canal supply)
Operational Spills = 5 percent (of canal supply)

FIGURE A-7
RECLAMATION DISTRICT NO. 1004
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY
TM 4 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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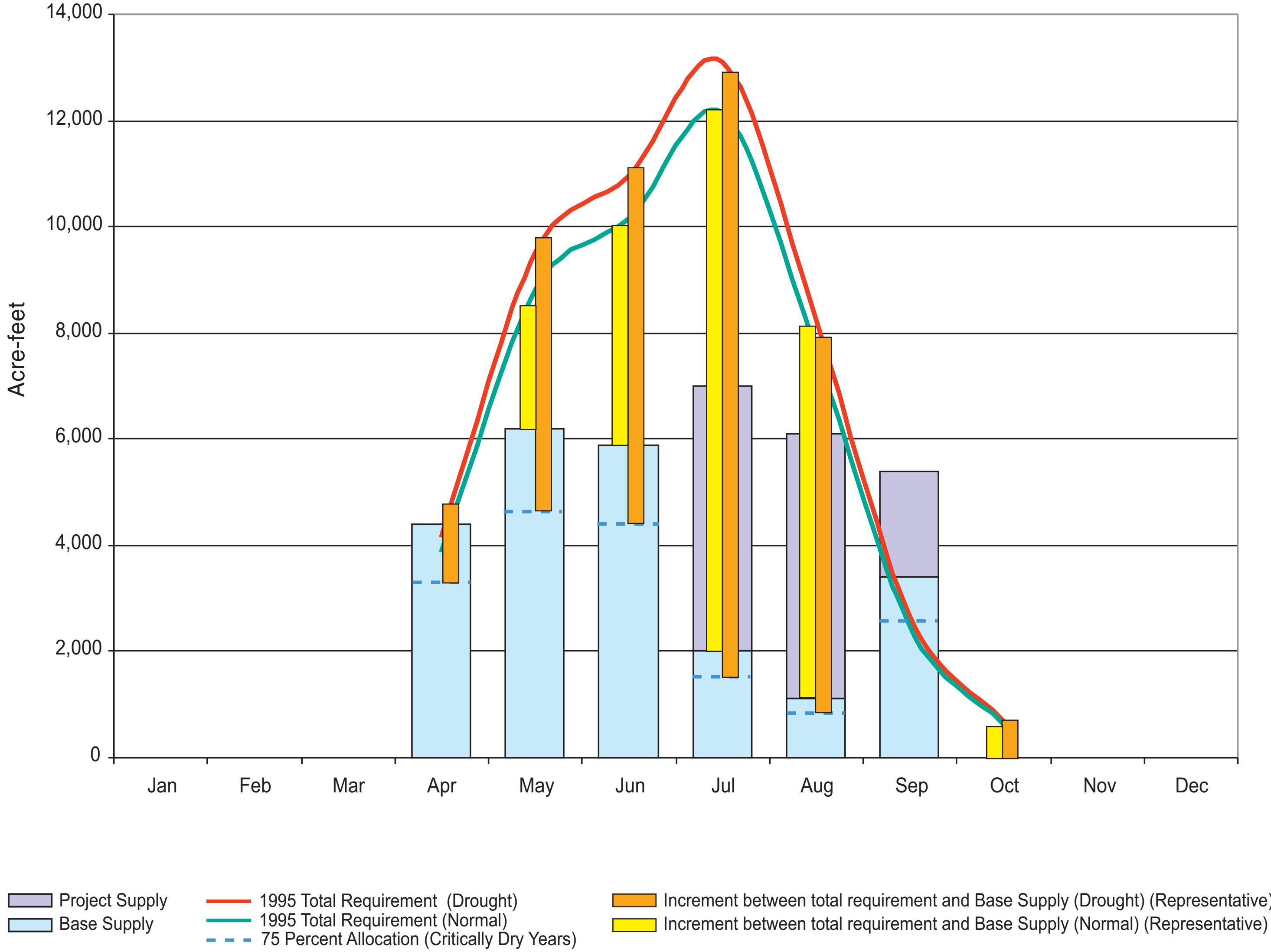

Assumptions: Seepage = 15 percent (of canal supply)
Operational Spills = 10 percent (of canal supply)

FIGURE A-8
MERIDIAN FARMS WATER COMPANY
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY
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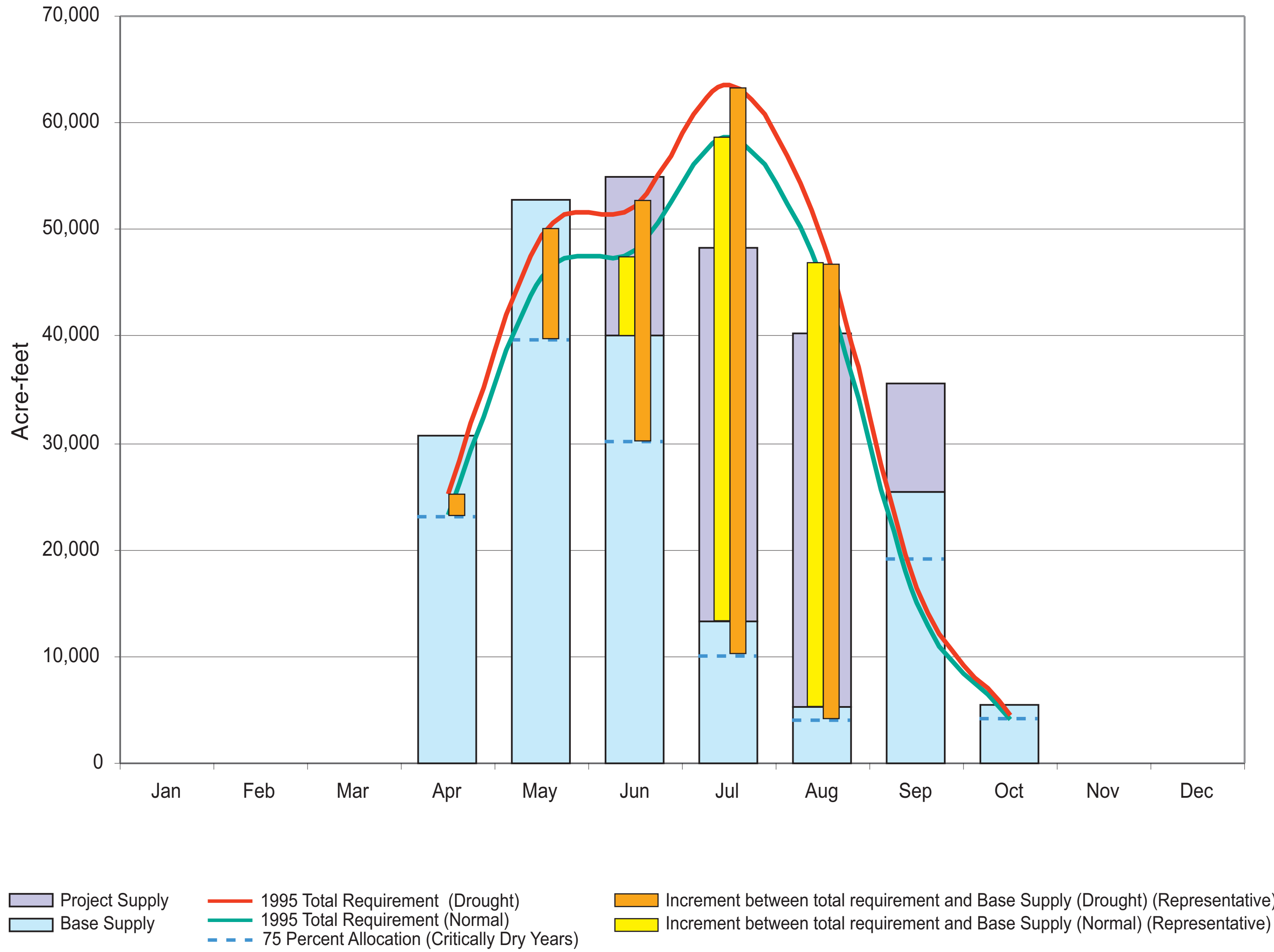

Assumptions: Seepage = 15 percent (of canal supply)
Operational Spills = 5 percent (of canal supply)

FIGURE A-9
SUTTER MUTUAL WATER COMPANY
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

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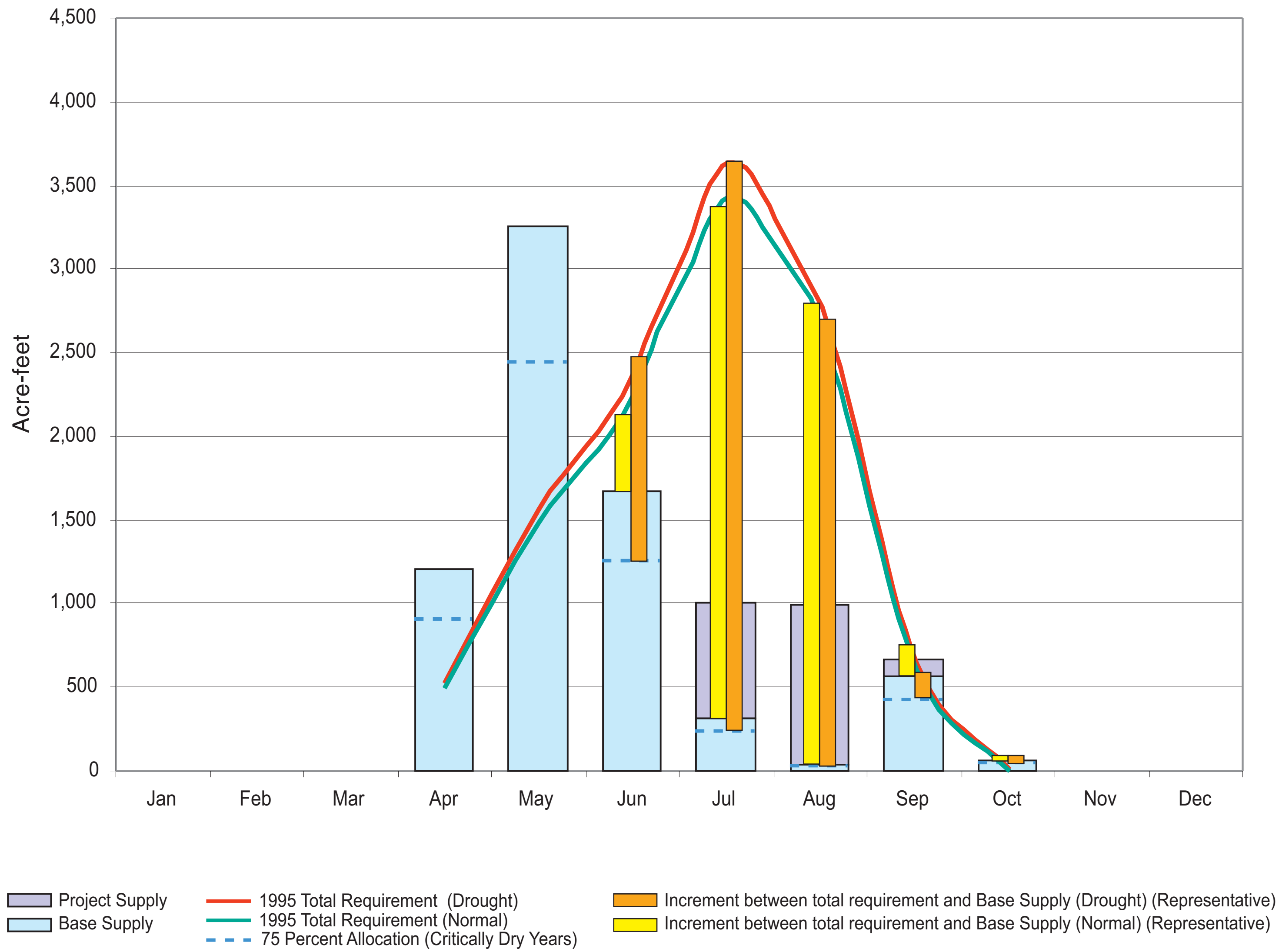

Assumptions: Seepage = 10 percent (of canal supply)
Operational Spills = 5 percent (of canal supply)

FIGURE A-10
PELGER MUTUAL WATER COMPANY
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

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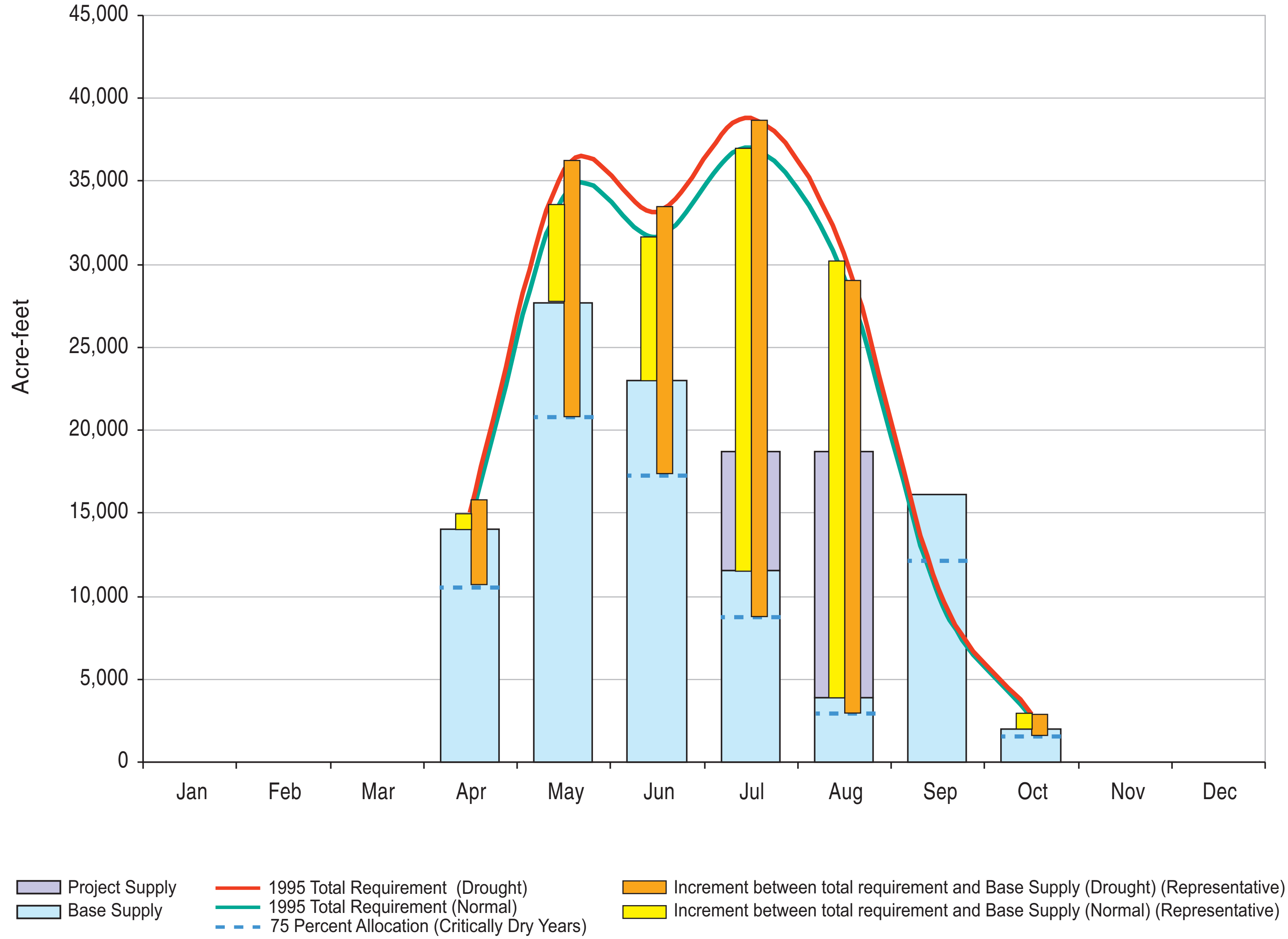

Assumptions: Seepage = 10 percent (of canal supply)
Operational Spills = 5 percent (of canal supply)

FIGURE A-11
NATOMAS CENTRAL MUTUAL WATER COMPANY
MONTHLY CONTRACT SUPPLY
TOTAL DISTRICT REQUIREMENTS AND INCREMENT OF TOTAL DISTRICT WATER REQUIREMENTS NOT MET BY BASE SUPPLY

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Technical Memorandum No. 5

Sacramento River Basinwide Water Management Plan Water Management and Supply Options

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MBK

October 2004

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Figures

Acronyms and Abbreviations

$/ac-ft	dollars per acre-foot
AB	Assembly Bill
ac-ft	acre-feet
ac-ft/yr	acre-feet per year
ACID	Anderson-Cottonwood Irrigation District
AWMC	Agricultural Water Management Council
BMP	Best Management Practice
BWMP	Basinwide Water Management Plan
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DWR	California Department of Water Resources
EWMP	efficient water management practice
GCID	Glenn-Colusa Irrigation District
ISI	Integrated Storage Investigation
maf	million acre-feet
MFWC	Meridian Farms Water Company
MID	Maxwell Irrigation District
MOU	Memorandum of Understanding
NWR	National Wildlife Refuge
NCMWC	Natomas Central Mutual Water Company
O&M	operations and maintenance
PCGID	Princeton-Codora-Glenn Irrigation District
PID	Provident Irrigation District
PMWC	Pelger Mutual Water Company
Pool	Sacramento River Water Contractors' Association Project Water Pool
RD 1004	Reclamation District No. 1004
RD 108	Reclamation District No. 108

Reclamation	U.S. Bureau of Reclamation
SCADA	supervisory control and data acquisition
SRSC	Sacramento River Settlement Contractors
Standard Criteria	Standard Criteria for Evaluating Water Management Plans
SVWMA	Sacramento Valley Water Management Agreement
SWMC	Sutter Mutual Water Company
SWRCB	State Water Resources Control Board
taf	thousand acre-feet
TCCA	Tehama-Colusa Canal Authority
TM	technical memorandum
UC	University of California
VFD	variable-frequency drives
WCP	Water Conservation Plan
WUE	water use efficiency

Introduction

Scope and Purpose

Technical Memorandum (TM) No. 5 develops and evaluates a wide range of water management and supply options required to help meet the water needs identified in TM 4, *District Water Requirement and CVP Supply/Sub-basin Water Balances*. Water management and supply options that may be applicable at a district level and/or basinwide level are considered. Each option is evaluated using a range of criteria, including the following:

- Water supply yield
- Capital costs
- Operations and maintenance (O&M) costs
- Annual cost per acre-foot (ac-ft) of new or conserved water
- Potential secondary impacts such as environmental benefits or drawbacks
- Applicable institutional issues

The three main goals of this TM are as follows:

1. Develop a wide range of water supply and management options, for both individual districts and basinwide consideration.
2. Conduct preliminary evaluation of these options.
3. Summarize preliminary analysis results to assist in producing a refined list of local and regional water management and supply options that can then be combined into a range of comprehensive basinwide management plan alternatives.

The wide range of options considered in this TM cannot all be analyzed at the same level of detail. Generally, the options that involve specific capital improvements or operations modifications within a given Sacramento River Settlement Contractor's (SRSC) service area, such as canal lining or automation, can be analyzed using specific methodology for sizing and location of facilities, estimating capital and O&M costs, and approximate yield or water savings. Other options, such as Central Valley Project (CVP) re-operations and water transfers, are very complex and have too many uncertainties regarding implementation to permit detailed evaluation within the scope of this TM. Evaluations of these options will require future cooperative work by the involved parties, such as CVP modeling of reservoir release patterns and development of specific transfer proposals. Analysis of these options in this TM is limited to summarizing current conditions, identifying potential benefits from the option, and identifying major implementation issues for further development.

TM 5 addresses the following questions to set the framework for evaluating the water supply and management options:

- What specific water management and supply options should be considered?
- For each option, does implementation result in net new water supplies, increased management efficiency and flexibility, or both?

- Using the regional flow-path concept, where and how does the option impact local and regional water balances?
- Are the water supply and management options compatible with recommendations from established state and federal water management and conservation programs?

Each of these is addressed in more detail below. Within this framework, the remainder of the TM discusses each option, including the current status or level of development, potential benefits and goals for future development, and major implementation issues. For each SRSC, a summary evaluation of the water management and supply options is presented.

General Classification of Options

As discussed above, TM 5 presents a wide range of options that may be considered for implementation as part of a basinwide water management plan. Each option is distinctive in terms of how it affects the fundamental water supply and demand balance and in terms of the physical and institutional factors that impact its overall effectiveness and implementation. To address these complexities, it is helpful to classify options into basic categories for discussion and analysis. The categories used in this TM are based on two fundamental considerations.

First, does the option primarily involve net new water supplies (supply option), or is it focused on more efficient and flexible use of existing supplies (management option)? An example of a "supply option" would be the development of new surface water supply through offstream storage, as this would potentially provide a net increase in the water supply to a SRSC or the basin. An example of a "management option" would be canal system automation, which may help reduce net conveyance losses within an SRSC service area by reducing end-spills and therefore increase the efficiency of the water conveyance system. The end-spill water loss is recoverable for other uses because it either returns to the river, percolates to groundwater, or is reused through drainwater pumping. From a regional perspective, there is no net gain in water supply. However, the change in river diversion timing and/or quantity may have some benefits from an overall river management viewpoint by increasing in-stream flows within a specific reach of the river. Management options that reduce "irrecoverable losses," such as conveyance leakage or deep percolation to a saline groundwater sink, may be viewed as increasing the net water supply. However, such losses are essentially insignificant in the Sacramento Valley, with the minor exception of the area influence by connate groundwater, incidental evapotranspiration by plants, and evaporation from open channels.

Secondly, can the option be implemented by individual water suppliers (SRSCs), or is it primarily an option that requires regional implementation to be effective? For example, conveyance facility automation is considered a "district-level" option because its implementation and effectiveness are largely driven by each district's unique distribution system layout and delivery methods. Conversely, offstream storage would be considered a "basin-level" or regional option because the large capital investment and complexity of implementation would likely be warranted only with multiple users and regional benefits.

These two broad categories, supply/management and district level/regional, are not exclusive, and many options can reasonably be classified as both supply and management focused, and applicable at a district level and/or regional level. However, these categories do provide a useful starting point for screening of the options, based on where in the overall "flow path" the option has influence, and at what institutional level it would be implemented.

Table 1 lists the water supply and management options that are analyzed in this TM. For each option, information is presented in the respective section of this TM.

TABLE 1
Water Supply and Management Options Menu

Option	Supply/Management	District/Basin Level
Groundwater Development	Supply/Management	Both
Drainwater Reuse	Management	Both
Canal Lining	Management	District
Conveyance Systems Automation	Management	District
Water Measurement	Management	District
Incentive Pricing	Management	District
Conjunctive Water Management Program	Both	Sub-basin/regional
CVP Project Water Supply Purchases	Supply	District
CVP Operational Changes	Both	Sub-basin/regional
Water Transfers	Both	Both
Offstream Storage	Supply	Sub-basin/regional

Flow-path Concept

The flow-path concept can be a useful visual and accounting tool to show where each option influences the overall water supply system, diversions, distribution, use, and return to the source. The flow path shows the interdependent aspects of water supply and management options and where particular options may have an influence in the overall flow path. Figure 1 shows a simple flow-path diagram for a typical Sacramento Valley agricultural water system.

State and Federal Agricultural Water Use Efficiency Programs

The development of the Sacramento River Basinwide Water Management Plan (BWMP) is taking place in a period of increased state and federal water management efforts, whose outcomes may have profound impacts on the Sacramento Valley's water resources. In developing the water management and supply options for the BWMP, it is necessary to keep the state and federal programs in mind. State and federal programs potentially influence water use efficiency (WUE) standards, regulatory impacts, and possible funding sources for specific capital projects through cooperative arrangements with state and/or federal initiatives. The following are four primary programs at this time:

- The state-level Assembly Bill (AB) 3616 Agricultural Water Management Council Program.
- The CVP Improvement Act (CVPIA) of 1992, which required the U.S. Bureau of Reclamation (Reclamation) to develop criteria to evaluate water management plans, and to evaluate these plans by those criteria.

- The joint federal-state CALFED Agricultural WUE Program (agricultural water management council), as a component of the overall CALFED program.
- Section 210(b) of the Reclamation Reform Act of 1982, which required the preparation and submittal of a Water Conservation Plan (WCP) from certain entities that have entered into a repayment contract or water service contract with Reclamation; these plans must be updated every 5 years.

The following sections present a brief overview of these programs and key elements that are relevant to the formulation of water supply and management options for the BWMP.

Assembly Bill 3616 Program

The AB 3616 (Agricultural Water Suppliers Efficient Water Management Practices Act of 1990) Program facilitated the cooperative development of a standardized process for identifying, evaluating, and implementing efficient water management practices (EWMP). In 1996, a Memorandum of Understanding (MOU) was signed between the California Department of Water Resources (DWR) and agricultural water supply agencies throughout the state. The MOU established specific basic standards for water management plans, processes for evaluating and implementing EWMPs, and a list of specific EWMPs. The MOU also established the Agricultural Water Management Council (AWMC), which is an entity formed by parties to the MOU, to review and approve AB 3616 EWMPs submitted by participating water suppliers.

Not all EWMPs are applicable to each district. Rather, a combination of some range of EWMPs is selected using the evaluation procedures in the MOU. The EWMPs fall into one of three categories, depending on the level of evaluation required before implementation. Table 2 summarizes the EWMPs by category.

Not all of the SRSCs participating in the BWMP are signatories to the AB 3616 MOU. However, this TM does address most of the "conditionally applicable" and "other" options under AB 3616. The generally applicable EWMPs, with the exception of having a formal AB 3616 plan, have been implemented by each SRSC. Many of the EWMPs are similar to measures listed in the Reclamation program below.

Reclamation Contractors Water Management Plan Program

In response to the 1982 Reclamation Reform Act and the more recent CVPIA mandates, Reclamation requires that all agriculture water contractors serving over 2,000 acres implement a water management plan. The purpose of the plans is to ensure the highest level of WUE that can be reasonably achieved with cost-effective Best Management Practices (BMP). Reclamation has developed "Standard Criteria for Evaluating Water Management Plans" (Standard Criteria), which require minimum contents, level of detail, and analysis of a water management plan, and a list of BMPs (December 2002).

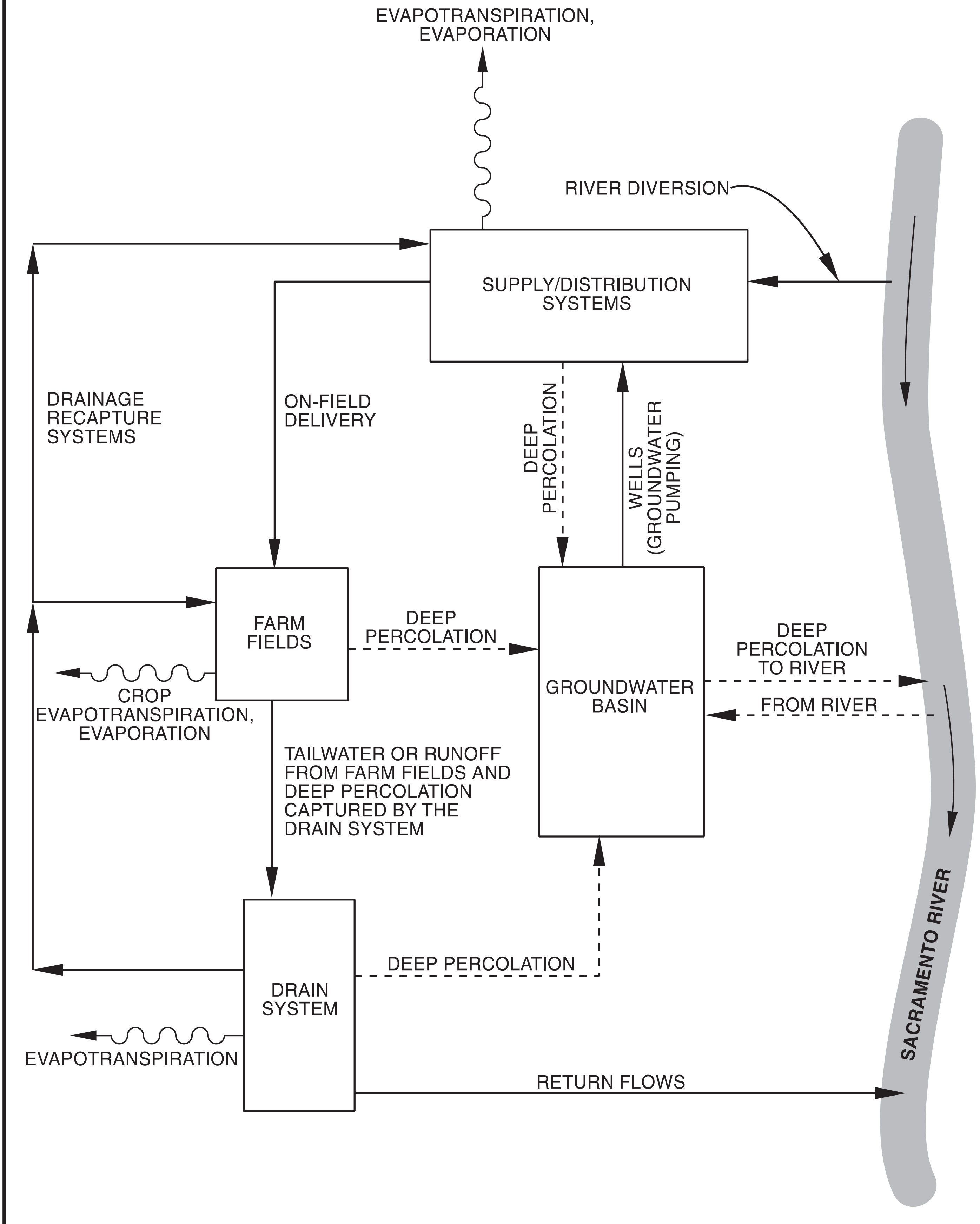

FIGURE 1
FLOW-PATH DIAGRAM
TM 5 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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W062004006RDD_812_TM 5 (7/12/04)

TABLE 2
Summary of AB 3616 Efficient Water Management Practices

Generally Applicable EWMPs	Conditionally Applicable EWMPs	Other EWMPs
Prepare and adopt WMP	Facilitate alternative land use	Water measurement and water use reports
Designate water conservation coordinator	Facilitate recycled water use	Pricing incentives
Support cooperative water management services to other water suppliers	Facilitate financing of on-farm capital improvements for irrigation systems	
Support communication and cooperation among suppliers, users, and agencies	Facilitate voluntary water transfers	
Evaluate institutional changes that facilitate flexible deliveries and storage	Line or pipe ditches and canals	
Evaluate and improve supplier pump efficiencies	Increase operating flexibility to match supply and demand	
	Spill- and tailwater recovery systems	
	Conjunctive water management of groundwater and surface water	
	Automate canal structures	

Standard Criteria

The 2002 Standard Criteria lists two levels of BMPs: "critical BMPs," which are required to meet the water management plan requirements; and "exemptable BMPs," which are to be implemented unless a contractor can show that the particular BMP is not appropriate based on a standard list of factors (cost, legality, and environmental impacts). Table 3 lists the critical and exemptable BMPs, most of which are addressed in this TM. The Standard Criteria has been developed in coordination with the AWMC and is intended to satisfy both the AWMC requirements and the Reclamation water management plan requirements. Participation by a contractor in discretionary benefit programs sponsored by Reclamation generally requires compliance with the Standard Criteria and completion of an approved water management plan. The Standard Criteria was originally approved in 1993 as criteria for evaluating water management plans. Pursuant to CVPIA Section 3405e, these criteria are updated every 3 years.

TABLE 3
Summary of Reclamation 2002 Standard Criteria BMPs

Critical BMPs	Exemptable BMPs
Water measurement (three categories of devices)	Facilitate alternative land use changes in high water-duty areas
Designate a water conservation coordinator	Facilitate use of available recycled water (M&I, not drain)
Provide or support water management services (e.g., University of California [UC] Extension) to water users	Facilitate financing of on-farm capital improvements related to irrigation efficiency
Pricing structure – based at least in part on quantity delivered	Incentive pricing to encourage one or more of the following: • Increased farm-level efficiency • Planned conjunctive water management • Increased groundwater recharge • Reduced problem drainage • Management of environmental resources • Effective management of all water sources throughout the season by adjusting seasonal rates based on current conditions
Evaluate policies of supplying agency (Reclamation) for increased flexible delivery	Lining or piping of canals and ditches
Evaluate and improve pump efficiencies of contractor's pump	Increase flexibility of water delivery to users
	Tailwater recovery
	Optimize conjunctive water management of surface water and groundwater
	Automation of canal control structures
	Facilitate or promote water user pump testing and evaluation

CALFED Agriculture Water Use Efficiency Program

The CALFED WUE Program is one of eight Program Elements of the Preferred Alternative identified in CALFED's Phase II report released in December 1998. The WUE Program addresses four major water uses – agriculture, urban, managed wetlands, and recycling. The agriculture element of the WUE Program is based on the following main features:

- **Incentives** – CALFED is developing a program of technical and financial incentives for the implementation of WUE measures in the agricultural sector.
- **Locally tailored programs** – The Agricultural WUE Program will foster locally cost-effective measures and seek to identify additional appropriate water management measures.

- **Quantifiable objectives** – Quantifiable objectives are objectives for water management improvements 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.
- **Assurances** – The assurance mechanisms are structured to ensure that 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 or seller 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 modified operation of facilities), water suppliers will need to show that they are in compliance with the applicable agricultural council agreements and applicable state laws.

The AWMC, formed under the AB 3616 MOU, has been working on the development of locally tailored programs in conjunction with CALFED WUE Program. The council is developing practical policies and procedures for implementing and evaluating water management options. The work of the AWMC and the BWMP are being done in parallel, with common representation by key personnel participating in both efforts.

Regional Plan Criteria

In addition to the Standard Criteria for use in evaluating individual contractor Water Management Plans, Reclamation and the SRSCs mutually developed draft criteria for use in evaluating "regional water management plans." Similar to the Standard Criteria, the Regional Criteria defines the scope and content of a regional water management plan. Reclamation would then review and approve the water management plan. The idea of a single coordinated plan that addresses agricultural water management for all Reclamation contractors in a common region has not been implemented. The BWMP is the basis for the first such practical effort.

Most of the SRSCs covered by the BWMP are participants in one or more of the above programs and have begun or completed a WCP. Table 4 lists the status of each SRSC's efforts in these regards.

TABLE 4
Summary of SRSC Districts Individual Plan Status

District	Draft or Complete Plans	Comment/Other
Anderson-Cottonwood Irrigation District (ACID)	NRCS Resource Management Plan	NRCS study done in 1982.
Glenn-Colusa Irrigation District (GCID)	Draft Agricultural Management Council Plan	Draft complete.
Provident Irrigation District (PID)		Will incorporate BWMP findings.
Princeton-Codora-Glenn Irrigation District (PCGID)		Will incorporate BWMP findings.
Maxwell Irrigation District (MID)		
Reclamation District No. 108 (RD 108)	Draft Agricultural Management Council Plan	
River Garden Farms Company (RGFC)		
M&T Chico Ranch (MTCR)		
Reclamation District No. 1004 (RD 1004)	WCP	
Meridian Farms Water Company (MFWC)	Draft WCP	Joint study, draft. On hold pending BWMP results.
Tisdale Irrigation and Drainage Company (TIDC)	Draft WCP	
Sutter Mutual Water Company (SMWC)	NRCS Resource Management Plan Draft WCP	Part of cooperative funding with Reclamation, will incorporate BWMP findings.
Pelger Mutual Water Company (PMWC)	WCP	WCP approved by DWR, rejected by Reclamation. Will incorporate regional BWMP findings.
Natomas Central Mutual Water Company (NCMWC)		Will incorporate BWMP findings.

Note:

NRCS = Natural Resources Conservation Service

Sacramento Valley Water Management Agreement

The SRSCs participating in this BWMP, in addition to numerous other water districts and companies throughout the Sacramento Valley, executed the Sacramento Valley Water Management Agreement (SVWMA) in December 2002. Parties to the SVWMA include Reclamation, DWR, California Department of Fish and Game, and the U.S. Fish and Wildlife Service, as well as a large number of downstream water users including the State Water Contractors, San Luis & Delta-Mendota Water Authority, Westlands Water District, Kern

County Water Agency, and Contra Costa Water District. The SVWMA is intended to improve water management while assisting in meeting water supply, water quality, and environmental needs throughout the Sacramento Valley and the state. A key premise of the SVWMA is the development of projects that contribute toward meeting Bay-Delta water quality requirements (thereby avoiding protracted litigation related to the California State Water Resources Control Board [SWRCB] Phase 8 Hearings), while improving inter- and intra-district water system management across the Sacramento Valley. The Short-term Workplan, released in October 2001, identified the following three types of projects across the Sacramento Valley:

- Conjunctive Water Management
- System Improvement
- Groundwater/Surface Water Planning

Regulatory and institutional issues that were agreed to impact water management were also investigated with respect to water transfer policy and unapproved diversions (e.g., Term 91).

With the implementation of the SVWMA, water districts and companies across the Sacramento Valley, including the SRSCs participating in this BWMP, are moving toward the implementation of projects. State funding assistance (e.g., Propositions 13 and 50) are being jointly pursued to support project design and construction. Many of the concepts and proposals included in the BWMP, including those discussed in this TM and TM 6 of this BWMP have been carried forward as projects included in the Short-term Workplan. Projects proposed by the participating SRSCs include the following:

- Conjunctive Water Management
  - ACID Conjunctive Use Program (Project 2B)
  - GCID Development of Conjunctive Water Management Facilities (Project 5B)
  - MID Conjunctive Use Project (Project 6A)
  - NCMWC Conjunctive Use Project (Project 7A)
  - RD 108 Pilot Well Development/Conjunctive Management Project (Project 10A)
  - Stony Creek Fan (GCID and Partners) Conjunctive Water Management Program (Project 8A)
- System Improvement
  - ACID Churn Creek Lateral Improvements (Project 2A)
  - ACID Main Canal Modernization Project (Project 2C)
  - GCID Flow Measurement Devices in Main Canal, Lateral System, and Drain Outflow Points/Existing Automation Program (Project 5C/D)
  - SMWC Irrigation Recycle Project (Project 22B)

- Groundwater/Surface Water Planning
  - GCID Regulatory Reservoirs and Off-canal Storage Feasibility Study (Project 5A)
  - GCID Glenn County Groundwater Monitoring Program and Model Development (Project 5E)
  - RD 1500 Sutter Basin Groundwater Monitoring Well (Project 22D; formerly 23A)
  - BWMP Sub-basin-level Water Measurement (Project 11A)

The project summary from the October 2001 Short-term Workplan for each of these projects is included in Appendix D. Many of these are currently (spring 2003) being updated in terms of yield, cost, and, in some cases, facilities. In addition, several new projects have been proposed by the SRSCs since October 2001. The parties to the SVWMA are preparing a Long-term Workplan, which is scheduled for completion in June 2005. The Long-term Workplan will assist in the development of a subsequent Long-term Water Management Agreement.

Conjunctive Water Management and Groundwater Use

Purpose and Scope of Analysis

Increased groundwater development can be viewed as both a "water supply" and "water management" option because it has the potential to both increase net water supply and improve operational flexibility on a local and regional scale. This TM considers groundwater development at two major levels:

- Coordinated groundwater development on a sub-basin or regional scale, under a formal conjunctive water management program
- Local groundwater development undertaken by individual SRSCs, outside the scope of a formal conjunctive water management program

These two broad development levels are discussed separately below. Factors that limit the scope of analysis and discussion regarding groundwater development in the Sacramento Valley include available hydrogeologic and groundwater use data (both local and regional), and a dynamic and uncertain legal and institutional framework governing groundwater development. For these reasons, the scope of discussion for coordinated conjunctive water management is limited to background on the status of regional groundwater planning, physical and institutional features of coordinated conjunctive water management, and a review of major implementation issues.

Local groundwater development by individual districts is addressed at a more detailed level. To provide a basis for quantifiable comparison with other district-level options, a uniform range of hypothetical groundwater development levels was considered for each SRSC. Reconnaissance-level analysis of annual yield, costs, and local groundwater level impacts was done for each SRSC. These results are presented under the individual SRSC evaluation sections of this TM.

See the following documents for additional information on groundwater:

- *Technical Memorandum No. 3 – Water Resources Characterization*: general basinwide groundwater characteristics, existing level of development by each SRSC
- *Technical Memorandum No. 4 – District Water Requirement and CVP Supply/Sub-basin Water Balances*: total annual groundwater use within each sub-basin, as part of basin water balance
- *BWMP Groundwater Hydrology Technical Memorandum* (DWR Northern Division, January 2000 draft): comprehensive baseline data report and detailed discussion of groundwater characteristics within each SRSC service area

Conjunctive Water Management

Background

Previous studies have shown that on a technical level, conjunctive water management programs could be implemented in most areas of the Sacramento Valley groundwater basin. However, implementation of these types of programs is greatly hindered by potential physical effects, and institutional, legal, and political issues. This TM summarizes these various issues and provides a framework for addressing the practicability of conjunctive water management as part of the BWMP. Subsequent efforts under the BWMP effort will use this information to formulate and evaluate conjunctive water management programs to determine those that have the best chance of success under these conditions. Conjunctive water management should be kept in mind as a critical element of any proposed groundwater development. Significant new groundwater development by individual SRSCs, without conjunctive water management, would likely result in unacceptable impacts to neighboring landowners. Conjunctive water management would be the link to minimizing these potential impacts and possibly increase the water supply potential.

Definition of Conjunctive Water Management

Numerous definitions of conjunctive water management exist. As part of the CALFED Integrated Storage Investigation (ISI), DWR recently published a paper describing conjunctive water management and its role in the CALFED process (DWR, undated). In its paper, DWR succinctly defines conjunctive water management as "… the planned, coordinated use of groundwater and surface water resources." A review of definitions by other prominent sources revealed lengthier definitions, all virtually having the same meaning.

For the purposes of the BWMP, a definition similar to DWR's definition will be adopted, and will also recognize water supply availability more specifically. The working definition is as follows, "The coordinated use of groundwater and surface water to manage the timing of water supply availability."

Characteristics of Conjunctive Water Management Programs

Acceptable approaches to conjunctive water management programs vary widely from basin to basin. Several variables inevitably influence the framework of a program, such as groundwater basin hydrogeology, accessibility to conveyance facilities, water quality considerations, and existing basin management practices.

There are two basic types of conjunctive water management systems: indirect recharge and direct recharge. An indirect recharge system has no physical recharge facilities, and groundwater storage is accomplished as a result of surplus surface water being used in lieu of pumping groundwater. A direct recharge system requires recharge facilities such as spreading basins or injection wells.

Regardless of whether direct or indirect recharge is being considered, the following basic elements are required:

- Surface water supply (entitlement and diversion facilities)
- Conveyance and distribution facilities

- Recharge facilities
- Groundwater storage
- Groundwater extraction facilities
- Basin operating criteria
- Entitlement exchange
- Identification and role of participants

These elements can be individually crafted and combined, resulting in a range of conjunctive water management programs for a given area designed to meet specific goals, while adhering to prescribed basin criteria. The various program scenarios would be scrutinized to determine which program best meets these goals. This type of evaluation would address the technical merits and economical feasibility of a program, and the practicability of implementing such a program given the presence of various institutional, legal, and political barriers.

Objectives of Conjunctive Water Management Programs

The basic objective of the BWMP is to provide the SRSCs with a comprehensive plan for managing water resources to meet their existing and future water needs in a manner that can also serve other water needs in the Sacramento Valley, including but not limited to needs for the use of water for the environment. There are countless ways to configure a conjunctive water management program to address this basic objective. At a minimum, the conjunctive water management program should have the following specific objectives:

- Provide new "real" and economical water supplies to SRSCs in a given region or regions.
- Improve basinwide water management to enhance water supplies for environmental purposes, and other water users in the Sacramento Valley.
- Observe and protect other landowners' rights.
- Minimize substantial adverse impacts.

Implementation Issues

Groundwater storage is usually the least expensive type of water storage, the type that can be implemented most rapidly, and the type with the least environmental impact. However, conjunctive water management programs frequently generate concerns about the following:

- Geochemical and physical effects
- Legal issues
- Institutional and political issues

These factors require serious consideration prior to implementing any program. When considering conjunctive water management, the BWMP will explore programs that could be implemented in a way to overcome these concerns. As a starting point, a summary of these concerns is provided below.

Physical Effects

By definition, conjunctive water management causes groundwater levels to fluctuate – up when groundwater recharge exceeds extraction (e.g., above average precipitation) and down when extraction exceeds recharge (e.g., drought periods). This fluctuation can become an issue with neighboring well owners. Declining groundwater levels can increase pumping costs or result in well interference with other pumpers. Changes in groundwater levels changes the dynamic interaction between groundwater and surface water, and can increase stream losses to groundwater, impacting in-stream flow conditions. Lowering groundwater levels may also result in subsidence of overlying land. Rising water levels can cause flooding problems for others within a district and impact crops by saturating root zones.

A requirement of any conjunctive water management program is to ensure the plan has no unreasonable impacts on the environment, water rights holders, groundwater users, or CVP project operations within the groundwater basin. Defining what is meant by unreasonable impacts is not an easy task, and varies by basin. This is one of the most important considerations of any conjunctive water management program, and is required to surpass the many institutional and political barriers that have hindered implementation of programs in the past.

An example of a proposed conjunctive water use program that would incorporate a monitoring effort is the Sacramento Valley Water Management Program (SVWMP). As part of implementation of the SVWMP, groundwater level monitoring is proposed to ensure no unacceptable impacts, including impacts to any local ordinances or management practices. In addition, the SVWMP is proposing a project-specific remedial action plan be developed if monitoring reveals impacts are occurring. Both the monitoring approach and the remedial action plan concept are currently being developed in cooperation with both Reclamation and DWR, with input from local counties. The final project-specific approaches will also be developed with Reclamation and DWR as individual, project-specific implementation agreements. Other future conjunctive management projects and programs will need to develop a similar approach to implementation to ensure potential impacts are minimized and local agencies concerns are addressed.

Legal Issues

Groundwater management in California is an institutional challenge that has not yet been fully addressed. California is one of only two states in the western United States without a comprehensive, statewide groundwater management code. California landowners have a right to extract as much groundwater as they can put to beneficial use on their overlying land. In some basins, groundwater rights have been defined by a court through the adjudication process. There are no adjudicated basins in the Sacramento Valley.

Two additional attempts to manage groundwater in the Sacramento Valley have recently been used:

- The adoption of groundwater management plans under AB 3030
- The attempted management of groundwater resources through the adoption of city and county ordinances

These existing programs will need to be addressed as part of the implementation of any conjunctive water management program. The existing plans in the Sacramento Valley are summarized below.

Assembly Bill 3030

Passed by the legislature in 1992, AB 3030 authorized existing local water service agencies to develop and implement groundwater management plans within their service areas. AB 3030 encourages basinwide coordination of groundwater management. Joint powers agreements among authorized water services agencies, or MOUs or other agreements between authorized water service agencies and other public or private entities can form the organizational basis for regional groundwater management. Because district and county boundaries were not delineated with groundwater basins in mind, it is not uncommon for a single agency to be involved with groundwater management in several sub-basins or for several agencies to cover the same basin.

Within the Sacramento River Basin, several coordinated AB 3030 groundwater management plans have been developed by individual agencies and groups of agencies including the following:

- Redding Area Water Council, in cooperation with individual private pumpers and water-related districts (the Shasta County Flood Control and Water Conservation District serves as lead agency)
- Tehama County Flood Control and Water Conservation District
- GCID
- RD 108
- PCGID and PID (joint plan)
- Yolo County Flood Control and Water Conservation District (management plan under development)
- Western Canal Water District
- RD 1004 (AB 3030 plan under development)
- RD 1500/SMWC
- South Sutter Water District and Sacramento Metropolitan Water Authority (joint plan)
- RD 1000 and NCMWC (joint AB 3030 plan under development)

In northern Sacramento and southeastern Sutter Counties, coordinated groundwater management is being planned and implemented by the Sacramento Area Water Forum and the Sacramento North Area Groundwater Management Authority pursuant to the Sacramento County Water Agency Act.

These groundwater management plans developed under the AB 3030 process generally recommend implementing specific programs designed to meet specified groundwater management goals. They also provide a common framework from which entities can identify present and future demands for groundwater, address groundwater quantity and quality issues, establish monitoring programs, and determine data deficiencies. There are no legal means by which elements of a groundwater management plan developed under the AB 3030 process can be enforced. The most an entity can ask for is voluntary compliance by water users within the management plan area.

County Ordinances

Additional authority to manage groundwater is provided through county ordinances. Within the Sacramento River Basin, the Counties of Shasta, Tehama, Glenn, Butte, Colusa, Yolo, and Sacramento have adopted groundwater ordinances. Each of these ordinances establishes procedures for applying for a permit to export water and establishes criteria that must be met prior to any out-of-county water transfer. Among the issues addressed in these ordinances are groundwater overdraft, land subsidence, saltwater intrusion, injury to overlying groundwater users, and adverse effects on long-term groundwater storage or transmission characteristics of the aquifer. Each county ordinance requires the completion of an environmental review with financial responsibility for this review resting with the applicant. Butte, Colusa, and Glenn Counties have adopted additional groundwater ordinances that address well spacing and health and safety issues. The nature and extent of the police power of cities and counties to regulate groundwater is presently uncertain (Water Fact No. 4, Groundwater Management Districts or Agencies in California, DWR, January 1996).

Institutional and Political Issues

A number of questions arise when conjunctive water management programs are proposed. Some of the more frequently asked questions include the following:

- Who is going to own and operate the program and facilities?
- Who should benefit from surplus surface water stored beneath the ground?
- Should recharged water be transferred from groundwater basin to groundwater basin?
- How much of the water supply generated from a program is “new” water?
- What are the potential impacts, and who is responsible for mitigating them?

These questions are by far more difficult to address than any technical issue. That is not to say that technical viability of a conjunctive water management program should take a backseat, but rather that unless these political issues are addressed first, then the technical questions become irrelevant. To address these questions, discussions must occur between potential participants, and consensus on each of these questions must be reached. Furthermore, coordination with other parties that may be affected by such a program must occur.

In Southern California, one approach to addressing these issues had been to identify a groundwater basin manager. The nature of this entity varies from basin to basin, but has typically been a court-appointed water master or groundwater special district. The entities that lie within the basin boundaries, for example water districts or corporate private parties, comprise or govern the groundwater basin manager.

CALFED Integrated Storage Investigation

Statewide support for conjunctive water management is very strong, and funding opportunities exist for exploring local programs. The statewide thrust is occurring through the CALFED ISI effort. This effort intends to develop critical information for determining the optimal role of conjunctive water management projects in the mix of all available water management options. The ISI conjunctive water management element will provide opportunities for intensified groundwater monitoring, modeling, and evaluation. The ISI will also promote pilot projects to assess opportunities and impacts of these potential programs.

The ISI effort will be coordinated with related programs, such as the one described in DWR's Bulletin 118 update. The ISI effort will develop valuable hydrogeologic information for the sub-basins underlying the SRSC service areas. CALFED has formed the Conjunctive Use Advisory Team with staff from CALFED agencies and stakeholders, providing a forum for discussion of local interests and issues. CALFED intends to continue evaluating these opportunities before deciding which projects it may support through loan or grant programs.

With the BWMP already underway, the SRSCs are in a position to consider these types of programs locally, and to position themselves for support, as necessary, from CALFED. Continued coordination with the ISI effort will maximize local benefits, if any, from this regional effort.

Groundwater Development at the District Level

Background

Most of the SRSCs currently have some level of groundwater development within their service areas. Private landowner wells typically make up the majority of development and account for most of the groundwater pumping. Groundwater is used primarily as a supplemental source in drought/critical years when SRSCs' surface water supplies are reduced. This is due to the lower cost and generally adequate supply of surface water available in normal years. During the drought/critical periods, some SRSCs have cooperative programs with the private landowners to coordinate the use of increased groundwater pumping and reduced surface water supplies. In normal years, groundwater use is negligible, typically supplying less than 1 percent of the total district water supply. In drought/critical years, some of the smallest SRSCs may supply up to 25 percent of their total district requirement with groundwater; but for most districts, groundwater use represents less than 5 to 10 percent of the total district requirement, including cooperative groundwater pumping by private landowners.

The following discussion considers groundwater development as a supplemental supply for use primarily during drought/critical years, with the goal of improving the effective management of the overall water supply. Groundwater development is a complex and uncertain undertaking, even with actual wells in the ground and exhaustive technical analysis to support a particular proposal. The following discussion should not be viewed as presenting recommendations for actual groundwater development programs. Within the context of this TM, the development scenarios are intended only to help provide order-of-magnitude estimates of groundwater quantity, capital and O&M costs, possible impacts, and related issues for use in comparing and discussing groundwater development within the context of the other water supply and management options presented in this TM. ***The importance of keeping in mind the limitations of a "reconnaissance-level" evaluation, such as is presented here, cannot be overstated.***

Potential Groundwater Development Scenarios

Groundwater development is often approached from the question of "What is the safe yield?" The presumption is that the answer to this question will provide an estimate of the range of sustainable development levels for a groundwater basin. Addressing groundwater development from this perspective is beyond the scope of effort for the BWMP, given the complexities of groundwater resources in the Sacramento Valley and the differing interpretations of terms such as "safe yield" and "perennial supply."

This TM approaches groundwater development options from a water management perspective by assuming that the basic goal would be to supplement the primary surface water sources each SRSC has available. To do this, a uniform range of three hypothetical management goals for supplemental use of groundwater was looked at for each SRSC. These include the following:

Option 1: Replace the SRSCs' Project Water supply in quantity only, over a 6-month pumping window.

Option 2: Replace the contractor's critical month Project Supply within a pumping window equal to the contractor's critical month period (typically 2 or 3 months), thereby replacing Project Water in both quantity and timing.

Option 3: Supplement groundwater for the 25 percent cutback in Base Supply during a critical year, over a 6-month pumping window.

Actual groundwater development programs could have a range of target yields and operational strategies based on more specific local programs, and these three are presented only as a simplified uniform starting point for comparison purposes only. A screening-level analysis procedure was applied to determine necessary facilities, capital and O&M costs, and possible impacts on local groundwater levels. See Appendix A for a sample groundwater development worksheet, and Appendix C for a detailed discussion of the analysis procedure. See the individual SRSC evaluation sections in this TM for a discussion of each district's options.

Implementation Issues and Potential Impacts

Although groundwater development has the potential benefits of providing substantial and reliable supplemental water supplies, the overall feasibility of this option depends on the following critical factors:

- The safe yield (or perennial yield) and quality of the groundwater
- The types of crops, land use practices, and irrigation methods within a district
- Energy and capital costs, which influence the unit cost of the water relative to other sources

- Impacts to groundwater use by adjacent landowners or water management agencies
- Impacts on existing or future regional groundwater plans implemented by other water management/supply agencies or county governments
- Environmental impacts to stream or river flows, and riparian or wetlands areas that might be negatively impacted by lowered groundwater levels

As the cones of depression from new wells spread and groundwater levels drop, there might be an increased tendency for water to flow out of surface water bodies such as streams, reservoirs, and the Sacramento River to recharge the groundwater basin. Similarly, areas where groundwater has historically discharged to the surface, such as drains and some wetlands, may receive less water from groundwater discharge as groundwater levels decline. With continued pumping, the spreading cones of depression of adjacent wells may eventually intersect, so that the drawdowns in the wells themselves are compounded and groundwater levels may be lowered significantly over large areas. In addition to the impacts discussed below, the cumulative drawdown increases energy costs because the annual cost of pumping the groundwater is a large portion of the groundwater development cost. For example, the energy required to pump water from 500 feet below the ground surface is roughly 5 times that required to pump from 100 feet.

The current system of water use and distribution has developed slowly, and the delivery and conveyance systems have come to rely on groundwater levels being near current, somewhat predictable, levels for proper operation. Increased groundwater pumping may impact the current system, and these impacts must be anticipated, kept to acceptable levels, and managed to ensure adequate supplies and allow the system to adjust to new conditions. New groundwater development may generally result in lower groundwater levels, and a number of impacts can be expected, including the following:

- Lower levels and reduced yield in existing wells
- Lower groundwater inflow to drains and ditches that have come to rely on groundwater inflow for water supply and recycling
- Increased leakage from canals and ditches where high groundwater levels have historically reduced and/or prevented leakage
- Increased leakage from flooded fields where historical groundwater levels have been at or near the ground surface during part or all of the year
- Increased loss of river and stream flows to groundwater
- Drying of fields or other areas that have historically remained wet during part or all of the year due to high water tables
- Loss of subirrigation water source in fields with historically high groundwater levels
- Lower levels in some wetlands and surface water bodies that have historically depended on groundwater inflow for all or part of their water source
- Land subsidence on local to regional scales

Drainwater Reuse

Background

Drainwater reuse is primarily a water management option that can increase overall WUE within a district or sub-basin. Reuse can be instituted at both a district and regional level. Drain reuse is already a widely applied management option within the Sacramento Valley and is a critical factor in the Valley's ability to make efficient use of available water supplies. The unique crop management and water supply practices for rice cultivation are largely responsible for the extensive level of drainwater reuse. The current drainwater reuse practices have several significant impacts from a regional perspective. The use of one farm or service area's drainwater by downstream users directly increases WUE at the sub-basin or regional level. The supply provided by drainwater reuse reduces diversions on the Sacramento River that would otherwise be necessary to meet the water supply needs of the growers. This reduction in river diversions in turn has regional benefits by increasing in-stream flows for use in meeting fishery, water quality, and other regional management goals.

Drainwater supplies and sources vary widely between districts. Most drainwater is a combination of field tailwater, operational spills from laterals or canals (due to transient mismatch between supply and demands), intentional spills made by districts to supply water to drain-served fields, and, in some areas, inflow from shallow groundwater. Each SRSC has developed a drain reuse infrastructure (e.g., ditches and checks, and pumps) unique to the topography and drain flow patterns in each service area. Drainwater reuse represents a major portion of most SRSC district's supply, and during peak summer months may provide up to 25 percent or more of the applied water.

Increased Drainwater Reuse

As a district-level option, new or increased drainwater reuse might be implemented in the following general stages. First, an assessment of the available quantity, quality, and timing of drainwater supplies must be made. If the irrigation and cultural practices are such that there is a significant amount of unused drainwater available during a corresponding demand window, the necessary diversion and conveyance facilities would be planned. These facilities would typically consist of drain check structures for ponding and gravity diversion if possible, pump stations for lifting drainwater from the pool or drainage ditch, and distribution ditches to convey the drainwater back to fields or into existing distribution canals. Surface storage reservoirs may also be required in some cases if there is a mismatch in the timing of drainwater supply and on-field water demand. The district would operate these facilities to supplement available water supplies based on the timing and quantity of the primary water supply, drainwater flows, and on-field demand.

Implementation Issues

The effective implementation of new or expanded drainwater reuse can be impacted by several critical factors. First, there must be water in the drains to use. Significant changes in upstream cropping patterns, irrigation methods, or cultural practices that reduce or eliminate the supply of drainwater or influence water quality can influence the feasibility of drainwater recapture as a management option. If a district is heavily reliant on the drainwater runoff from upstream service areas, increased drainwater reuse in the upstream service area can directly reduce the supply to the downstream users. There may be legal constraints on the quantity and timing of drain diversions that require application for a new drain use license from the SWRCB. Existing agreements with regional drain users may also have restrictions involving the quantity and timing of drain flows.

The relationship between drainwater quality and soil salinity on the farm fields is a critical factor in determining the long-term sustainability of a given level of drainwater reuse. If the drainwater quality is such that it results in salinity buildup in the soils and impacts such as reduced crop yields, it may be necessary to reduce drainwater reuse and/or periodically flush the fields with higher-quality water to reduce soil salinity. There has been some evidence of long-term soil salinity increases due to drainwater use in some areas of the Sacramento Valley. Additional field studies are required to more clearly determine the relationship between drainwater reuse and field soil salinity, and allow improved long-term management approaches for drainwater reuse.

The cost of building and operating the expanded drain reuse system should be competitive with the unit cost of alternative water supplies. The general topography of the district(s) and the layout of existing supply and drainage facilities can impact the construction and operation costs of a new or expanded drain reuse system. Factors such as pumping costs, the location of drainwater diversion points relative to the on-field demands, and the need for regulating storage to match supply and demand timing can have a significant influence on the resulting unit cost of the water supply.

Canal Lining

Canal lining is a district-level water management option. Lining may reduce recoverable and/or irrecoverable leakage losses from the distribution system, increasing the district's overall efficiency. There are many miles of lined canals and laterals within Sacramento Valley irrigation districts. Lined canals are primarily in those areas where the soil characteristics result in rapid leakage losses, such as areas near historical river channels and other gravely or porous soils. However, canal lining is not extensively used as a water management option. This is partially due to two key factors. First, many areas of the Valley have fairly "tight" clay soils that minimize leakage losses in the native soils. Secondly, most leakage losses are recoverable because the lost water moves into either the underlying groundwater basin, recharging the basin, or into adjacent surface drains or natural channels where the water can be diverted for reuse. The first step in implementing a canal-lining program is to gather leakage rate data. These data would generally include soil types, leakage rates along the canal system, and shallow groundwater characteristics. Canal reaches with potentially high leakage loss would be tested using ponding, mass balance, and seepage meters, or other methods to quantify the losses. Lining would then be considered for those reaches with excessive leakage, and a more detailed design and cost/benefit analysis would be done for these reaches. Finally, those canal reaches with net benefits from lining would be lined.

Canal lining must be considered with the following factors in mind. First, and possibly most important, there must be an accurate understanding of the leakage losses to determine if the water is being "lost" to nearby surface water areas such as adjacent drain ditches or the Sacramento River, useable groundwater basins, or saline sink areas. Leakage into useable surface water or groundwater areas may be readily recovered within the SRSC service area or be available for downstream users. The economics of the canal lining, including both capital and O&M costs, must be competitive with other management options. Finally, the potential environmental impacts of lining an earthen canal are significant if the unlined channel supports habitat for threatened or endangered species.

Conveyance Systems Automation

Conveyance system automation with remote monitoring and control is a district-level management option that may increase the overall delivery system efficiency. The basic goal of conveyance system automation is to allow the system operator to more closely match supplies and demands, in terms of both quantity and timing, thereby minimizing operational spills caused by excess flows in the canals. Conveyance system automation can also increase the distribution system's flexibility and reliability, which in turn can increase each grower's ability to more closely match irrigation delivery with crop requirements, lessening any tendency to over irrigate because of uncertainty in the timing of the next delivery. Potential on-farm distribution uniformity efficiencies improvements can be gained by constant canal levels made possible through automation systems. Operational spills are estimated to range from approximately 5 percent to as high as 20 percent of total inflows to the canal system, based on data provided by the districts. A minimal amount of operational spill is required in most open-channel distribution systems to ensure adequate and reliable supply to customers as demand and supply rates fluctuate.

Major canal systems within the Sacramento Valley typically have some level of automated monitoring and controls, with major pump stations and canal structures linked via supervisory control and data acquisition (SCADA) systems to centralized locations, as well as monitoring of lateral end spills and drain flows. However, most smaller districts have little or no automation and rely on manual setting of supply rates and canal control structures. Several SRSC districts are currently involved in cooperative efforts with Reclamation to determine needed automation improvements and to obtain funding assistance for the improvements.

To implement new or expanded automation, a district would need to determine which points in the system are most critical to matching supplies and demands. A district would need to assess its major supply facilities, canal control structures, lateral headgates, and spill locations. An integrated plan would be put together based on the district's delivery methods (e.g., on-demand, rotational, or arranged) and supply system facilities. Typically, key facilities would then be linked up to a districted SCADA system to collect and transmit data on pump flow rates, canal levels, headgate flows, and spills. The SCADA system could both monitor and control the flows by changing pumping rates and gate positions within preset limits, or simply provide monitoring information for district crews to use in manually setting these controls. Capital improvements might include new pumps or controllers, motor-operated slide gates or radial gates to control water level or flow, automated drain relift pumps, and necessary office computer units and communication facilities.

An evaluation of canal automation system options to reduce operational spills must consider the broader picture of the overall district operating requirements. First, canal system automation is often driven by factors other than conservation of operational spills. These include improved level of service to district customers, the potential for greater on-farm efficiency that derives from the improved delivery service, and reduced operations costs. Secondly, spills do not necessarily equate to wasted water. Many districts have planned spills into drains to allow diversion by farmers that may not have adequate supply from the normal delivery system. In other cases, drains are kept charged to suppress the inflow of underlying shallow saline groundwater. In nearly all cases, operational spills are available for recapture within the originating district's drain system, by downstream drain diverters in neighboring districts, or by return to the river for use by downstream diverters.

Water Measurement

Background

Water measurement is a district-level management option that may provide the necessary information and monitoring data to more efficiently make decisions to better manage the water supply. Water measurement for a typical Sacramento Valley irrigation district can be considered in terms of four basic operations levels – supply, conveyance and distribution, turnout to individual fields or customers, and drainage. The methods used to measure water at each of these operations levels is driven largely by several key factors common to most of the SRSC districts. These include arranged water delivery scheduling (as opposed to on-demand or rotation), unlined earthen canals and laterals on open-channel distribution systems, extensive use of drainwater, the predominance of particular crops and related irrigation methods within a given district, and the O&M costs related to different measurement methods. There are also many local and site-specific factors that influence the choice of measurement method, both between and within districts. The extent of water measurement, the methods used, and the level of recording and documentation vary greatly between individual SRSCs, from extensive measurement and reporting at all operations levels to fairly minimal measurement at key supply and distribution points only.

The following sections discuss the potential benefits of improved water measurement, factors in selecting measurement methods, and water measurement for each operational level for both current practices and potential improvements. Specific measurement improvements for each district are discussed under the Preliminary Evaluation of District-level Water Management and Supply Options section in this TM. Details of the many operations and design issues related to water measurement are beyond the scope of this document, and can be found in standard technical references such as Reclamation's *Water Measurement Manual*.

Benefits of Water Measurement

Accurate water measurement offers many benefits to a district. Existing and future water measurement practices should be evaluated with one or more of the following potential targeted benefits in mind:

- Allowing district staff to more closely monitor and control O&M costs of specific supply and distribution practices
- Evaluating leakage losses in canals and laterals, and related planning of possible prevention measures, such as lining and/or a revised management approach
- Providing district staff with key information needed to support long-term planning of water supplies and capital facility improvements
- Providing basic inputs for automation of supply and distribution control facilities

- Monitoring and control of field runoff, operational spills, deep percolation, and associated problems
- Verifying equitable distribution of water supplies to all service area customers
- Providing on-farm managers with necessary information to optimize their water practices and effectively implement farm-level BMPs
- Providing ability to implement effective quantity-based pricing programs for encouraging farm managers to implement farm-level BMPs

Factors in Selection of Water Measurement Methods

The selection of an effective water measurement method is dependent on many diverse factors, and cannot be standardized. Table 5 lists key factors that must be considered in determining the most effective water measurement method for a given combination of operations levels and field conditions.

TABLE 5
Factors in Selection and Evaluation of Water Measurement Methods

Factor	Comment
Accuracy requirements	Most devices can provide ±10 percent under proper conditions. Poor installation or operating conditions will compound errors.
Cost	Consider both capital and long-term O&M costs.
Legal constraints	State or federal requirements may govern key supply measurements such as wells and river diversions.
Range of flow rates	Wide range of flows at most operational levels (rice flood-up versus maintenance flows).
Head loss	Many systems have little or no drop in laterals and between fields and laterals.
Site conditions	Hydraulics of measurement device should not adversely impact, or be impacted by, normal operating conditions (i.e., submergence of flumes).
Type of measurement needed	Quantity, flow rate, or both.
Debris and sediment	Significant problem for all SRSC systems, mostly unlined channels, bank vegetation, illegal dumping, and miscellaneous debris.
Maintenance requirements	Varies widely in frequency (daily to annual) and activity (e.g., cleaning, calibration).
Vandalism potential	Many remote areas in SRSC systems; vandalism is common.

Measurement Practices and Options by Operations Level

Sacramento River Diversions

Current Practices

Diversions from the Sacramento River are the primary water source for each SRSC. These diversions are delivered via either pump or gravity flow. Pumped diversions are measured and recorded using meters or calibrated pump curves. Gravity diversions are measured using either water-level measurement at weirs or flumes, or by flow meters (propeller type) installed in full-flow pipes such as road-crossing culverts. Measurement devices for river diversions are typically installed and maintained by Reclamation staff.

Improvement Options

Water measurement at river diversions is generally adequate. No options for modified measurement are generally required. Future improvement options may include linking flow measurement to district SCADA systems, and/or replacing mechanical devices with improved electronic measurement devices, as such products are proven reliable and affordable.

Distribution Canals and Laterals

Current Practices

Flows in the canals and laterals are typically measured at major flow control structures such as in-line gates (checks) and at lateral turnouts (headgates). The most common type of measurement uses gate or weir geometry and position, and measured water level or head in the canal. Typically, only the flow rate is recorded at these points. Some districts do measure both flow rate and total flow using the average flow rate and time of operation. This requires either very stable water level control or continuous water level measurement to provide good accuracy. In some cases, lateral turnouts are measured using propeller meters installed in short runs of full-flow pipes downstream of headgates, such as road-crossing culverts. This type of installation provides both flow rate and total quantity with good accuracy. In-line flumes and weirs with stage recorders are used in a very few locations for main canal flows only.

Improvement Options

The types of flow rate measurement used provide good accuracy if the structures and measuring devices (e.g., stage gauges) are in good operating condition. However, most do not provide continuous recording and total flow quantity. The two general types of improvements that could be considered include improved canal water level control and/or continuous recording of stage at key measurement points. Improved canal water level control can be achieved using broad-crested weirs, radial gates, drum gates, or tilting weir gates. Automated undershot (slide) gates set to maintain upstream water surface may also be used, although the previous options are likely to be simpler and more effective. Improved water level control helps provide improved water measurement by providing more stable water levels in the canal reach upstream of the control structure, which in turn allows more accurate measurement at turnouts with orifice flow devices such as undershot gates. Flow measurement improvement can be achieved using constant stage recording devices in combination with conventional measurement weirs or long-throated flumes.

Groundwater Wells

Current Practices

Within most districts, wells are primarily privately owned. District-owned wells typically have flow meters and totalizers. In some cases, total quantity of flow may be estimated through power use records. However, this requires some measurement of the water level in the well, which may fluctuate over large ranges during the time of operation.

Improvement Options

Any wells that do not have meters and totalizers could have this equipment installed.

Drains

Current Practices

Drain-flow measurement can be categorized within each district's service area in terms of total inflows and total outflows. Inflows include drainwater coming into the service area from upstream districts, tailwater runoff from individual fields, and operational spills (intentional or not) at the ends of laterals or overflow points. Outflows from drains include pumping from drains back into the distribution system, gravity outflow as the drain leaves a district service area, and pumped outflow from pump stations directly into the Sacramento River.

Most districts do not measure total inflows to drains. In some cases, inflows from other districts are estimated by water stage at key drain diversion point check structures. Some districts do measure operational spills and intentional turnouts to drains by recording water level at overflow weirs on a regular (daily) basis. Inflows from field tailwater are generally not measured.

Outflows from drains are generally measured by a combination of drain pump (re-lift to laterals) meters or power use records, reclamation drain pump meters or power use, and recording of drainwater stage at key gravity outflow points from the district service area.

Improvement Options

Potential improvements in drainwater measurement can generally be achieved by one or more of the following practices:

- Installation of meters on all drain re-lift pumps and reclamation district drain pumps
- Installation of continuous-stage recording devices in upstream pools of key drainage check structures (for both inflows to and outflows from district area drains)
- Improved measurement of operational spills to drains with use of stage recorders at overflow weirs

Field Turnouts

Current Practices

Delivery of water to individual fields is measured for flow rate only in most cases, and for both flow rate and total quantity delivered in other cases. Districts measure flows using a combination of the following methods:

- Standard canal gates (screw gates) at upstream end of short culvert – measure flow rate using differential head and gate position
- Flash-board overshot or undershot weirs – measure flow rate using head and weir or orifice geometry

- Constant-head-orifice arrangements – measure flow using differential head on upstream gate
- Gated culverts or constant-head-orifice turnouts with open-channel propeller meters on downstream end – measure flow rate and total quantity

Measurement of total quantity requires recording flow rate and the total time of delivery with a relatively stable canal water surface, or use of a totalizer device. Several districts measure and record both flow rate and total delivered quantity without using meters, by having operators record both the set flow rate and the start-stop time of each daily delivery.

Flow Meters

Most SRSC districts have tried flow meters (open-channel propeller meters) in the past, but many have experienced problems with frequent clogging from debris, resulting in loss of accuracy and high maintenance requirements. Currently only one SRSC (RD 1004) uses flow meters to measure all field turnouts. These meters are used for recording flow rates and delivery quantity for billing purposes. The meters have been in service for several years and are considered by the district to work effectively with reasonable maintenance such as regular cleaning by operators.

Discussions with other SRSC operations staff have highlighted the following concerns related to field turnout meters:

- Accuracy – meters are typically ±5 percent to 10 percent. Under marginal or poor operating conditions, accuracy may decrease to ±15 percent or worse. This degree of accuracy limits the ability to track proportionate changes in efficiencies.
- Cost – relatively high capital costs for meters and necessary related upgrades such as headwalls, new culverts, and downstream stilling wells; O&M costs for cleaning, repair, and calibration.
- Range of flow rates – rice fields may require two meters for low/high flows.
- Headloss – minimal head in many canal reaches cannot drive flow sufficient for meter to function and still get required flow rate and velocity combination needed.
- Ability to pass sediment and debris – standard references such as the Reclamation *Water Measurement Manual* do not recommend meters if debris or moss are present (Reclamation, 1997). Maintenance issues include calibration, replacement of damaged components, removal for and replacement after winter storage, and frequent debris cleaning.
- Vandalism potential – high in many remote areas of districts.

Potential Improvements for Field-level Measurement

Two primary options exist to provide measurement of both flow rate and quantity. First, the existing infrastructure can be used in most cases to record flow rate and total delivered quantity with reasonable accuracy. This does require operators to record the set flow rate and gate position, plus the start-stop time for each delivery. The influence of varying canal water surface can be minimized in most cases with improved operational controls such as long-crested weirs, radial gates, or other flow and water-level control devices. The installation of continuous-stage recording devices within each major canal reach would also allow computing of total delivery by knowing average head for the turnouts in that reach during the time of service.

The second option is the use of flow meters on each major field turnout. As listed above, many issues are associated with the use of flow meters that make them a potentially poor choice under some operating conditions. However, some districts have been able to implement districtwide metering with positive results. The use of meters, like other measurement devices, requires evaluation on a case-by-case basis.

Joint Reclamation/SRSC Cooperative Field-level Measurement Study

The issue of appropriate water measurement at various operational levels within the SRSCs' service area distribution systems continues to be an important issue for both Reclamation and the SRSCs. The SRSCs and Reclamation are participating in a cooperative study to evaluate options for improved water measurement within the SRSC service areas, including the evaluation of appropriate field-level measurement. The initial effort is focused on establishing a work plan, budget, and schedule for a full program. It is expected that additional funding will be obtained as required based on the final scope and work plan. This funding may come from a mix of sources, including Reclamation programs, CALFED WUE funds, or DWR assistance programs.

As part of this initial effort, specific study locations (fields and/or groups of fields) are being identified within SRSC service areas to collect key baseline information needed during the study process. Study areas are anticipated to consist of a continuous block of fields, served by a single supply lateral. It is intended that measurement devices will be installed and data will be collected at these specific locations at the turnout and lateral level. The study intends to make general comparisons of these two levels of measurement in terms of irrigation operations, overall water balance accuracy, and device costs and maintenance. Data collected as part of the study could potentially be used by some districts to develop quantity-based pricing. In addition to Reclamation and SRSC technical staff participation, the overall approach and process for selection of specific locations is being conducted in association with an outside technical expert to ensure objectivity and proper focus.

Sub-basin-level Measurement Study

In an effort to support improved water management in the Sacramento Valley on a broader scale, the Sub-basin-level Water Measurement Study was proposed by the SRSCs and subsequently funded through CALFED. Given the BWMP's recommendation that sub-basin management be further explored, this water measurement study focuses on increasing the water measurement level of accuracy at a sub-basin level. This ongoing study is a preliminary investigation of potential measurement locations, facilities, and associated implementation issues to allow for water measurement in the five Sacramento Valley sub-basins addressed in the BWMP. The original sub-basin-level proposal included an extensive evaluation, design, permitting, and construction program to install and improve existing measurement capability.

The ongoing initial study is focused on identifying key logical measurement locations and the condition of existing facilities. Current water measurement practices at major sub-basin outflow locations are being assessed as to operation, maintenance, and potential improvements. Data collection procedures and calibration are also being documented along with observed accuracy issues. The sub-basin measurement study will culminate with recommendations to improve water measurement at key sub-basin outflow locations, as well as anticipated associated costs and implementation issues.

Pricing Structures

Background

Water pricing is a fundamental agricultural water management tool. When used effectively, water pricing structures can provide a direct economic signal for the water user between the quantity of use and farm-level water management practices, crop types, and net financial results. As a district-level management option, water pricing structures themselves do not result in net new water supplies, but can be used to encourage more efficient use of existing water supplies and/or other specific targeted benefits. The mechanisms and influence of water pricing structures on WUE and overall agricultural economics are complex. Detailed evaluation of the impacts of pricing structures on existing district practices requires sophisticated economic modeling to capture the multitude of influences that ultimately determine land use choices, irrigation practices, water use levels, crop prices, and net economic benefits or costs to growers and districts. The following sections provide a summary of existing pricing structures, a range of possible new pricing structures, and issues related to the evaluation and implementation of an incentive pricing program.

Existing Pricing Structures

Existing pricing structures are influenced by many factors. These include the cost of water supplies, the water district or company incorporation charter and regulations, operating costs, and common crop types and irrigation methods within a service area. Districts typically set a pricing structure to cover O&M costs and long-term capital replacement and improvement costs. Some of the current price structures do include a direct or indirect quantity component.

All pricing structures include a basic annual maintenance charge (e.g., $10/acre per year or $10/share of company stock per year) independent of water use. In addition to this annual charge, pricing structures typically include one of the following charges:

- **Per acre charge:** $/acre irrigated/season. May vary by crop type, or be same for all crops.
- **Per irrigation:** $/acre/irrigation. Charged for each scheduled irrigation throughout the season. May vary by crop type, or be same for all crops. May also vary by time of year, with the first irrigation of the season having the highest cost, subsequent regular irrigations a slightly lower cost, and post-harvest irrigations for weed control or rice decomposition another cost.
- **Per ac-ft:** $/ac-ft delivered. Charged for volume delivered.

Table 6 lists the current pricing structures for each SRSC, based on the 1999 irrigation season.

TABLE 6
Existing SRSC Pricing Structures

SRSC	Pricing Structure
ACID	Base charge of $55/acre per year. Annual irrigation charge of $110 per acre. Irrigation delivery is on rotation basis.
GCID	Base charge of $6/acre per year. Annual irrigation charge of $19 to $45 per acre, varies by crop.
PID	Base charge of $10/acre per year. Annual irrigation charge of $65/acre (rice).
PCGID	Base charge of $2/acre per year. Annual irrigation charge of $38/acre (rice).
MID	---
RD 108	Annual irrigation charge of $41/acre for rice. $7.50 per irrigation (first of season) and $5.50 per irrigation (subsequent) for all other crops.
RD 1004	Per ac-ft charge of $5.50/ac-ft, measured at customer turnout.
MFWC	Base charge of $15/acre per year. Annual irrigation charge of $45 to $48, varies by crop type.
SMWC	Base charge of $20/acre. Per ac-ft charge of $12/ac-ft, measured at customer turnout.
PMWC	Base charge of $15/share. Annual irrigation charge of $30 to $50 per acre, varies by crop.
NCMWC	Base charge of $26.48/share. Annual irrigation charge of $66/acre (rice) and $13/acre (all other crops). Rice decomposition flooding charge of $11/acre.

Indirect Price Signals Related to Water Use

Water pricing is only one of several direct and indirect cost signals to which a grower may be subject. For a farmer who pays a flat rate, the sum of the base charge and annual irrigation charge as referenced in Table 6, for water use as an SRSC customer, the quantity of water use may still have a monetary impact through such things as quantity and cost of fertilizer, pesticides, and herbicides. Increased water use may increase former costs for these inputs. Poor water management by over irrigating may reduce yields and resulting gross revenue. If the farmer operates a private well or drain pump, the electrical power costs are a direct cost related to water use. Districts must cover all operating and capital expenses, based on the revenue from customers. Excessive irrigation results in increased pumping costs from the Sacramento River, the drain system, and wells. These costs are ultimately passed directly back to the growers, albeit at a rate averaged across all district customers. Many SRSC operating staff also have the authority to shut off delivery to a customer whose field is observed to be poorly irrigated and allowed to have excessive tailwater runoff.

Alternatives for New Pricing Structures

In addition to the above pricing structures, possible variations on these could include the following (all of these pricing structures would generally require some type of quantification of delivery at the field level):

Alternative 1: $/acre/year with differing rates by crop type and a surcharge for delivery above a targeted water duty for each crop. This is similar to the flat rate per acre now used, and encourages irrigators to achieve the unit water duty.

Alternative 2: $/acre/year with differing rates by crop type and field location, and a surcharge rate for delivery above a targeted water duty. Location factors could include soil types and delivery methods to account for factors such as higher soil infiltration rates and pumping costs incurred to serve some areas. The target unit water duty would be derived based on the crop type and soils characteristics.

Alternative 3: $/acre/irrigation with differing rates by crop type, similar to current methods, with a target duty by crop type. May or may not include surcharge for delivery beyond target duty.

Alternative 4: $/ac-ft delivered at turnout. Uniform rate in $/ac-ft, or vary by crop type, field application method, and/or location.

Alternative 5: $/ac-ft delivered at turnout, with uniform rate up to target duty (i.e., 90 percent of average district field efficiency or UC Extension water duty estimate), rebates for water use below this target, and/or increases in unit cost above the target duty.

As discussed in the Water Measurement section, the SRSCs and Reclamation are developing a cooperative field-level study. The data generated by the study could potentially be used by some districts to develop or refine quantity-based pricing.

Implementation Issues and Secondary Impacts

Modifying an SRSC's pricing structure is not a simple matter. Major issues must be addressed on a case-by-case basis to evaluate the feasibility of any proposed modifications. Some of these factors include the following:

- District incorporation charter and bylaws may contain limitations on how charges can be assessed, basic annual revenue features such as surplus quantities, and equitable access to water in both quantity and price.
- Growers who have already made on-field improvements for improved water efficiency must not be penalized directly or indirectly for this investment.
- Growers must have viable alternatives to current irrigation and cultural crop management practices so that the price signals can be linked to economically viable actions.
- Price structures should not be intended to drive grower's choice of crop selection based on external (non-landowner) land use targets.
- Pricing program must be linked to specific targeted benefits. These could include generation of conserved water for transfer or sale, reduction in drainage, reduced river diversions at critical seasonal windows, or others.
- Pricing may be market driven, or regulatory driven, but cannot be based on vague social values.

In considering the impact(s) of proposed pricing structures, the following range of potential secondary impacts should be considered:

- Changes in crop type, or complete transition away from agricultural land use
- More intensive agricultural land use, such as vineyards or orchards as compared to field crops, and resulting environmental impacts such as drain and field habitat loss
- Potentially same or higher net consumptive use by crops based on land use changes
- Water use pattern impacts on available drainage water supply
- Water use quantity and pattern impacts on total district demands and resulting Sacramento River diversion patterns

CVP Project Water Supply Purchases

Increased demands on the CVP system, fueled by California's continuing population growth and new requirements for fish and wildlife uses, are anticipated to result in decreased availability of finite CVP supplies, particularly in drought conditions. Current planning documents, most notably the CVPIA Programmatic Environmental Impact Statement would decrease deliveries to water service contractors, and increase the number of years that such contractors will receive reduced supplies (including an increase in the number of years no water would be available). As described above, the largest water service agricultural users within the Sacramento River Basin are the districts affiliated with the Tehama-Colusa Canal Authority (TCCA). Aside from reduced availability, provisions of the CVPIA also stipulate that the price of CVP supplies be increased, and an additional charge be made for environmental restoration purposes. Water service contractors are presently experiencing these increases across the state, with water costs more than doubling for some entities since the implementation of the CVPIA.

Although the SRSC's contractual standing and curtailment provisions differ significantly from the water service contractors, it is anticipated that the range of increased demands identified above will lead to an increase in the cost of CVP water (see TM 3 and TM 4 for further information on Project Water quantities available for purchase and historical and estimated typical use). The SRSCs currently pay $2/ac-ft for their respective Project Water entitlements on an annual basis, regardless of whether it is used or not. The difference between the actual cost of service rate and the $2/ac-ft contract rate is a deficit being accrued by Reclamation and may be subject to repayment at contract renewal. Use of Project Water is also subject to an approximately $7/ac-ft charge related to the CVPIA restoration fund. This charge varies by year and escalates annually according to provisions in the CVPIA. Water that is purchased in addition to the CVP Project Water entitlement (such purchases have been made by various SRSCs in the past [see TM 3]) is priced at a cost-of-service rate of approximately $8 to $12/ac-ft.

Reclamation is considering allowing an SRSC the flexibility to only pay for the Project Water diverted instead of paying for all Project Water, whether diverted or not. This may affect the SRSC's position with regard to contract renewal but is not a major issue relative to this BWMP.

Subject to the upcoming contract renewal process, it is anticipated that the quantity of CVP water available for SRSC purchase will likely not change appreciably, but that supplies will become more expensive. The degree of increase is not yet known. However, trends indicate that the cost of such supplies could increase substantially. The cost of such supplies will have a direct bearing on each SRSC's individual decision to use CVP water or rely more heavily on other available supplies and/or implement system improvements.

CVP Operational Changes

CVP Operational Constraints

As identified in TM 3, the primary water supply source within the overall Sacramento River Basin is the river itself, the flows of which are regulated by various CVP facilities. CVP releases north of the Delta (the primary area being the Sacramento River Basin) related to contractual entitlements for the SRSCs, agricultural, and M&I water service contractors, municipal water rights holders, and refuge water supplies total approximately 4 million ac-ft (maf). Among the facilities that regulate Sacramento River flows are Shasta Dam in conjunction with Keswick Dam and the Trinity Division. These facilities are operated to meet multiple demands and objectives. Shasta Reservoir has the greatest capacity of any reservoir in the state at 4.6 maf. Annual releases have ranged from 9 maf in wet years (illustrating that large volumes of water are in essence passed through Shasta Dam in wet years) to 3 maf in dry years. Aside from the contractual agreements discussed below, the following key operational issues drive Shasta Dam releases:

- Temperature control in response to the needs of the federal- and state-listed winter-run Chinook salmon
- Flood control
- Storage and release for agricultural, M&I, fish and wildlife, refuges, and other needs
- Bay-Delta water requirements
- Generation of hydroelectric energy
- Navigation flows (although commercial navigation no longer occurs between Sacramento and Chico Landing, what were historically navigation target flows are currently maintained to facilitate diversion of water in this reach of the river)

CVP operations are guided by a series of documents including the 1992 CVP Operations Criteria and Plan, various biological opinions for endangered aquatic species (primarily the winter-run Chinook salmon and the Delta smelt), the Coordinated Operating Agreement between Reclamation and the State Water Project, Regional Water Quality Control Board (Basin) plans, and operations-oriented provisions of the CVPIA. Key among the CVPIA mandates is the requirement that approximately 800,000 ac-ft of water be provided for fish and wildlife purposes (commonly referred to as "b(2) water," in reference to the particular provision of the CVPIA). Use of and accounting for b(2) water is carried out in accordance with U.S. Department of Interior policy. The U.S. Department of Interior policy dated May 9, 2003, describes the process and the terms under which b(2) is currently implemented.

The biological opinion, which focuses on minimizing impacts to winter-run Chinook salmon, is one of the most influential factors governing Shasta Dam releases in terms of quantity and timing. The biological opinion set temperature compliance requirements below Keswick Dam for April through October, and established end-of-September carryover storage for Shasta Reservoir of 1.9 maf. The biological opinion contains a provision that specifies that in particularly dry years when the storage target cannot likely be met, Reclamation is to re-initiate consultation with the National Oceanic and Atmospheric Administration Fisheries. The National Oceanic and Atmospheric Administration Fisheries maintains jurisdiction over the winter-run Chinook salmon, given it is an anadromous species. Daily temperature requirements are also specified at Bend Bridge (under normal conditions) and Jelly's Ferry (in dry conditions). Both of these compliance points are located north of Red Bluff, which is upstream of all the participating SRSC diversion points other than ACID. To meet these temperature requirements, Reclamation attempts to maintain a minimum cold-water pool in Shasta Reservoir through coordinated operations with the Trinity Division. The critical summer incubation period for the salmon is a major driver of daily summer operations.

The need and timing for temperature control-related releases in the summer months in large part mirrors the agricultural demand for irrigation water within the basin. As mentioned above, all SRSC diversion points other than ACID are downstream of the compliance point. Other diversions above the compliance point include M&I uses within the vicinity of Redding, as well as the diversion point at the Red Bluff Diversion Dam used by member districts associated with TCCA.

CVP Sacramento River Contract Supply Requirements

The CVP supplies approximately 6 to 7 maf annually to water contractors in the Central Valley, Santa Clara Valley, and Contra Costa County. As identified above, total CVP contractual entitlements north of the Delta total approximately 4 maf. Contracts with various entities specify that full contractual water deliveries be made except in dry periods. During periods of reduced supplies, water deliveries are decreased according to the curtailment terms in the contracts (additional information on contractual terms is presented in TM 3, *Water Resources Characterization*). CVP contractors along the Sacramento River are grouped into the following three major categories:

1. **Sacramento River Settlement Contractors**. Most of these contractors claimed water rights in the Sacramento Basin prior to the construction of Shasta Dam. Contract provisions specify potential reductions of no more than 25 percent of contracted amounts during dry conditions (as determined by the Shasta Inflow Index). Approximately 2.2 maf of water (1.8 maf being designated as Base Supply) is allocated annually for delivery to all SRSCs. This total represents approximately 55 percent of the total quantity of water Reclamation must provide for agricultural, M&I, and refuge uses north of the Delta. The SRSC entitlements represent the majority of CVP water that is used north of the Delta. Additionally, these supplies are the most reliable among those that hold contracts in that the SRSC entitlements are subject to the least severe curtailments.

2. **CVP Water Service Contractors**. These agricultural and M&I water service contractors entered into agreements with Reclamation for delivery of CVP water as a supplemental supply. Water deliveries to agricultural water service contractors can be reduced up to 100 percent in particularly dry years. Maximum curtailment levels are not specified for most M&I water service contractors. Water availability for delivery to CVP water service

contractors during periods of insufficient supply is determined based on a combination of operational objectives, hydrologic conditions, and reservoir storage conditions. Given the curtailment provisions, contractors holding such contracts have a relatively less reliable supply than the SRSC. Examples of this type of contractor within the Sacramento River Basin include those contractors associated with the TCCA.

Approximately 1 maf of water is allocated annually for delivery to all water service contractors (approximately 0.5 maf is allocated to agricultural and M&I water service contractors, respectively) in the basin. This total represents approximately 25 percent of the total quantity of water Reclamation must provide for agricultural, M&I, and refuge uses north of the Delta.

3. **Colusa Drain Mutual Water Company.** This company was chartered in 1988, to serve as a vehicle for entering into a contract with Reclamation. The company is composed of diverters from the Colusa Basin Drain who are not within previously existing water districts. The company’s service area includes approximately 57,500 acres, extending over 80 miles of the Colusa Drain from Glenn to Yolo Counties. The Reclamation contract with the company has no provisions for a physical supply of water. Rather, the company pays Reclamation for project releases, which are required to offset the impacts to senior water rights holders downstream of the company diverters, caused by calculated consumptive use within the company’s service area. The company has historically required approximately 25,000 to 30,000 ac-ft of replacement water that has been met with Project Water provided under its contract with Reclamation or has been met with water transfers from SRSCs.

Water Supply Transfers

Introduction

Water transfers can serve as both a management option and as a net source of new water for a receiving district. The following discussion summarizes existing water transfer programs and policy as well as how water transfers can be used as a tool to facilitate improved water management within the Sacramento Valley and statewide. This section does not go into the fine detail of transfer issues but relies on previously published documents on water transfer issues. The most recent and complete publication is the State of California Division of Water Rights, *A Guide to Water Transfers*.

Potential Benefits of Transfers

The ability to transfer water assists in facilitating water management. The ability to transfer water from one area to another can provide a reliable water source to a water user that may not have the physical water supply or water right under current conditions. Water transfers may provide improved reliability, local and regional operational flexibility, and environmental benefits, depending on the timing and quantity of the transfer. Increased environmental awareness and the enactment of various environmental statues and acts such as the CVPIA have increased the transfer of water for in-stream environmental purposes.

The importance of water transfers as a method of improving water management is underscored through its inclusion in the CALFED process as part of the preferred program alternative. As identified in the *Water Transfer Program Plan*, transfers can provide benefits such as the following:

- Helping to relieve mismatches between water supply and demand.
- Assisting in implementing the proposed Environmental Water Account.
- Providing a short-term method to move supplies to areas with temporary reductions in water supply (e.g., facilities under construction and outages).
- Moving water from storage facilities (surface or sub-surface) to various end-users.
- Assisting in water quality improvement.
- Providing water for in-stream flow augmentation through conservation, conjunctive water management, or potentially, crop idling.

As water demands across California continue to increase, the value of water transfers to assist in meeting agricultural, urban, and environmental needs will also increase. Within the Sacramento Valley, the most recent example of a multi-user water transfer was the Forbearance Agreements. In April 2001, a group of 21 SRSCs entered into agreements with Reclamation to provide water to the Westlands Water District in the San Joaquin Valley. The Forbearance Agreements stipulated that the participating SRSCs forgo diversion associated with reducing consumptive uses by 160,000 ac-ft of water, which, in turn, was transferred to Westlands Water District. These Forbearance Agreements could be used as a basis for additional short- or long-term water transfers in the future.

A number of the SRSCs participating in the BWMP, and numerous other districts (both federal and state water contractors) across the Sacramento Valley signed the Short-Term Settlement Agreement in February 2003. The Short-Term Settlement Agreement established a coordinated water management process (the Short-Term Program) that includes the Sacramento Valley water users, the DWR, Reclamation, and CVP and State Water Project contractors that receive water from the Delta pumping plants. The intentions and goals of the participants are that the Short-Term Program will implement a series of projects that will satisfy the principles of the 2001 Stay Agreement, which stayed the need for SWRCB hearings related to meeting the 1995 Water Quality Control Plan. The intent of the Short-Term Program is to optimize the use of existing supplies, enabling development of additional supplies, and, in turn, enhance water management flexibility. The Short-Term Program will also ensure that water stored and released by the State Water Project and CVP is available for the following purposes:

- Meeting downstream flow-related objectives of D-1641 and for State Water Project and CVP purposes
- Facilitating the development of new near- and long-term water supplies through agreements among the parties and through the Governor's Drought Contingency Plan
- Assisting with meeting CALFED's goals

The current Short-Term Settlement Agreement identifies a total capacity of 185,000 ac-ft that is ultimately to be made available for potential use both north and south of the Delta. The majority of this water would be made available through increased local use of groundwater that would then reduce the need for surface water diversions. The signatories to the Short-Term Settlement Agreement are continuing to evaluate the potential benefits of the program, as well as potential issues including surface water/aquifer interactions, groundwater-level effects, and environmental impacts related to program implementation.

Sacramento River Water Contractors' Association Project Water Pool

A total of 34 SRSCs (including the Colusa Drain Mutual Water Company, which is a form of SRSCs) currently participate in the Sacramento River Water Contractors' Association Project Water Pool (Pool), which was formed in 1974, to facilitate commingling Project Water supplies. Since its inception, the Pool has been the forum to move Project Water supplies determined to be available within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project Supply that they wish to make available to the Pool rather than divert for consumptive use. Contributions need to be identified by April 15 each year. The total quantity of water within the Pool that is committed and actually sold, which has varied greatly on an annual basis, is then available for use by other participating members. Additionally, the Sacramento River Water Contractors' Association has acted collectively to transfer water to other Sacramento River users outside the Sacramento River Water Contractors' Association. All of these transfers have been short term and driven by individual user needs typically related to hydrologic conditions. Over the last decade, the Pool was used most extensively in 1994, in response to a dry year. Large volumes of water (approximately 138,000 ac-ft) were transferred to various entities, including DWR and Reclamation. Typical transfer policy and regulations were relaxed during this period in response to severe shortages. In wetter years, the total amount of water sold through the Sacramento River Water Contractors' Association has been less than 500 ac-ft because of limited demand. The Pool could also be used to accommodate transfers of Base Supply, as well as out-of-basin transfers, if it were expanded in scope.

Sacramento River Settlement Contractor-initiated Transfers

In addition to moving water through the Pool, direct transfers of Project Water have also occurred or been attempted directly between individual SRSCs and other users. Approximately 20 such successful transfers have occurred since 1972. Transfers to other SRSCs, water service contractors, non-CVP users, and users south of the Delta are discussed in each of the sub-basin discussions. Most recently, SMWC and RD 108 completed a successful temporary water transfer to the Contra Costa Water District related to weed abatement.

Project Water Supply Transfers

Enactment of the CVPIA in October 1992 provided new authority and expanded flexibility to Reclamation for transfers of federally developed water. One purpose of the CVPIA is to improve the operational flexibility of the CVP and to increase water-related benefits provided by the CVP through expanded use of voluntary water transfers. The CVPIA authorizes transfers of Project Water to be used to assist California urban and agricultural water users, and others in meeting their future water needs.

The transfer of Project Water is governed by the water transfer provisions of Section 3405(a) that authorize CVP contractors to transfer, subject to certain conditions, all or a portion of the Project Water subject to contracts with any California water user or agency, state or federal agency, Indian Tribe, or private nonprofit organization for any purpose recognized as beneficial under state law.

The water transfer provisions of the CVPIA also provide flexibility to project contractors within the same areas of origin. Basically, transfers of Project Water between project contractors located within the same areas of origin, as those terms are used under California law, are deemed to meet the historical use and consumptive use provisions of the transfer provisions of the CVPIA. For example, a contractor can transfer up to its entire Project Water supply identified in its contract to another project contractor within the same area of origin without being limited to the amount of project water that has historically been used or the amount of Project Water that would have been consumptively used or irretrievably lost to beneficial use during the year or years of the transfer. Project Water transfers of this nature have taken place since the enactment of the CVPIA. Increased transfers have occurred between SRSCs to other project contractors within the Sacramento Valley such as the Colusa Drain Mutual Water Company and TCCA. The flexibility allows contractors within the same areas of origin to maximize the management and use of Project Water supplies. The flexibility provided by the CVPIA may prove to be more valuable as the in-basin demand for water increases. This flexibility will be even more important as future water demand shifts from agriculture to domestic or industrial uses.

Base Supply Transfers

Base Supply, as defined and recognized under the Sacramento River Settlement Contracts, is not subject to the transfer provision of CVPIA governing the transfer of Project Water, and the provisions of Section 3405(a) do not apply to the transfer of Base Supply. The transfer of Base Supply is accomplished under the water transfer provisions of California law pursuant to changes taken by the contractors under the appropriative water rights held by the contractors authorizing the diversion and use of water from the Sacramento River and/or its tributaries.

The transfer provisions of state law authorize a water right holder to change the point of diversion, place of use, or purpose of use due to an out-of-basin transfer or exchange of water or water rights if the transfer would only involve the amount of water that would have been consumptively used by the permittee in the absence of the change.

Water users within the Sacramento Valley have implemented various measures, not strictly for the sole purpose of water conservation, that result in reduced diversions and applied water. The CALFED Water Transfer Group is investigating the possibility of providing an incentive to water users that may reduce diversions and applied water, resulting in different timing of water diversions within the Sacramento Valley. This may or may not result in consumptively used water being made available for transfer to another consumptive use in or out of the area of origin. An incentive program is also being developed to reduce diversions and applied water that may provide water quality and/or temperature benefits for the fisheries in the Sacramento River.

Offstream Storage

Background and Scope of Evaluation

Offstream storage is primarily a basin-level option that would result in net new water supplies. The primary purpose of offstream storage is to capture and retain excess winter runoff from a combination of mainstem Sacramento River flows and various tributaries to the Sacramento River. This stored water is then released to supplement water supplies in the Valley during normal seasonal or sustained inter-annual dry periods. This can be done either by direct release from storage into the Sacramento River via natural drainage or engineered conveyance facilities, or by supply of stored water to users who then reduce their normal river diversions.

Offstream storage in the Northern Sacramento Valley area has been considered since the early 1960s by Reclamation, DWR, the U.S. Army Corp of Engineers, and various private parties. A wide range of potential reservoir locations, water sources, and project configurations have been examined. The efforts to assess these potential projects have ranged in scope and detail from cursory concept studies to extensive and detailed feasibility/predesign studies. However, no major offstream storage projects have been built or proceeded beyond detailed feasibility studies.

Beginning with the CALFED program in the early 1990s, a renewed effort at assessing the list of potential offstream storage projects was initiated and is still underway as part of CALFED's ISI. The goal of the ISI is to derive a refined list of the most feasible and beneficial offstream storage projects. In addition, DWR is conducting renewed assessment efforts of previously examined projects, under separate mandate, of the most feasible projects.

The following discussion draws primarily from reports produced by previous and ongoing efforts lead by DWR and CALFED to present information on each project's location, size, related facilities, yield, capital costs, and other pertinent data. It is important to note that these studies have used a range of development and assessment methods, hydrologic periods, cost estimate data, reservoir operating rules assumptions, and design/operations criteria, which make direct and detailed comparison of findings tenuous. Cost estimates typically have included only construction costs of main project components, excluding related costs such as environmental permitting and mitigation, O&M, power (or revenue from generation), or financing. Each of these excluded items could have a major impact on the actual cost of each project. Therefore, the relative costs, yields, and other key factors presented here should be considered approximate and adequate for general comparisons only.

Overview of Major Storage Projects

A comprehensive listing and brief description of previously identified offstream storage projects for the Sacramento Valley is presented in the state's most recent water plan, *The California Water Plan Update Bulletin 160-98.* Fourteen offstream storage options were initially screened based on past study efforts, and eight of those were determined to warrant further examination. Storage projects were retained or deferred based on major implementation factors such as cost, yield, and environmental impacts. Table 7 lists the eight projects.

TABLE 7
1998 California Water Plan List of Potential Storage Projects

Project Name	Watershed	Storage Volume Range (maf)
Lake Berryessa Enlargement	Putah Creek	Up to 11.5
Thomes-Newville Reservoir	Stony Creek	1.4 - 1.9
Glenn Reservoir	Stony Creek	6.7 - 8.7
Sites Reservoir	Various	1.2 - 1.8
Colusa Reservoir	Various	3.0
Deer Creek	Deer Creek	0.6
Red Bank Project	South Fork Cottonwood Creek	0.35
Clay Station	Laguna Creek	0.2

Of these eight potential projects, the following four have been identified as the most feasible and warranting more detailed assessment:

- Red Bank Project
- Thomes-Newville Project
- Sites Reservoir Project
- Colusa Reservoir Project

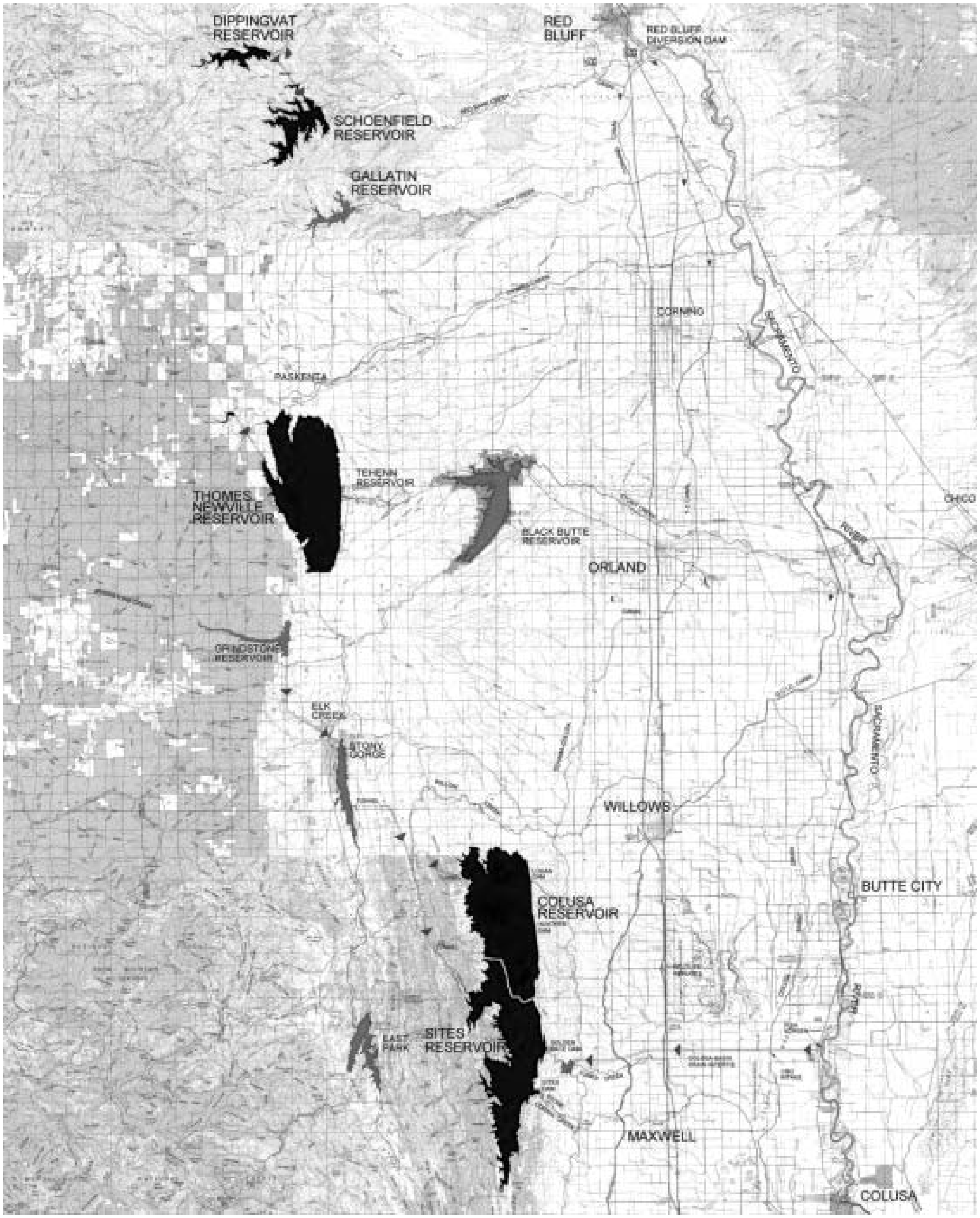
Based on the extensive evaluation of these four projects, they are considered the most likely candidates for potential integration into a BWMP. The following section presents a summary of each of these projects. Figure 2 shows the locations of each of these projects. Table 8 summarizes the storage, dry-period yield, and capital cost for each of the five projects.

TABLE 8
Offstream Storage Project Summary

Project	Storage Capacity (taf)	Dry-period Yield (ac-ft)	Capital Cost
Red Bank	354	25,000	$215 million
Thomes-Newville	1,800	187,000 - 255,000	$684 million
Small Sites	1,200	155,000	$230 million
Large Sites	1,800	244,000	$450 million
Colusa	3,000	430,000	$1,140 million

Note:

taf = thousand acre-feet



EXCERPTED FROM DWR REPORTS

FIGURE 2
POTENTIAL OFFSTREAM STORAGE PROJECT LOCATIONS

TM 5 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Red Bank Project

The Red Bank Project was initially presented as the Dippingvat-Schoenfield project in DWR's 1957 *Bulletin No. 3, California Water Plan*. The U.S. Army Corp of Engineers conducted further investigation in the 1960s and 1970s regarding a potential flood control project. The DWR's evaluation efforts continued intermittently, and in 1993 an updated study titled *Red Bank Project Pre-Feasibility Design Alternatives Report* was issued. DWR evaluated this project again in the 2000 *North of Delta Offstream Storage Investigation Progress Report*. The 2000 report is the basis for current findings on the Red Bank Project. Although this project is classified as offstream, its water supply is the natural runoff within the two watersheds in which the dams are built. The term "offstream" in this context means the project does not involve damming of a mainstem river.

The Red Bank Project is located in Tehama County approximately 20 miles west of Red Bluff (see Figure 3). The primary features are the Schoenfield Reservoir located on Red Bank Creek and the Dippingvat Reservoir located on South Fork Cottonwood Creek. The water source is the natural runoff in these two watersheds, with the majority of supply coming from South Fork Cottonwood Creek. Water would be diverted from storage in the Dippingvat Reservoir via a series of tunnels, small regulating reservoirs, and canals to the Schoenfield Reservoir. The stored water would then be released into Red Bank Creek for conveyance to a diversion structure that feeds the Tehama-Colusa Canal. This new supply to the Tehama-Colusa Canal would allow a corresponding reduction in diversions at the Tehama-Colusa Canal's intake at Lake Red Bluff on the Sacramento River, freeing up these supplies for downstream use.

The combined storage capacity of the two reservoirs would be 354,000 ac-ft, with 72,000 ac-ft allocated to flood storage (South Fork Cottonwood Creek) and an active storage of 282,000 ac-ft. The estimated average yield is approximately 83,000 ac-ft per year (ac-ft/yr), with a critical dry-period annual yield of 25,000 ac-ft/yr. However, the 2000 report indicated that the yield of this project could be reduced due to in-stream fish flows on Cottonwood Creek.

Thomes-Newville Project

The Thomes-Newville Project and the related Glenn Reservoir Project have been studied by Reclamation and DWR, during efforts dating back to the 1960s, as possible future components of the CVP and State Water Project. The most recent comprehensive feasibility study is the DWR 2000 *North of Delta Offstream Storage Investigation Progress Report*. The Glenn Reservoir Project is essentially an expanded version of the Thomes-Newville Project with a much larger reservoir (up to 8.7 maf). The DWR has presently deferred the Glenn Reservoir project from further evaluation for landowner and environmental reasons. The following description is for the Thomes-Newville Project, as presented in the 2000 DWR report.

The Thomes-Newville Project is located within the Stony Creek watershed, upstream of the existing Black Butte Reservoir; see Figure 4. The project would have three primary water supplies – runoff within the North Fork of Stony Creek, runoff diverted from Thomes Creek, and runoff diverted from the main stem of Stony Creek. The primary features are Newville Reservoir located on the North Fork of Stony Creek, the Millsite Reservoir and associated pump station and tunnel/canal used to divert excess flows from the main stem of Stony Creek into Newville Reservoir, and a diversion intake and canal from Thomes Creek to Newville Reservoir. The 2000 report also reported diversion of excess flows from the Sacramento River into Newville Reservoir through a canal from the Tehama-Colusa Canal. Stored water would be released from Newville Reservoir, through a hydroelectric plant into the North Fork of Stony Creek and conveyed via Black Butte Reservoir and the downstream reach of Stony Creek to either the Tehama-Colusa Canal or the GCID Canal.

The 2000 study used the hydrologic records from 1922 to 1993 as input to the modeling for estimating average and critical annual yields. The estimated average annual project yield ranges from 213,000 ac-ft/yr to 275,000 ac-ft/yr, depending on supplies. The critical dry-period annual yield ranges from 146,000 ac-ft/yr to 319,000 ac-ft/yr. The yield estimates have this wide range because actual yield would be dependent on how the reservoir was operated in terms of its integration with the existing Stony Creek reservoir system and Sacramento River, and the operating criteria for releases, conservation storage, and power generation.

The 2000 DWR report mentions the potential for the Thomes-Newville Project's storage capability to be readily expanded up to 3.4 maf given the topography of the reservoir site. This is also the upper range size listed in the CALFED ISI report. This storage volume can not be justified given the runoff of the Thomes Creek and Stony Creek watersheds. Rather, this larger project option would require surplus water supplies diverted from the Sacramento River and pumped into the Newville titled Reservoir using additional pump stations and pipelines or canals. This plan has not been examined in detail.

Sites Reservoir Project

The Sites Reservoir offstream storage project is one of the most widely studied and favorably rated potential projects north of the Delta. There have been several studies since the 1960s by DWR, Reclamation, and private parties, which have looked at a variety of project configurations based on reservoir size and water supply sources. The most recent assessment efforts by DWR are presented in the 2000 DWR report, and that report is the basis for the following summary.

The Sites Project would be located about 10 miles west of Maxwell in Antelope Valley (see Figure 5). Two principle projects of differing size have been proposed for this location – Sites with a 1.8-maf reservoir and the Colusa Project with a 3.0-maf reservoir. The Colusa Project is discussed in the following section. The Sites Reservoir would be formed by two main dams on Stone Corral Creek (Sites Dam) and Funks Creek (Golden Gate Dam), with several smaller saddle dams. The reservoir would be filled using excess winter flows from the Sacramento River. This water could be diverted and conveyed to the project area using either or both the Tehama-Colusa Canal or the GCID Canal, together with a new series of pump stations, pipelines, and regulating reservoirs, or with a new canal that diverts water near Maxwell. The stored water would be released back into either canal for distribution to the Colusa Basin Drain or directly into the Sacramento River.

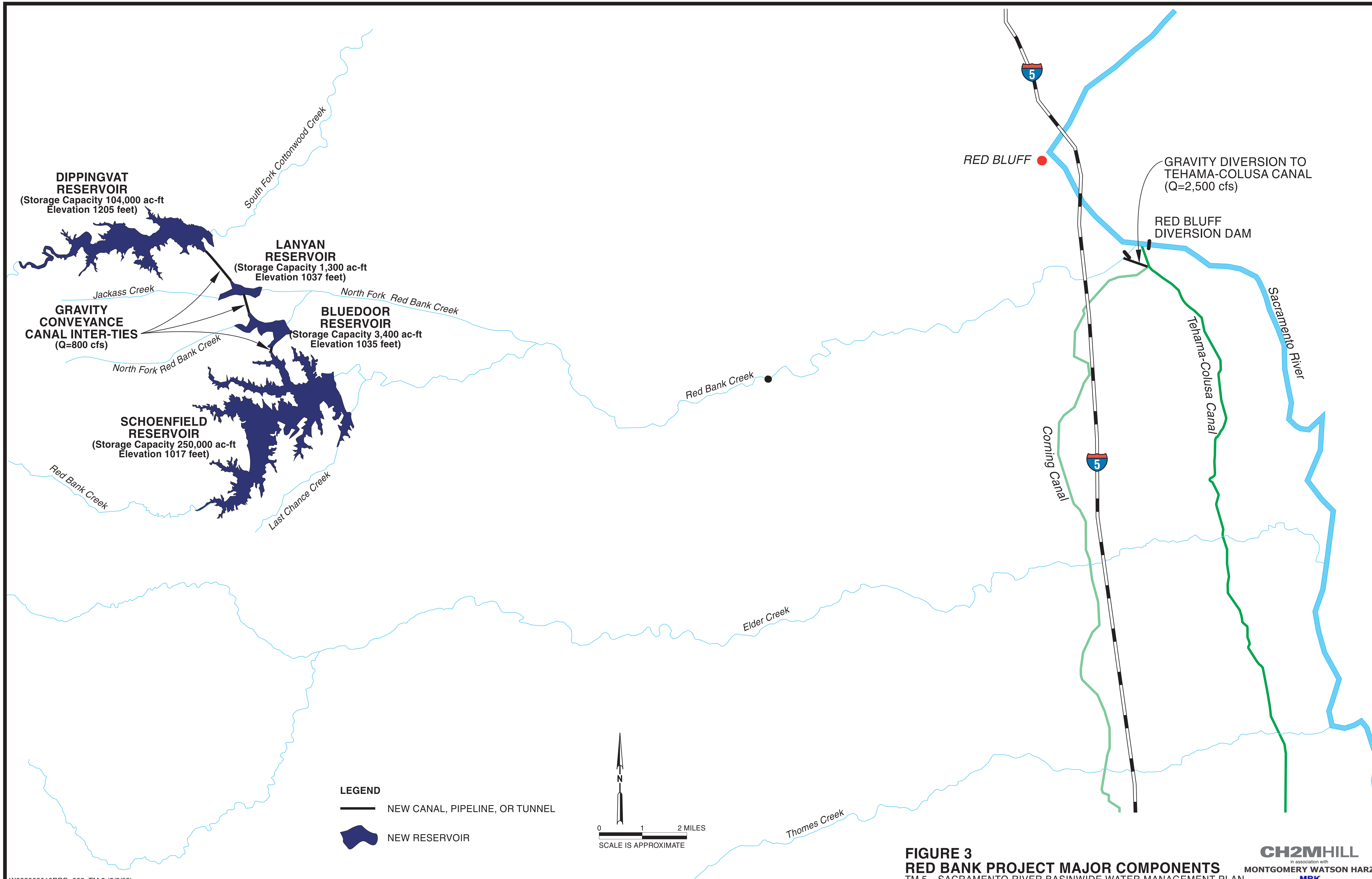

FIGURE 3
RED BANK PROJECT MAJOR COMPONENTS
TM 5 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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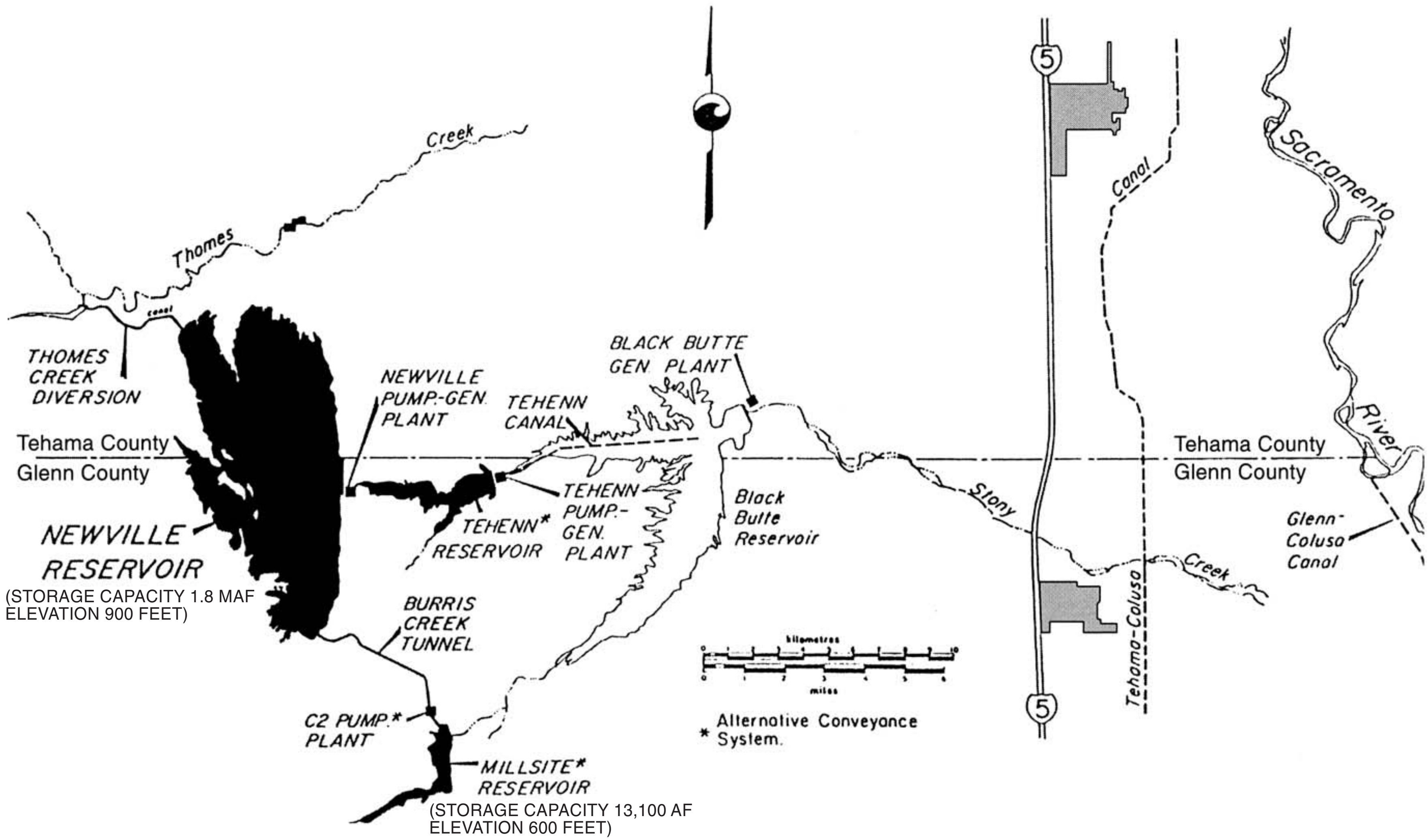

SACRAMENTO RIVER BASINWIDE MANAGEMENT PLAN

FIGURE 4
THOMES-NEWVILLE PROJECT MAJOR COMPONENTS
TM 5 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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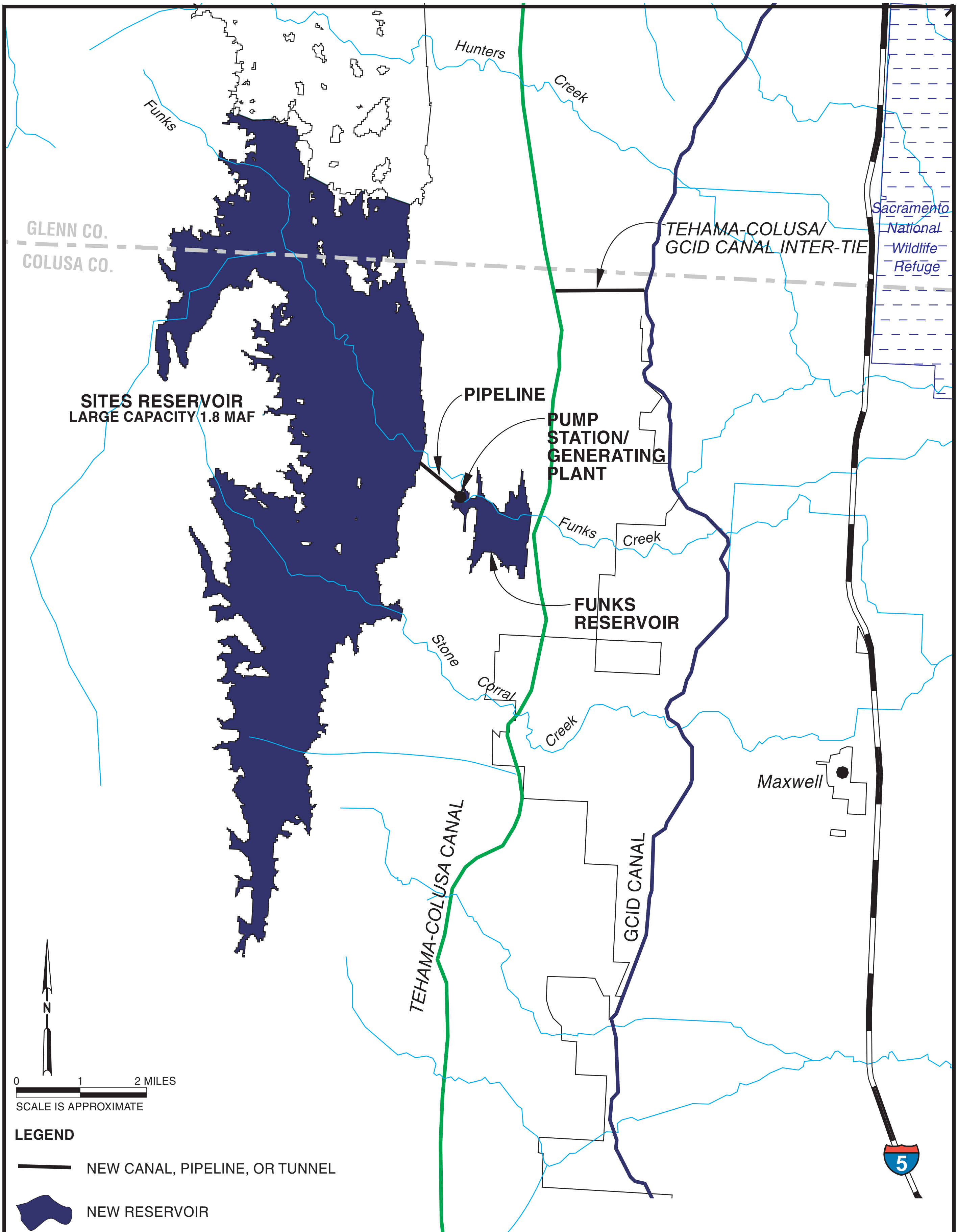

FIGURE 5
SITES PROJECTS
MAJOR COMPONENTS

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Colusa Reservoir Project

The Colusa Project is essentially an expanded Sites Reservoir, increasing the reservoir storage up to 3.0 maf by expanding into the "Colusa compartment" along the northern boundary of the Sites Reservoir. The Colusa Project would require the construction of two additional major dams (Hunters Creek and Logan Creek) and several smaller saddle dams (see Figure 6). The 1.2 maf in increased capacity from the Large Sites Project comes at the expense of overall project efficiency as indicated by the 5:1 ratio of dam volume (and cost) between the Colusa Project and the Large Sites Project.

The Colusa Project would operate in the same manner as the Sites Projects, with excess winter season flows diverted from the Sacramento River and pumped into the reservoir for storage and later release. However, the conveyance system would use a new canal and pump station (the Willows pump/generating plant) inter-tie between the Tehama-Colusa and GCID Canals, a new forebay (Logan Forebay) just west of the Tehama-Colusa Canal, and a canal from the Logan Forebay to a pumping/generating plant located at the new Logan Dam site for lifting the water into the Colusa Reservoir. The 2000 DWR report indicates that the average yield would be 236,000 to 42,800 ac-ft/yr. The average drought-period yield from the Colusa Project would be 159,000 to 412,000 ac-ft/yr. The estimated capital cost, in 1995 dollars, is $1,140 million. Based on these figures, the approximate unit cost for dry-period yield is $2,651 per ac-ft.

Summary

For the 2000 report, DWR conducted preliminary engineering and environmental analysis. The Red Bank Reservoir location had the most habitat diversity of those projects, and steelhead were found in Red Bank Creek within the footprint of Schoenfield Reservoir and spring-run Chinook salmon and steelhead were found in South Fork Cottonwood Creek. A California red-legged frog also was sighted in the Red Bank area. The next most diverse location was the Thomes-Newville Project, which had over 400 acres of jurisdiction wetlands and over 200 acres of other waters of the U.S. Fall-run Chinook salmon and steelhead were found in Thomes Creek. Subsequent studies by DWR (results presented in a 2003 meeting) indicated that Thomes-Newville Reservoir had more prehistoric and historic cultural resources than other reservoirs. The DWR 2000 report indicated that the Colusa cell (located outside of the Sites Reservoir footprint) also had more potential environmental impacts than the other reservoirs because of the more extensive footprint. Further studies are being completed by DWR and Reclamation on these reservoirs.

Previous reports have indicated the capital costs to be $250 to $500 million for the reservoirs. Ongoing, detailed studies being completed by DWR and Reclamation have found that these values are appropriate for the dams. However, all of the projects include inlet/outlet structures and generating plants (ranging from $290 to $550 million) and road relocations around the reservoirs (ranging from $100 to $240 million); and most projects would require conveyance facilities to move water through existing or new canals and from the Sacramento River to the dams ($500 to $1,170 million). Therefore, the total price for the entire project could range from $1,000 to $2,000 million (based on the 2003 presentation by DWR and Reclamation).

Issues Common to All Offstream Storage Projects

Each of the above projects must go through much more extensive analysis in the future to determine which project(s) could actually be implemented as part of a BMWP. The following is a brief listing of issues that need to be analyzed in greater detail as part of future study efforts.

Regional hydrology and coordination with other regional projects – Each of these projects would have a significant impact on the hydrology of the Sacramento River in terms of flows available for diversion by either existing or new water projects. Additionally, use of existing facilities such as the TCCA Red Bluff diversion and canal or the GCID Hamilton City diversion and canal for any single offstream storage project may preclude their use in other projects.

Delta hydrology – The feasibility of any of these projects could be heavily influenced by changes in environmental requirements for Delta outflow quantity, timing, and quality. Such impacts could be further complicated by changes in CVP and State Water Project operations that impact Delta hydrology.

Geology – Further investigation is required for all dam locations and adjacent areas to determine the suitability for foundations, the availability of construction materials (which can greatly impact construction costs), and the potential seismic hazards.

Environmental impacts – Although these projects have generally been highly rated in terms of minimal environmental impacts, much more detailed studies would need to be done for implementation. Generally speaking, more detailed study results in identification of greater impacts. Areas of concern include fisheries, wildlife, and plant species. The mitigation requirements today are generally much more stringent that when most of the feasibility studies for these projects were done, with corresponding increases in mitigation costs for land purchase.

Institutional coordination – Each of these projects would represent a massive capital construction project and involve multiple state and federal agencies for permitting, resource issues, water rights, and coordination with other regional water projects. Which agency or entity is responsible for construction and operation of the project may determine where and how the resultant water supply is used.

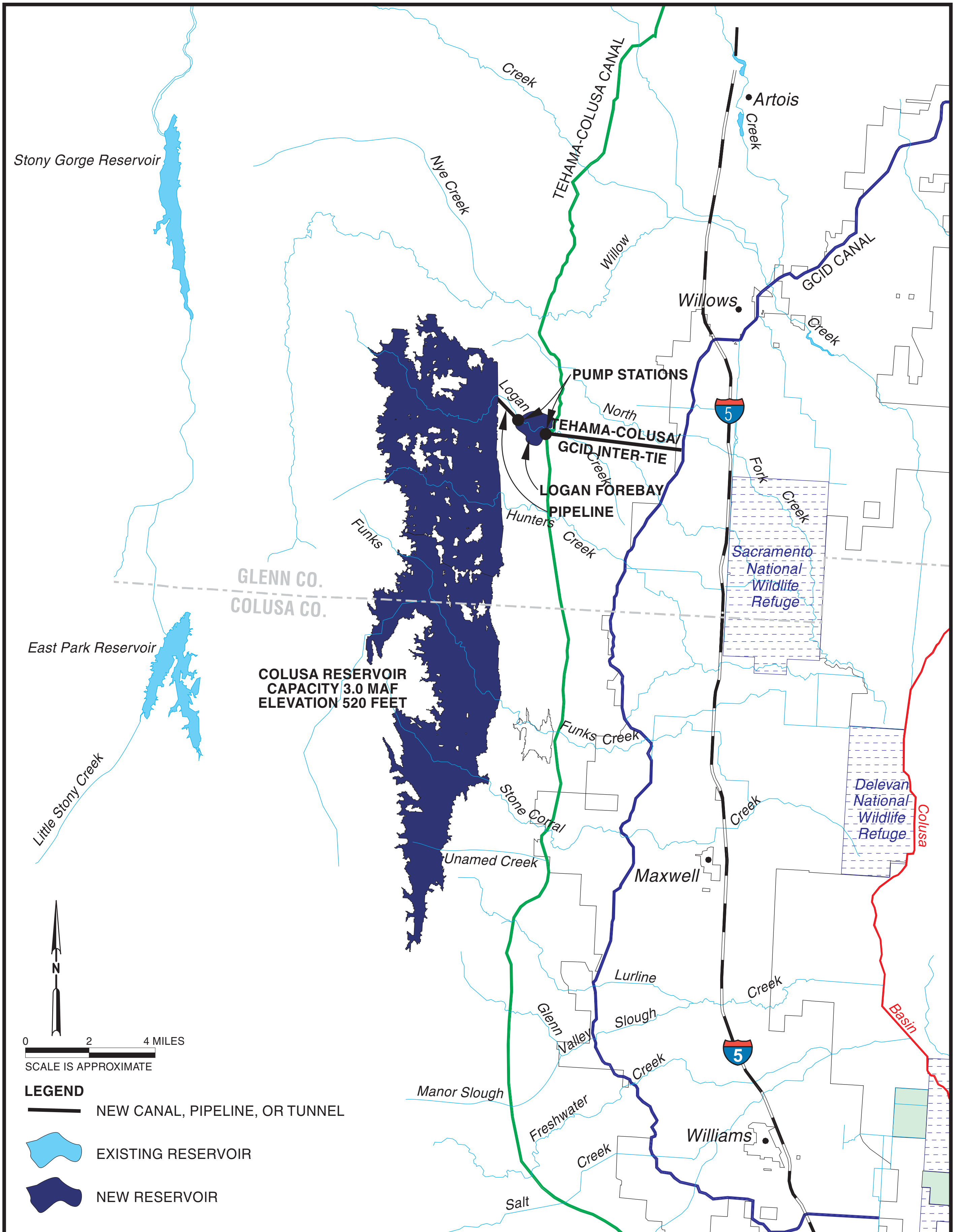

FIGURE 6
COLUSA PROJECT MAJOR COMPONENTS
TM 5 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Preliminary Evaluation of District-level Water Management and Supply Options

Review of Methodology and Evaluation Criteria

A standard list of water management and supply options was evaluated for each SRSC (district). The goal of these evaluations was to determine for each district the following: the existing level of implementation of each option, the potential for new or expanded implementation of the option, and key issues for each district that may impact new or increased development of each option. The evaluation was carried out in the following manner:

- Collected and reviewed available information from past district reports, water management and supply plans, DWR documents, meetings with district staff, and other sources to assess the current level of development of the option within the district and the factors within the district that may impact the feasibility of each option.
- Documented the findings using standard data collection sheets, and reviewed with District staff for accuracy and completeness.
- Evaluated the potential for additional implementation of the option using uniform analysis methods and assumptions where necessary.
- Reviewed the key data, assumptions, and preliminary findings with district staff and revised as necessary.
- Calculated capital and O&M costs and the resultant unit cost of water provided under the option, again using standard calculations, unit costs, and economic parameters to allow uniform comparisons among the options on a standard basis, namely the unit cost of the water in dollars per acre-foot ($/ac-ft). See Appendix B for unit costs.
- Documented the findings for each district in standard summary tables.

Appendix A contains sample data collection and calculation worksheets. Appendix C presents descriptions of the assessment methods for each option. Using the results of the evaluation, the options were then evaluated based on three general criteria:

- **Yield** – amount of potential additional or new water made available.
- **Cost** – capital and O&M, and the potential resulting unit cost of new or conserved water.
- **Implementation** – potential major implementation issues such as secondary environmental impact and institutional issues.

The following sections summarize the results of the evaluation for each district. ***Water quantities and costs for all options are listed as a range to reflect the uncertainty associated with preliminary evaluations that lack detailed site-specific feasibility and engineering study.***

Redding Sub-basin

- **Anderson-Cottonwood Irrigation District**

Anderson-Cottonwood Irrigation District (ACID or District)

Table 9 summarizes the water supply and management options evaluated for ACID.

TABLE 9
Summary of ACID Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	10,000 - 40,000	1,722,000 - 6,396,000	60 - 100	• Moderate to severe impacts on groundwater levels • Integration with M&I regional groundwater development
Drain Reuse	2,500 - 5,000	350,000 - 700,000	15 - 33	
Canal Lining	13,500	2,150,000 - 4,300,000	22 - 48	• Habitat impacts • Existing leakage returns to useable groundwater or surface water
Conveyance System Automation	3,350 - 6,700	297,500 - 637,500	4 - 9	• Staff training • Rotation versus arranged service
Water Measurement	1,650 - 3,300	310,100 - 664,500	9 - 20	
Farm-level Measurement	11,500 - 23,000	1,995,000 - 4,275,000	25 - 53	• Current system is rotation-based, may require change to arranged • Combine with incentive pricing
CVP Purchases	10,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Note: NA = Not Applicable

Groundwater

There is currently only relatively minor groundwater development within ACID by private landowners. Portions of the District overlay a groundwater basin with significant potential yield and good water quality. Based on the preliminary evaluation of available groundwater information, groundwater could potentially supply a significant portion of ACID's future water needs. ACID has proposed and is seeking funding for a conjunctive water management project as part of the SVWMA (see Appendix D). Possible impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Use section of this TM. Regional groundwater development in the Redding Basin is being considered as part of the ongoing Shasta County Water Resources Master Plan, to meet both M&I and agricultural water needs. The nearby communities of Anderson, Redding, and Cottonwood (as well as several large industrial facilities) rely heavily on groundwater and are expected to increase their use of groundwater in the future as the communities continue to grow.

Drain Reuse

ACID's drain reuse is not representative of the typical Sacramento Valley irrigation district. The District typically uses about 5,000 ac-ft/yr of drainwater, or about 3 percent of its average river diversions. This is due to factors such as common crop types and irrigation methods, soils, and topography. ACID's major crops include pasture and hay crops (alfalfa), on which furrow and border check irrigation is commonly used. This does not generally lead to large tailwater runoff except during excessive irrigation application. The soils are generally well drained, and the topography results in rapid drainage runoff to nearby creeks and sloughs. There is generally minor potential for readily increased drainwater reuse.

Canal Lining

ACID currently has lining on about 5 miles of its main canal, in discontinuous portions, to minimize leakage in these areas. Past water management studies indicate that the main canal loses up to approximately 44,000 ac-ft/yr due to leakage (34 percent of average diversions). It is reasonable to assume that a significant quantity of water is lost to leakage, but the associated economics of any canal lining are heavily dependent on the distribution of these losses and the required quantity of lining. The lining option analysis for this TM is based on "middle-ground" assumptions regarding the spatial distribution of leakage, and indicates that canal lining could prevent a significant quantity of loss. The District's current proposal as part of the SVWMA (see Appendix D) will include more detailed determination of the spatial distribution of the canal losses, and will consider impacts to habitat along the unlined canal and the potential impacts to groundwater levels from reduction in leakage inflows to the groundwater basin.

Conveyance Systems Automation of Monitoring and Control

ACID's conveyance and distribution system operation has no automated control but has initiated monitoring at the main diversion. All operational flow changes and measurements are done manually by operations staff. Past studies have indicated relatively high quantities of operational spills due to supply and demand mismatch. There is significant potential within ACID for implementation of canal system automation for control and monitoring, with a resulting reduction in operational spills. The District is currently working with Reclamation to provide basic SCADA monitoring of the Churn Creek Pump Station and flow rate at the head of the main canal. Factors that need to be considered for any proposed automation program include the possible shift from a rotation-based delivery schedule to an arranged delivery schedule, and the impact of increased sophistication of operations on the level of training and skills for District field staff.

Water Measurement

ACID's main river diversions (Lake Redding and Churn Creek) have meters installed and operated by Reclamation, which provide both flow rate and total volume of flow. At major lateral headgates, the District measures flow rates manually using weir or gate head-flow tables. Flows at field turnouts are measured using canal headgate position tables. Drain pump flows are not metered, but the total volume pumped is estimated using power consumption and pump efficiency history. Increases in conveyance efficiency may be achieved with a program of water measurement that includes installation of intermediate measurement points along the main canals, improved lateral flow measurement, and installation of flow meters and totalizers on drain pumps.

Farm-level Measurement

ACID does not currently meter individual customer turnouts. Estimates of flow rate are made based on canal headgate position relationships. Total deliveries per customer are not recorded. ACID's on-farm efficiency is relatively low (45 percent based on 1982 NRCS study). Field metering in combination with modifying the delivery arrangement from a rotation basis to arranged, an appropriate incentive pricing structure, and on-field improvements such as land leveling may increase the average on-farm efficiency, with some savings in water use. However, the effective implementation of such a program would depend on the correct combination of all of the above factors, in addition to basic economic considerations such as the return on investment to the District and landowners. Additionally, the installation, maintenance, and reading of the meters (950) would represent a major up-front capital cost to the District as well as an ongoing labor and capital expense.

CVP Purchases

ACID's contract for Project Water provides up to 10,000 ac-ft/yr for use in July and August. The District's use of CVP Project Water is described in greater detail in TM 3. The District has historically used some portion of its CVP Project Supply, although the quantity has decreased since 1991, due to increased costs. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to ACID will remain the same. However, the cost of the water is expected to increase.

Colusa Sub-basin

- **Glenn-Colusa Irrigation District**
- **Provident Irrigation District**
- **Princeton-Codora-Glenn Irrigation District**
- **Maxwell Irrigation District**
- **Reclamation District No. 108**

Glenn-Colusa Irrigation District (GCID or District)

Table 10 summarizes the water supply and management options evaluated for GCID.

TABLE 10
Summary of GCID Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	105,000 - 180,000	16,200,000 - 48,700,000	70 - 130	• Moderate to severe impacts on groundwater levels and adjacent groundwater users • Loss of shallow groundwater habitat
Drain Reuse	25,000 - 50,000	3,500,000 7,000,000	15 - 33	• Impacts on downstream drain users from reduced water supply • Potential salinity impacts
Canal Lining	14,500 - 29,000	31,500,000 - 63,000,000	153 - 329	• Existing leakage returns to useable groundwater or surface water
Conveyance System Automation	FD	FD	FD	• Option fully developed
Water Measurement	FD	FD	FD	• Option fully developed
Farm-level Measurement	26,500 - 53,000	2,940,000 - 6,300,000	18 - 39	• Combine with incentive pricing
CVP Purchases	105,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Note: FD = Fully Developed

Groundwater

GCID currently runs only one District-owned well, but over 100 private landowner wells can provide a significant amount of groundwater and are used in a cooperative supplemental water supply program within the District. GCID's service area overlays a large groundwater basin with good water quality. DWR and the District have conducted preliminary studies to assess potential additional groundwater development. Groundwater could potentially provide a significant drought-year supplemental water source to the GCID service area. Possible impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Development section of this TM. Groundwater development is continuing to be coordinated with existing regional groundwater plans. Given the District's wide geographic coverage, GCID may have the potential to develop a formal conjunctive water management program as well. GCID has proposed a conjunctive water management project as part of the SVWMA, and is partnering with the Orland-Artois Water District and Orland Unit Water Users' Association on a cooperative project (see Appendix D).

Drain Reuse

GCID currently makes extensive use of drainwater, averaging about 155,000 ac-ft/yr. This equates to about 25 percent of the District's average Sacramento River diversion. There may be potential for significant additional development of drainwater reuse by GCID based on the quantity of drain outflow from the District. However, this will require a major investment in new diversion pumps, conveyance facilities, and possibly surface storage areas to allow capturing peak drain outflows during times of corresponding low water demand, for later use. Development of the potential additional 50,000 ac-ft/yr of drain reuse would have a major impact on downstream drain diverters, including other SRSC districts and Colusa Basin drainwater users, who would be forced to find replacement supplies such as increased river diversions or groundwater pumping. GCID also has contractual obligations with other districts regarding the use of drainwater that may conflict with such a large increase in drainwater use. The District has a drainwater quality sampling and soils salinity monitoring program underway. Drainwater use may be limited in the future if impacts on soil salinity and crop yield are identified from this program.

Canal Lining

GCID does not currently have any lined canals. Estimation of the leakage losses from the GCID main canal indicates that losses are minimal due to the low permeability of the clay soils that are common in the area. A relatively minor quantity of water could be "saved" by lining some portion of the main canal, but the preliminary analysis shows this to be a prohibitively expensive water management option. Most seepage from District canals returns to surface drains adjacent to the canals, or recharges the underlying groundwater basin, making net regional water savings from canal lining minimal.

Conveyance Systems Automation

GCID's canal system currently has a high level of automated control and monitoring, including motor-operated radial and slide gates, water-level and flow measurement at key points in the system, and integrated SCADA to match supplies and demands throughout the system. The District also has an ongoing program to increase the coverage of the SCADA system and to automate remaining major flow control structures. The District's operational spills are minimal based on the standard performance and requirements of an open-channel distribution systems, and it is not likely that significant reductions in the quantity of operational spills can be achieved.

Water Measurement

GCID states that it currently has an extensive water measurement program that covers all levels of operation. The main surface supplies are measured using meters or pump curves. Main canal flows are measured using meters at key points, including a new acoustic measuring device at the recently constructed Stony Creek siphon. Main laterals and sublaterals that serve field turnouts are metered. All District drain pumps and the single District well are metered. Turnouts to fields are measured and totalized by service area using the measurements for the service lateral that serves each area. Lateral spills are measured and totalized using lateral stage measurement and weir equations. Drain outflows from the District are measured and recorded using a combination of weirs and meters. Water measurement as a management option is considered fully developed within the GCID service area, with no significant water savings possible from increased operational measurements. GCID has proposed a water measurement improvement project as part of the SVWMA (see Appendix D).

Farm-level Measurement

GCID does not currently meter individual field turnouts, with the exception of several test plots that are used to provide detailed quantitative data for use in monitoring efforts to improve farm-level water management. GCID does, however, measure flow rates at turnouts using canal stage and head-discharge relationships for orifices and gates. Total deliveries per service lateral are recorded. The average on-farm efficiency for the District is approximately 65 percent, which is near the practical upper limit of around 70 percent. Farm-level measuring in combination with incentive pricing and on-farm improvements may potentially increase the average on-farm efficiency and provide a quantity of conserved water.

CVP Purchases

GCID's contract for Project Water provides up to 105,000 ac-ft/yr for use in July and August. The District's use of Project Water is described in greater detail in TM 3. The District has historically used its full Project Supply, although the quantity has decreased in the last several years due to pumping restrictions at the Hamilton City Pumping Plant imposed on the District until necessary fish screening and bypass improvements are completed. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to GCID will remain the same. However, the cost of the water is expected to increase.

Provident Irrigation District (PID or District)

Table 11 summarizes the water supply and management options evaluated for PID.

TABLE 11
Summary of PID Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	5,000 - 13,000	980,000 - 2,000,000	40 - 60	• Moderate to substantial impacts on groundwater levels and adjacent groundwater users • Loss of shallow groundwater habitat • Existing AB 3030 plans and county groundwater ordinances
Drain Reuse	1,500 - 3,000	210,000 - 420,000	15 - 33	• Supply limited by GCID and internal return inflows • Downstream drain users' agreements • SWRCB pumping license
Canal Lining	500 - 1,000	1,550,000 - 3,100,000	214 - 458	• Habitat impacts • Existing leakage returns to useable groundwater or surface water
Conveyance System Automation	600 - 1,200	67,000 - 144,000	8 - 18	
Water Measurement	350 - 700	175,000 - 375,000	25 - 53	
Farm-level Measurement	3,300 - 6,600	490,000 - 1,050,000	24 - 51	• Combine with incentive pricing
CVP Purchases	5,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Note: NA = Not Applicable

Groundwater

PID currently uses four District-owned wells to supplement surface water supplies. There are also several private wells in the service area. These wells provide a supplemental supply to the District during surface-supply cutbacks. In normal years, the wells also increase the District's ability to meet changes in demand without altering river diversions. The District's service area overlays a groundwater basin with significant potential yield and good water quality. Based on the preliminary evaluation of available groundwater information, groundwater could potentially supply a portion of PID's future water needs. Possible impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Development section of this TM. PID is party to both an AB 3030 plan and a county groundwater management plan. Future groundwater development will need to be coordinated within the framework of these agreements.

Drain Reuse

PID has an extensive drain reuse program in place that supplies approximately 50,000 ac-ft/yr, or about 71 percent of the District's average annual Sacramento River diversion. The District's ability to increase the use of drainwater is limited by several factors, and future increases are not likely to provide a significant new source of conserved water. The total supply of drainwater is limited to drain outflow from GCID and PID's own service area, and is not expected to increase in the future. Rather, it may decrease if more aggressive drain reuse is pursued by GCID or if either district significantly alters their on-farm management practices in such a way as to decrease return flows to the drains. PID also has legal agreements with downstream drain diverters to maintain the current general quantity and quality of drainwater to ensure the continued ability of these diverters to use the drainwater supply. Finally, any large increase would also require a new drain-pumping license from SWRCB.

Canal Lining

PID does not currently have any lined canals. The District has identified no significant leakage problem areas. Estimation of the leakage from the PID main canal indicates that losses are minimal due to the low permeability of the clay soils that are common in the area. Lining some portion of the main canal could save a relatively minor quantity of water, but the preliminary analysis shows this to be a prohibitively expensive water management option. Most leakage from the District canals returns to surface drains adjacent to the canals, or recharges the underlying groundwater basin, making net regional water savings from canal lining minimal.

Conveyance Systems Automation

PID currently is upgrading several major facilities in a cooperative effort with PCGID, Reclamation, and irrigation operations specialists from Cal Poly San Luis Obispo. Upgrades being done this year include installation of variable-frequency drives (VFD) on the Sidds Landing Pump Station, a centralized SCADA center at the PID office (for both Districts' use), and remote monitoring of several of the largest drain pumps. Most of the existing drain pumps have local automated control using float switches. Future plans include expansion of the SCADA system to cover all major drain pump stations (both the pumps and adjacent lateral control gates) and possibly main lateral headgates. The program should result in a reduction in operational spills and more efficient use of drainwater.

Water Measurement

PID currently measures flows at the main pump stations with flow meters. District wells and all drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts. Minor increases in conveyance efficiency could be achieved by improved operations measurement, with installation of measuring facilities at intermediate points along the main canal, and improved measuring at the heads of laterals. These new measurement facilitates would be integrated with the operations automation program described above to increase overall distribution system efficiency.

Farm-level Measurement

PID does not currently meter field turnouts. Flow rates at turnouts are estimated based on head-flow relationships for the turnout orifices or weirs. The District does not record total delivery to each customer. The average on-farm efficiency for the District is approximately 64 percent, which is near the assumed practical upper limit of around 70 percent. Field-level metering in combination with incentive pricing and on-farm improvements may potentially increase the average on-farm efficiency and provide a relatively minor quantity of conserved water.

CVP Purchases

PID’s contract for Project Water provides up to 5,000 ac-ft/yr for use in July, August, and September. The District’s use of Project Water is described in greater detail in TM 3. The District has historically used a large portion of its Project Supply. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to PID will remain the same. However, the cost of the water is expected to increase.

Princeton-Codora-Glenn Irrigation District (PCGID or District)

Table 12 summarizes the water supply and management options evaluated for PCGID.

TABLE 12
Summary of PCGID Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	13,000 - 15,000	2,200,000 - 4,700,000	50 - 70	• Moderate to substantial impacts on groundwater levels and adjacent groundwater users • Loss of shallow groundwater habitat • Existing AB 3030 plans and county groundwater ordinances
Drain Reuse	1,500 - 3,000	210,000 - 420,000	15 - 33	• Supply limited by GCID and internal inflows • Downstream drain users' agreements • SWRCB pumping license
Canal Lining	4,500 - 9,000	1,800,000 - 3,600,000	27 - 57	• Habitat impacts • Rate of leakage return to river • Existing leakage returns to useable groundwater or surface water
Conveyance System Automation	800 - 1,600	135,000 - 290,000	8 - 18	
Water Measurement	450 - 900	250,000 - 536,000	27 - 59	
Farm-level Measurement	2,000 - 4,000	490,000 - 1,050,000	39 - 84	• Combine with incentive pricing • Past use resulted in clogging, excessive maintenance requirements, poor accuracy
CVP Purchases	15,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Note: NA = Not Applicable

Groundwater

PCGID currently uses 5 District-owned and 15 private wells to supplement surface water supplies. These wells can provide a significant amount of supplemental supply to the District. The District's service area overlays a groundwater basin with significant potential yield and good water quality. Based on the preliminary evaluation of available groundwater information, groundwater could potentially supply a portion of PCGID's future water needs. Possible impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Development section of this TM. PCGID is party to both an AB 3030 plan and a county groundwater management plan. Future groundwater development will need to be coordinated within the framework of these plans.

Drain Reuse

PCGID has an extensive drain reuse program in place that supplies approximately 25,000 ac-ft/yr, or about 54 percent of the District's average annual Sacramento River diversion. The District's ability to increase their use of drainwater is limited by several factors, and future increases are not likely to be a significant new source of conserved water. The total supply of drainwater is limited to drain outflow from GCID and PCGID's own service area, and is not expected to increase in the future. Rather, it may decrease if increased drain reuse or field-level conservation is initiated by GCID. The District also has agreements with downstream drain diverters to maintain the current general quantity and quality of drainwater to ensure the continued ability of these diverters to use the drainwater supply. Finally, any large increase in diversions may require a new drain-pumping license from SWRCB.

Canal Lining

PCGID does not currently have any lined canals or laterals, with the exception of the first 0.25 mile of the main canal upstream of the Sidds Landing Pumping Plant. However, field testing by the District indicates that the River Branch Canal, which closely parallels the Sacramento River, has significant leakage losses (up to 25 percent of inflow) along an approximately 6-mile reach from the Sidds Landing Pumping Plant to the District's first main lateral turnout. Lining of this canal reach may provide significant water savings. Potential implementation issues include the high capital cost and habitat impacts. Additional study is required to isolate the most beneficial reaches for lining, and to determine if the leakage losses are returning rapidly to the Sacramento River, as this would influence the net benefit of lining in terms of short-term impacts on river flows.

Conveyance Systems Automation

PCGID currently is upgrading several major facilities in a cooperative effort with PID, Reclamation, and irrigation operations specialists from Cal Poly San Luis Obispo's Irrigation Research and Training Center. Upgrades being done in 2001 include a completely new pump station with VFDs at the Sidds Landing Pump Station, a central SCADA computer system at the PID office (for both Districts' use), and remote monitoring of several key drain pump locations. The District has also automated several of its drain pumps with local float switch controllers to maintain target water levels in the adjacent laterals. Future plans include expansion of the SCADA system to cover all major drain pump stations and possibly main lateral headgates. The program should result in reduced operational spills to drains and more efficient use of available drainwater.

Water Measurement

PCGID currently measures flows at the main pump stations with flow meters. District wells and all drain pumps are metered. Lateral headgate flows are measured using stage and gate position, or stage and weir geometry at flashboard turnouts. Minor increases in conveyance efficiency could be achieved by improved operations measurement, with installation of measuring facilities at intermediate points along the main canal and improved measuring at the heads of laterals. These new operations measurement facilitates would be integrated with the operations automation program described above to increase overall distribution system efficiency.

Farm-level Measurement

PCGID does not currently meter field turnouts. Flow rates at turnouts are estimated based on head-flow relationships for the turnout orifices. The District does not record total delivery to each customer. The District has installed flow meters on field turnouts in the past and experienced clogging by the debris that is common in earthen canals. The frequent clogging required cleaning of meters and resulted in poor accuracy. The average on-farm efficiency for the District is approximately 64 percent, which is near the assumed practical upper limit of around 70 percent. Field-level metering in combination with incentive pricing and on-farm improvements may potentially increase the average on-farm efficiency and provide a significant quantity of conserved water. The associated capital and O&M costs for metering would likely result in significant rate increases to District customers.

CVP Purchases

PCGID's contract for Project Water provides up to 15,000 ac-ft/yr for use in July, August, and September. The District's use of Project Water is described in greater detail in TM 3. The District has historically used a large portion of its Project Supply. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to PCGID will remain the same. However, the cost of the water is expected to increase.

Maxwell Irrigation District (MID or District)

Table 13 summarizes the water supply and management options evaluated for MID.

TABLE 13
Summary of MID Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	3,000 - 6,000	396,000 - 1,600,000	30 - 50	• Coordination with County and AB 3030 plans • Impacts on other groundwater users
Drain Reuse	2,000 - 4,000	60,000 - 130,000	11 - 22	• Reduction in downstream drain users supply • Future supply may decrease if GCID drain use increases
Canal Lining	700 - 1,500	2,600,000 - 5,500,000	420 - 900	• Existing leakage returns to drains or groundwater • Habitat impacts
Conveyance System Automation	300 - 600	70,000 - 150,000	11 - 24	
Water Measurement	200 - 300	35,000 - 75,000	11 - 24	
Farm-level Measurement	1,700 - 2,500	59,000 - 126,000	8 - 17	• Combine with incentive pricing
CVP Purchases	6,000	NA	---	• Uncertain future price

[a]Water rates for 2003.

Note: NA = Not Applicable

Groundwater

MID does not currently use any groundwater as part of the District's supply. There are six private agricultural wells in the service area that are not operated in coordination with MID. Based on the information presented in the Groundwater Hydrology TM (Draft) (January 2000, DWR), the District's service area overlays an area with useable groundwater resources. Preliminary evaluation indicates that groundwater development could potentially provide MID with a supplemental supply for use in normal and drought years. Potential impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Development section of this TM. MID has proposed a conjunctive water management project as part of the SVWMA (see Appendix D).

Drain Reuse

MID has made extensive use of drainwater in past years, at times supplying up to 80 percent or more of its supply by diversion from area drains. The District's use of drainwater in past years was motivated by the lack of reliable diversion capacity on the Sacramento River. Relocation and improvement of their Sacramento River pump station has allowed the District to begin using its Sacramento River supply more reliably, with a corresponding decrease in drainwater use. Minor increases in drainwater reuse may be possible by increasing the pumping capacity at the District's two main drain pump stations. However, increased diversions within MID may impact downstream users along the Colusa Basin Drain as outflow from MID is reduced. MID's primary source of drainwater is outflow from the GCID service area. This makes the future supply of drainwater dependent on actions within GCID, such as changes in irrigation practices or increased drain recapture, which may decrease the drainwater outflow to MID's service area.

Canal Lining

MID does not currently have any lined canals. The District has identified no significant leakage problems. Based on the common soil types in the area and their low permeability, the estimated losses from MID's main canal and the laterals within the service area are minimal. The majority of the leakage that does occur is recaptured in the drains that parallel the canals and is available for use through the drainwater reuse practices. The remaining leakage is most likely recharging the underlying groundwater basin. A minor quantity of water could be "saved" by lining a portion of MID's canals, but the preliminary analysis indicates that the unit cost of the avoided water loss is prohibitively expensive.

Conveyance Systems Automation of Monitoring and Control

MID currently has minimal automation of its conveyance system. Control and adjustment of flows and distribution are performed locally by the operations staff. The two main pump stations each have timers on one pump within each group, to try and match the average pumping rate with the system demand. The drain lift pumps have float switch controls to operate based on water levels in the adjacent lateral and drain. No data are available on existing operational spills. All spills end up in local drains or in the Colusa Basin Drain, where the water is reused. Automation of the key conveyance and supply facilities within MID may provide some reduction in operational spills. The automation improvements would include VFDs on the two main pump stations (the Sacramento River and at Stone Corral), and automation and remote monitoring of the main pump stations and other key points via a SCADA system linked to the District office. These improvements would result in minor reductions in operational spills, but would likely have significant benefit from improved operations efficiency via reduced pumping costs, and the ability of operations staff to more quickly respond to changes in system supply and demand.

Water Measurement

MID measures flow from the Sacramento River pump station using propeller meters installed in a downstream culvert structure. Flows into the main supply canal, from the Stone Corral lift pump station, are not metered. The various drain recapture pumps and lateral lift pumps are not metered. Total pumping can be estimated using power records, but is not normally done. Lateral flows are estimated using head on canal gates or flashboard weirs. Drain outflow from the service area is measured using stage recordings to estimate weir flow at the two main drain check structures. Increased water savings are possible through a program of improved water measurement that includes installation of meters on the lift pumps and drain pumps, long-throated flumes on the main service laterals, and continuous-stage recording devices at the main drain outflow points.

Farm-level Measurement

MID does not meter individual customer turnouts. Flow rates at field turnouts are measured using head/orifice or head/weir relationships. Total delivered volume is not measured or recorded. MID's average on-farm efficiency is approximately 63 percent, according to DWR data. Farm-level measurement, in combination with an appropriate pricing structure and on-field improvements such as land leveling, may increase the average on-farm efficiency, with some savings in water use. The most effective and efficient method to measure and quantify delivery, based on the characteristics of the MID conveyance system, would likely involve improved canal water level control, in combination with the practice of recording start/stop times and average flow rate for each delivery. With properly installed and operated canal gates, this method would provide an affordable and sufficiently accurate method of measuring delivery volume.

CVP Purchases

MID's contract for Project Water provides up to 6,000 ac-ft/yr for use in July, August, and September. The District's use of Project Water is described in greater detail in TM 3. The District has used most of its Project Supply since 1990, when the new Sacramento River pump station was built. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to MID will remain the same. However, the cost of the water is expected to increase.

Reclamation District No. 108 (RD 108 or District)

Table 14 summarizes the water supply and management options evaluated for RD 108.

TABLE 14
Summary of RD 108 Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	See discussion			• DWR conjunctive water management study ongoing
Drain Reuse	FD	FD	FD	• Drain use fully developed • Salinity impacts noted in some areas
Canal Lining	FD	FD	FD	• Canal lining complete on identified problem areas
Conveyance System Automation	FD	FD	FD	• Partial automation in place, ongoing improvements
Water Measurement	FD	FD	FD	• Option fully developed
Farm-level Measurement	5,000 - 10,000	---	---	• Combine with incentive pricing • Currently near maximum practical on-farm efficiency
CVP Purchases	33,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Note: FD = Fully Developed

Groundwater

RD 108 owns and operates three groundwater wells, which have a total capacity of approximately 20 cubic feet per second. The wells are located in the northern portion of the District, and are typically used during drought conditions to supplement reduced surface water supplies and meet emergency needs. Historical average use is approximately 5,000 ac-ft/yr. RD 108's service area overlays a groundwater basin with unknown potential yield of good water quality. The District is involved in a cooperative long-range study with DWR to consider a possible conjunctive water management program that would involve increased groundwater use by RD 108 in exchange for decreased river diversions. Several test wells have been installed and more are planned. RD 108 has proposed a conjunctive water management project as part of the SVWMA (see Appendix D).

Drain Reuse

RD 108 currently has drainage system facilities in place to capture nearly 100 percent of field runoff water, and has typically recycled up to 60,000 ac-ft/yr, or about 42 percent of their average Sacramento River diversion. In 1997, the District implemented a policy to minimize drainwater reuse in response to concerns from growers regarding salinity buildup and resulting crop-yield impacts. The District has a water quality sampling program underway, and will be doing further evaluation of the impacts of drainwater use on soil salinity. However, at present the District has made the necessary infrastructure investment to allow maximum use of drainwater; therefore, this management option is considered to be fully developed and does not offer significant potential for increased water conservation by the District.

Canal Lining

RD 108 currently has 35 miles of concrete-lined canals and laterals. These canals are located near the Sacramento River and in other areas with sandy soils and resultant high leakage losses. Past studies by the District have ranked the canal reaches into three levels of priority for lining, and all of the first-level and most of the second-level priority reaches have been lined. The remaining canals have minimal leakage. Canal lining is considered fully developed as a management option and does not offer significant potential for new water conservation by the District.

Conveyance Systems Automation

In 1997, RD 108 began upgrading and automating all major supply and canal control facilities. Currently over 50 percent of the District's distribution and drainage system pumping and control structure facilities are linked via a centralized SCADA system. The District is continuing this program with the goal of automating all major canal and lateral control structures. Operational spills are currently at the lower practical amount for an open-channel irrigation system, and further significant reductions are limited. Conveyance system automation, when essentially completed over the next few years, will be fully developed as a management option for RD 108 and does not offer significant potential for new water conservation.

Water Measurement

Reclamation currently measures water at each of the seven Sacramento River pump stations using flow meters. RD 108 measures drain pump and relift pump flows using pump efficiency curves and power use records. Drain flows leaving the District service area are also metered at the pump stations that are used to discharge the drainage into the Sacramento River. Flows in canals and laterals are measured using head measurements at gates and weirs. Some improvement in water measurement could be achieved along main canals and laterals with the installation of low-headloss flow measurement devices such as long-throated flumes and water level monitoring devices to quantify flows delivered to specific water service areas.

Farm-level Measurement

RD 108 measures flow rate at turnouts using head-discharge relationships for orifices and gates. Flow rates are set to match the field demand based on the irrigation method and field conditions. The total quantity of water delivered to each turnout is not recorded. The average on-farm efficiency for the District is approximately 66 percent, which is near the practical upper limit of around 70 percent. Operating conditions such as minimal head differential between supply laterals and fields and canal debris make widespread use of flow meters impractical for nearly all turnouts. The most practical method for quantifying delivery at turnouts may involve improved water level recording and control in the laterals, combined with recording of delivery times and flow rates at each turnout. Some method of quantification, along with field-level improvements and appropriate price incentives, may provide improved field-level efficiency.

CVP Purchases

RD 108's contract for Project Water provides up to 33,000 ac-ft/yr for use in July, August, and September. The District's use of Project Water is described in greater detail in TM 3. The District has historically used most of its Project Supply. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to RD 108 will remain the same. However, the cost of the water is expected to increase.

Butte Sub-basin

- **Reclamation District No. 1004**

Reclamation District No. 1004 (RD 1004 or District)

Table 15 summarizes the water supply and management options evaluated for RD 1004.

TABLE 15
Summary of RD 1004 Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	14,000 - 15,000	2,200,000 - 4,600,000	40 - 60	• District policy to not own/ develop wells; choice of private landowners • Moderate to substantial impacts on groundwater levels • Loss of shallow groundwater habitat • Existing AB 3030 plan and county groundwater ordinances
Drain Reuse	FD	FD	FD	• Drain use fully developed
Canal Lining	350 - 700	1,050,000 - 2,100,000	214 - 458	• Habitat impacts • Existing leakage returns to useable groundwater or surface water
Conveyance System Automation	500 - 1,000	343,000 - 735,000	29 - 63	
Water Measurement	FD	FD	FD	• All levels of supply/distribution measured
Farm-level Measurement	FD	FD	FD	• Meters installed on all turnouts
CVP Purchases	15,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Notes: FD = Fully Developed; NA = Not Applicable

Groundwater

RD 1004 has only one District-owned groundwater well. There are approximately 52 private irrigation wells in the service area. There is no formal agreement between the District and the owners of the wells for coordinated use of the wells as a supplemental source to the District's surface water supplies. Portions of the District service area overlay a groundwater basin with significant potential yield and good-quality groundwater. Some areas do have poor-quality groundwater near the eastern half of the service area, underlying the Butte Sink. Based on the preliminary evaluation of available groundwater information, groundwater could potentially supply a portion of RD 1004's future water needs. Future groundwater development by the District would require a change in this policy. Possible impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Development section of this TM. RD 1004 is party to both an AB 3030 plan and a county groundwater management plan. Future groundwater development will need to be coordinated within the framework of these agreements.

Drain Reuse

RD 1004 currently uses an average of 20,000 ac-ft/yr of drainwater, equivalent to approximately 36 percent of the District's average Sacramento River diversion. The District relies heavily on drainwater to supplement their other water sources. RD 1004's ability to increase its drainage water use is minimal. The District is already at or near the limit of the actual quantity of water available to recycle. During the regular irrigation season, all drains are ponded to allow pumping, and essentially no water outflows from the drains. The small amount of outflow allowed enters the Butte Creek/Butte Sink area where it is reused by the numerous downstream diverters.

Canal Lining

RD 1004's main canal crosses an area of very high-permeability soils east of the main Sacramento River pump station. The District has recently installed 1,800 feet of buried pipeline, and lined an additional 3,400 feet of canal to prevent leakage losses in this area. Additional reaches of the main canal are estimated by the District to have some potential for beneficial lining. A relatively minor quantity of water could be "saved" by lining of these canal reaches, but the preliminary analysis shows this to be an expensive water management option in terms of unit cost. Potential implementation issues include the high capital cost and habitat impacts. Additional study is required to isolate the most beneficial reaches for lining, and to determine if the leakage losses are returning rapidly to area drains and/or the underlying groundwater, as this would influence the net benefit of lining in terms of its impact on the District's overall water balance.

Conveyance Systems Automation of Monitoring and Control

RD 1004 recently completed a cooperative study with Reclamation and irrigation operations specialists from Cal Poly San Luis Obispo to identify priorities for automation improvements. Upgrades already completed include a completely new pump station on the Sacramento River, a SCADA system for control of the new pump station, and automated controls for drain pumps. The District's overall conveyance system efficiency is approximately 85 to 90 percent, based on the metered inflows and metered field deliveries. This is near the practical limit for an open-channel irrigation system. For this reason, future improvements in automation and water level control are primarily focused on improved level of service and reduced O&M costs, with only minor improvements in overall efficiency. These improvements may include two or more automated water level control structures on the main canal and increased SCADA coverage for drain pumps and main canal and lateral flow measurements.

Water Measurement

Water measurement is considered fully implemented as a conservation measure at RD 1004. The District measures flow and quantity at its river diversion pump stations using flow meters. Canal and lateral flow rates are measured using meters and totalizers installed at intermediate points such as road culverts. The one District well is metered. Drain pump flows are estimated based on power consumption and pump efficiency data. The only operations level that is not metered is the drain pumps, although the power consumption records and efficiency data provide fairly accurate estimates of total volumes pumped.

Farm-level Measurement

RD 1004 has flow meters installed on all of its customer turnouts. The meters are read and cleaned regularly, generally every 2 days. The District uses the meter data to record flow rates and total volume delivered at each turnout. These data are then used for the billing, which is based on a $/ac-ft charge.

CVP Purchases

RD 1004's contract for Project Water provides up to 15,000 ac-ft/yr for use in July, August, and September. The District's use of Project Water is described in greater detail in TM 3. The District has historically used most of its Project Supply. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to RD 1004 will remain the same. However, the cost of the water is expected to increase.

Sutter Sub-basin

- ❑ **Meridian Farms Water Company**
- ❑ **Sutter Mutual Water Company**
- ❑ **Pelger Mutual Water Company**

Meridian Farms Water Company (MFWC or Company)

Table 16 summarizes the water supply and management options evaluated for MFWC.

TABLE 16
Summary of MFWC Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	5,800 - 12,000	980,000 - 3,900,000	40 - 70	• Moderate to substantial impacts on groundwater levels • Loss of shallow groundwater habitat • Existing AB 3030 plan and county groundwater ordinances
Drain Reuse	1,000 - 2,000	140,000 - 280,000	15 - 33	• Increased drainwater-level impacts on shallow ground-water table (past lawsuits from this)
Canal Lining	1,300 - 2,600	850,000 - 1,700,000	43 - 92	• Habitat impacts • Existing leakage returns to useable groundwater or surface water
Conveyance System Automation	400 - 800	208,000 - 446,000	25 - 54	
Water Measurement	200 - 400	89,000 - 192,000	20 - 44	• Integrate with automation program
Farm-level Measurement	1,450 - 2,900	294,000 - 630,000	33 - 71	• Combine with incentive pricing
CVP Purchases	12,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Note: NA = Not Applicable

Groundwater

MFWC currently uses three Company-owned wells and one private well to supplement surface water supplies, with a combined capacity of 25 cubic feet per second. These wells are used in both normal and drought years to provide a supplemental supply to the Company. The Company's service area overlays a groundwater basin with significant potential yield and good water quality. Based on the preliminary evaluation of available groundwater information, groundwater could potentially supply a portion of MFWC's future water needs. Possible impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Development section of this TM. MFWC is party to both an AB 3030 plan and a county groundwater management plan. Future groundwater development will need to be coordinated within the framework of these agreements.

Drain Reuse

MFWC currently uses an average of 15,000 ac-ft/yr of drainwater, equivalent to approximately 60 percent of the Company's average Sacramento River diversion. The Company relies heavily on drainwater to supplement their other water sources. The Company's drain system is also an integral part of its supply and distribution system as 40 percent of the Company service area is supplied directly by drainwater diversion, without direct lateral connections to the main distribution system. MFWC's ability to increase its drainage water use is limited by several factors. First, the Company is already at or near the limit of the actual quantity of water available to recycle (total diversions into the distribution system, minus consumptive use and deep percolation), as shown by the very small amount of water that leaves the Company via the Reclamation District No. 70 pump station discharge to the Sacramento River. Company customers have raised concerns regarding the impacts on farm fields of the shallow water table caused by the elevated drainwater levels required for diversion. Finally, it is not likely that the Company can obtain the necessary license from SWRCB to increase its drain pumping given the impacts on adjacent drain users. Increased drainwater use may provide a minor quantity of water to the Company but will require increased pumping capacity and possibly some amount of surface storage (such as expanded acreage at Long Lake) to capture peak drainage outflows that exceed daily demands.

Canal Lining

MFWC currently has about 14 miles of lined canals. Most of the lining was installed in the 1940s, most likely to reduce required maintenance on the ditches. The Company's service area is bounded by the Sacramento River at its western edge, and the soils in this area are generally very coarse and have high infiltration rates. The Company has identified several reaches of canal that experience high leakage losses and may benefit from lining. Lining of these canal reaches could save a relatively minor quantity of water, but the preliminary analysis shows this to be an expensive water management option in terms of unit cost. Potential implementation issues include the high capital cost and habitat impacts. Additional study is required to isolate the most beneficial reaches for lining and to determine if the leakage losses are returning rapidly to the Sacramento River, as this would influence the net benefit of lining in terms of short-term impacts on river flows.

Conveyance Systems Automation of Monitoring and Control

MFWC's conveyance and distribution system operation has no automated control or monitoring at this time. All operational flow changes and measurements are done manually by operations staff. It is likely that there are significant quantities of operational spills due to supply and demand mismatch. However, these spills are generally recovered for use by the Company's drain pumps. There is some potential within MFWC for implementation of canal system automation for control and monitoring, and associated reduction in operational spills. This could primarily be achieved by installation of VFDs on the river pump stations, automation of key canal and lateral control structures, and automation of drain pumps. The quantity of prevented operations spills are small relative the large amount of drain recapture.

Water Measurement

MFWC measures water at its three river diversion pump stations using flow meters. Canal and lateral flow rates are measured using weir or gate head/flow curves. All wells are metered. Drain pump flows are estimated based on power consumption and pump efficiency data. Minor increases in water savings are possible through a program of improved water measurement that includes installation of intermediate measurement points along the main canals, improved lateral headgate measurement, and drain pump metering. These new measurement facilitates would be integrated with the operations automation program described above to increase overall distribution system efficiency.

Farm-level Measurement

MFWC does not meter individual customer turnouts. Flow rates at field turnouts are measured using head/orifice relationships. MFWC does not measure and record the total quantity of water delivered to each turnout. MFWC’s on-farm efficiency is approximately 65 percent. Field metering, in combination with a modified delivery arrangement, an appropriate incentive pricing structure, and on-field improvements such as land leveling may increase the average on-farm efficiency, with minor savings in water use. The effective implementation of such a program would depend on optimal combination of all of the above components, in addition to basic economic considerations such as the return on investment to the Company and landowner. The installation, maintenance, and reading of the 150 meters would represent a major upfront capital cost to the Company as well as an ongoing labor and capital expense.

CVP Purchases

MFWC’s contract for Project Water provides up to 12,000 ac-ft/yr for use in July, August, and September. The Company’s use of Project Water is described in greater detail in TM 3. The Company has historically used most of its Project Supply. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to MFWC will remain the same. However, the cost of the water is expected to increase.

Sutter Mutual Water Company (SMWC or Company)

Table 17 summarizes the water supply and management options evaluated for SMWC.

TABLE 17
Summary of SMWC Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	Undetermined	---	---	• High-salinity groundwater in many areas
Drain Reuse	5,000 - 10,000	700,000 - 1,400,000	15 - 33	• A decrease in rice acreage could reduce available drainwater • Water quality impacts from connate water seepage to drains
Canal Lining	10,000 - 20,000	1,350,000 - 2,700,000	9 - 20	• Habitat impact • Investigation of path of leaked water, shallow groundwater and drains
Conveyance System Automation	3,500 - 7,000	167,000 - 357,000	2 - 5	
Water Measurement	1,650 - 3,300	160,000 - 342,000	5 - 11	
Farm-level Measurement	9,500 - 19,000	1,120,000 - 2,400,000	19 - 41	• Field turnout quantity measured now • Meters tried in past, high O&M and low accuracy
CVP Purchases	95,000	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Note: NA = Not Applicable

Groundwater

The groundwater basin underlying most of the SMWC service area has poor water quality due to the presence of a high-salinity connate water mound. The groundwater quality is generally unsuitable for use on irrigated crops. Most wells in the area have been abandoned for this reason. SMWC has an ongoing groundwater monitoring program in cooperation with the U.S. Geological Survey and DWR to obtain improved estimates of the extent, flow patterns, and variation in water quality of the connate mound and other areas of the groundwater basin. SMWC has proposed a conjunctive water management project as part of the SVWMA (see Appendix D).

Drain Reuse

SMWC presently uses approximately 10,000 to 15,000 ac-ft/yr of drainage water. Private landowners pump an additional 5,000 to 15,000 ac-ft/yr from area drains. The total average use of approximately 15,000 to 30,000 ac-ft/yr equals about 7 to 15 percent of SMWC's average Sacramento River diversion of 200,000 ac-ft/yr during the last 10 non-drought years. Drainwater use is an important part of the Company's water management program, and helps meet transient demand increases without increased river diversions. Based on the current quantity of drainwater available, SMWC could potentially develop additional drainwater use as a water management option. This increase in drain use would require increased storage of water in the main reclamation drain by enlarging several miles of the drain, similar to the function of a conventional reservoir. This stored drainwater could then be managed to match supplies and demands with reduced changes in river diversion rates.

SMWC's use of drainwater is influenced by the seasonal inflow of low-quality shallow groundwater. SMWC is considering various management options, such as controlling and timing the checked-up depth of the drains to minimize the inflow of the saline groundwater, but has not formalized a plan at this point. SMWC has also had a general decrease in rice acreage over the past decade, which has resulted in decreased total inflow to the drains. SMWC has proposed an irrigation water recycling project as part of the SWVMA (see Appendix D). This project has not been developed sufficiently to provide detailed descriptions of program implementation. However, it is known that Phase 1 will evaluate program feasibility and implementation.

Canal Lining

Past studies of SMWC's canal leakage have indicated that there are some reaches of canal with excessive losses. Approximately 5 miles of canal lining have been identified as potential lining areas to achieve the water savings listed above. Further study will be required to determine the most severe leakage areas, detail the flow interactions between shallow groundwater and the canals, and the most economic quantity of lining. The feasibility of lining may be limited by excessive groundwater elevation. Lining may also impact the surcharge effect that minimizes upward flow of the shallow connate water. Habitat impacts will also need to be considered.

Conveyance Systems Automation of Monitoring and Control

SMWC currently is planning the beginning elements of a SCADA system in a cooperative study with Reclamation and irrigation operations specialists from Cal Poly San Luis Obispo. Upgrades being planned include installation of VFDs at two pump stations (Portuguese Bend and Tisdale), improved water measurement and headgate automation on three main laterals, and a centralized SCADA module at the Company office. As this program is implemented and expanded, the Company should achieve a significant reduction in operational spills.

Water Measurement

SMWC currently measures flows at the main pump stations using flow meters and pump flowcharts. Flows at lateral headgates are measured using headgate position. Drain lift pump flows are measured using power consumption records and capacity information.

Drainage leaving the Company is measured using a DWR formula for the main drainage discharge pump station. Minor increases in conveyance efficiency could be achieved by increased operations measurement, with installation of measuring facilities along the main canal and at the heads of laterals. Any new operations measurement program should be integrated with the long-term operations automation program described above.

Farm-level Measurement

SMWC currently measures both the flow rate and the total quantity of water delivered at each turnout. Flow rates are measured using canal stage and turnout gate position. The volume of delivery is measured based on the flow rate and time of delivery (typically 24 hours). SMWC's average on-farm efficiency of approximately 63 percent could potentially be increased through a combination of incentive pricing and on-farm improvements, providing some conservation savings.

CVP Purchases

SMWC's contract for Project Water provides up to 95,000 ac-ft/yr for use in June through September. The Company's use of Project Water is described in greater detail in TM 3. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to SMWC will remain the same. However, the cost of the water is expected to increase.

Pelger Mutual Water Company (PMWC or Company)

Table 18 summarizes the water supply and management options evaluated for PMWC.

TABLE 18
Summary of PMWC Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	1,000 - 2,000	400,000 - 600,000	50 - 60	• Groundwater quality
Drain Reuse	FD	--	--	• Drainwater use at maximum
Canal Lining	85 - 170	187,000 - 374,000	143 - 306	• Verify if leakage is being captured for reuse in adjacent drains
Conveyance System Automation	NA	NA	NA	
Water Measurement	FD	FD	FD	
Farm-level Measurement	NA	NA	NA	• No conservation potential; fields at maximum practical efficiency
CVP Purchases	1,750	NA	---?	• Uncertain future price

[a]Water rates for 2003.

Notes: FD = Fully Developed; NA = Not Applicable

Groundwater

The groundwater basin underlying the PMWC service area has mixed water quality. Some wells produce adequate water quality, but many nearby wells in SMWC have been abandoned due to the presence of a high-salinity connate water mound. The three wells now in use for PMWC do provide a reliable drought-year supplemental supply and have been used to facilitate transfers of surface water to the State Water Bank during recent drought years. Based on the available information at this time, additional groundwater development may be possible within the PMWC service area to increase the Company's drought-year supply. Possible impacts from new groundwater development include all of the impacts described under the Conjunctive Water Management and Groundwater Development section of this TM.

Drain Reuse

PMWC presently uses approximately 5,000 ac-ft/yr of drainage water. The Company's ratio of drainwater use to Sacramento River water use has shifted drastically since the late 1980s, in an effort to maximize WUE. The average use of approximately 5,000 ac-ft/yr equals about 125 percent of the Company's average Sacramento River diversion of 4,000 ac-ft/yr. Drainwater use is an important part of the Company's water management program, and helps meet transient demand increases without increased river diversions. Based on the current supply of drainwater available, PMWC has fully developed its use of drainwater and cannot reasonably increase drain use in the future.

Canal Lining

PMWC has lined the main supply canal from the Pelger Pumping Plant on the Sacramento River to minimize leakage losses in the high-permeability soils near the river. The Company is considering lining the Highline Ditch, which is used to convey drainwater from the "downstream" end of the service area back up to the head of the supply system, for reuse. This ditch is elevated above the surrounding land, as necessary to create the gradient for conveying water in a direction opposite that of the general land slope. The feasibility of lining this ditch, from the perspective of avoided leakage losses, hinges mainly on if the lost water is largely recovered in the adjacent drainage ditches. There may be pumping energy cost savings associated with the reduced leakage losses, but further study is required to determine if there is any net conservation of water supply.

Conveyance Systems Automation of Monitoring and Control

The conveyance system for the PMWC is fairly simple, due to the Company's small service area and limited number of customers. The drain pumps and river pumping plant are run on timers to average out the supply and match the steady demand flows at the turnouts. Control and adjustment is done daily by the Company's manager. There is essentially no operational spill from the system because all drains are checked up to supply fields, with only minor outflow from the system during the irrigation season. No beneficial opportunities for automation of operation have been identified.

Water Measurement

PMWC currently measures flows at the main pump stations using flow meters. Flows at lateral headgates are measured using headgate position. Drain pump flows are measured with meters. The three wells each have flow meters installed. Review of the Company's records for the last ten seasons indicates that the existing water measurement program is very effective in matching supply and demand and accounting for the flow of water at all key points in the system. The average deficit between supply into the distribution system and delivery to field turnouts is approximately 15 percent, which is largely accounted for by estimated leakage losses. No beneficial improvements are identified for the Company's water measurement program.

Farm-level Measurement

PMWC currently measures the flow rate and the total quantity of water delivered at each turnout. Flow rates are measured using canal stage and turnout gate position. The volume of delivery is measured based on the flow rate and time of delivery. The Company's average on-farm efficiency of approximately 70 percent, estimated using DWR crop consumptive use data and Company field delivery data, is near the upper practical limit for the crop types and irrigation methods in the service area. There is no significant potential for efficiency savings by use of flow meters at turnouts.

CVP Purchases

PMWC's contract for Project Water provides up to 1,750 ac-ft/yr for use in July through September. The Company's use of Project Water is described in greater detail in TM 3. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to PMWC will remain the same. However, the cost of the water is expected to increase.

American Sub-basin

- **Natomas Central Mutual Water Company**

Natomas Central Mutual Water Company (NCMWC or Company)

Table 19 summarizes the water supply and management options evaluated for NCMWC.

TABLE 19
Summary of NCMWC Options Evaluation

Option	Potential Yield/Reduced Diversions (ac-ft/yr)	Capital Cost ($)	Annual Unit Cost of Water[a] ($/ac-ft/yr)	Implementation Issues
Groundwater	22,000 - 25,000	3,400,000 - 4,000,000	46 - 50	• Substantial impacts to groundwater levels • Integration with potential future conjunctive water management program • Possible reduced drain supply
Drain Reuse	5,000 - 11,000	700,000 - 1,540,000		
Canal Lining	4,000 - 7,000	2,500,000 - 3,400,000	28 - 60	
Conveyance System Automation	In Progress	---	---	
Water Measurement	In Progress	---	---	
Farm-level Measurement	14,000 - 28,000	1,800,000 - 3,800,000	20 - 42	• O&M impacts
CVP Purchases	22,000	--	--	• Uncertain future cost

[a]Water rates for 2003.

Groundwater

NCMWC's service area overlays a groundwater basin with good water quality. Studies show stable, high groundwater levels. NCMWC currently owns two small groundwater wells which, combined, produce less than 200 ac-ft/yr for supplementing surface water supply. Neither well is used extensively. Presently, 10 private irrigation wells can provide groundwater in a cooperative supplemental water supply program. There are 51 other private irrigation wells in the service area, the majority of which are for private residential use. The remainder of these wells are used for either primary irrigation supply for small plots or for supplemental supply during drought-year conditions. Over 4,000 acres of land are irrigated with groundwater, using an average of 20,000 ac-ft/yr.

Studies conducted since 1966, including a 1997 conjunctive water management study for the American Basin by DWR, show that groundwater could potentially provide a significant supplemental water source to the NCMWC service area without serious damage to long-term groundwater supplies. However, increased groundwater use may have multiple impacts. Large increases in groundwater pumping may have substantial impacts on groundwater levels and existing wells, as well as the various impacts described under the

Conjunctive Water Management and Groundwater Development section of this TM. The lowering of groundwater levels may reduce the supply of drainwater, as shallow groundwater would no longer feeds area drains. Applied water demand for crops in some areas may also increase as subirrigation from shallow groundwater is eliminated. The American Basin groundwater supplies are already being heavily developed by major M&I users to the south/southeast of NCMWC who are also benefiting from the recharge qualities of NCMWC's extensive use of surface water. Because these users are downgradient from the NCMWC service area, large increases in groundwater use within NCMWC, with the accompanying decrease in surface water use, could impact levels in these areas as well.

NCMWC participated in the Sacramento region's Water Forums regional water supply negotiations, and is a party to that Memorandum of Agreement. One element of that agreement was the creation of a public entity charged with the responsibility of protecting groundwater resources north of the American River. Those groundwater resources are primarily used by M&I purveyors. Natomas, as a party to the various Water Forum agreements, is a member of the public body (Sacramento North Area Groundwater Management Authority) charged with groundwater management in the region, which includes the Company service area. NCMWC is working with those 20 entities, through Sacramento North Area Groundwater Management Authority, on future groundwater management options. In 1997, NCMWC joined with RD 1000 in the creation of a groundwater management plan in accordance with AB 3030. Presently, a committee of the Board is directing groundwater research by a consulting engineer to identify adaptive management options for the service area. NCMWC has proposed a conjunctive water management project as part of the SVWMA (see Appendix D).

Drain Reuse

Drainwater use is a major source of irrigation water supply within NCMWC, and is used to improve management operations by providing more flexible matching of supply and demand throughout the service area. In 1986, the installation of an expanded drainwater re-pumping system has allowed much greater use of drainwater, while decreasing drainwater discharge to the Sacramento River. Average drainwater use is approximately 60,000 ac-ft/yr. The amount of available drainwater will probably increase over the next 20 years as more urban runoff is emptied into the basin's drainage system. During the growing season, developed detention basins will also contribute groundwater inflow to active irrigation deliveries. In addition, with an expected conversion of 10,000 acres of agricultural land to urban uses in that same time frame, the ability for the Company to continue to use all of the drainwater available will be increasingly more difficult.

Even with this extensive system of drainwater reuse, changes could be made to increase the amount of water annually generated by the Company's recirculation system. One consideration is the gradual impact of poor-grade runoff from development into agricultural water deliveries. NCMWC is working with the City of Sacramento on water quality impacts. A water quality testing program is about to be initiated, which would assist the City and NCMWC make adaptive changes to storage basins, the delivery system, or both.

Several times during the year and at the end of the rice irrigation season, the amount of drainwater exceeds the Company's ability to use it. On those occasions the Company applies water to fallow land, stores water in the drainage canals, and/or returns water to the river. None of these methods are the best use of the water. By expanding the Company's drainwater recirculation system, particularly in its northern area, the Company could increase the number of acres that have the ability to use drainwater. Approximately 30 to 40 percent of the Company's service area cannot be delivered drainwater as a supplemental supply. For all of those reasons, drainwater resources cannot be considered a fully developed option.

Canal Lining

The Company has concrete-lined more than a mile of the southern end of one of its main supply canals, the Northern Garden Highway Canal in its Elkhorn system (middle of area). Both the Company's Northern and Southern Garden Highway Canals serve the basin's finer soils and were constructed using dirt from that area. These canals, therefore, have the highest leakage rates and losses of any of the Company's canals. The unlined sections of these two main canals combine to make up over 10 miles of potential canal lining projects.

In 1999, the Company proposed to RD 1000 that they join together to study the feasibility of replacing the Company's Southern Garden Highway Canal with a 5-mile concrete pipeline. This joint project would improve water deliveries in the area, reduce water losses from leakage and evaporation, and improve the stability of the Sacramento River East Levee Berm. The Company has estimated that this project would cost nearly $2.5 million. The canal supplies between 3,200 and 8,400 ac-ft of water to adjoining properties, with an average annual usage of 6,600 ac-ft. Water losses in this region of the Company's service area have been estimated to be as high as 50 percent. It is possible that this project could generate or reduce diversions by several taf of water annually.

Both of the Garden Highway Canals are located at the base of the Sacramento River berm. Beginning in 1999, RD 1000, along with U.S. Army Corp of Engineers, Sacramento Area Flood Control Agency, and California, began the process of improving the stabilization of this berm. A possible ancillary improvement would be to concrete-line the 10 miles of the Company's canals at the berm's base. Alternatively, if a concrete pipeline replaced the canals, the resulting reduction in water loss could be coupled with a vast improvement to the stabilization of the berm.

Conveyance Systems Automation of Monitoring and Control

All of the Company's main pumping plants are equipped with level-control devices. One of the pumps at each pumping plant cycles on and off, in response to the water level in the adjoining canal. These devices were installed to eliminate any excess water entering the basin. The problems associated with these devices are (1) excessive wear on the pump motor, (2) fluctuating canal levels, (3) increased erosion of canal banks, and (4) inability to measure water deliveries to the service gate (due to fluctuations).

In 1998, the Company purchased a VFD motor for one of its pumps as a pilot project toward stabilizing the water levels in canals. Although the effort has not been completely successful, the field staff is encouraged by the potential the limited success has shown. It is the desire of the Company's field staff to replace at least one of the motors at each pumping plant with a VFD motor.

In 1999, the Company entered into an agreement with the California and Reclamation. This study would investigate the feasibility of consolidating several of the Company's diversions into one main screened pumping facility. Along with the consolidation of facilities, an increase in the amount of automation would be required. It is expected that this new facility would have an extensive SCADA system, with water flow and water level monitors in the Company's main canals. The Company has agreed to another study, to be conducted by DWR and Cal Poly, to provide advanced SCADA facilities at primary control points throughout the service area. This study would join the feasibility report on the consolidation of diversions.

The Company operates 84 pumps in over 40 locations to maintain its closed system and the benefits to the river. It is possible to improve upon the Company's current highly efficient water use record through the installation and operation of a fully integrated automated system. This system would include automated pumping plants, water level sensors, and automated gates in the canals and laterals, along with an extensive SCADA system. This automated system would allow the Company's customers to have a water-on-demand system for improved water efficiency. The system would also maintain a constant water level in both the irrigation and drain canals and laterals for more precise water deliveries. Together with the completion of the Company's water recirculation system, these improvements would allow the Company to deliver water to its customers in the most timely and water-efficient way.

Water Measurement

NCMWC measures water at its five Sacramento River diversion pump stations using flow meters provided by Reclamation. No flow measurements are taken and recorded internally on any of the main canals or laterals. Adjustments to water flows for delivery purposes are made manually, using a method of approximation. This method is highly labor intensive but has proven successful for improving water management.

The Company's internal drain pumps and secondary lift pumps are not equipped with any type of measuring device. Delivered water volumes from these facilities are estimated based on power consumption and pump efficiency data. This method is also used to estimate the outflow amounts from RD 1000's drainage pumps into the Sacramento River. Only RD 1000 has the ability to discharge water back into the river.

Through the installation and use of flow measuring devices on its internal pumping plants and in the main canals and laterals, the Company believes there is potential for some level of improved management. It is possible that water savings might occur by eliminating excess water usage through measured water deliveries. These improvements would complement the automation improvements discussed in the previous section.

Farm-level Measurement

NCMWC does not meter individual customer turnouts. The Company's current water rate structure does not require the field staff to measure and record the total quantity of water delivered to each turnout. Its rate structure is an annual flat rate, per-acre charge for rice and wild rice crops, with a modified, annual flat rate, per-acre charge for all other crops. The modified flat rate varies according to the number of times water is applied to a crop. Crops applying water more often are charged more per acre (unrelated to measurement). The Company also provides a discount to growers extracting their own irrigation water from the drains.

Field measurement and quantification, in combination with an appropriate incentive pricing structure and on-field improvements, may increase the average on-farm efficiency. The effective implementation of such a program would depend on optimal combination of all of the above components, in addition to basic economic considerations such as the return on investment to the Company and landowners. However, the overall NCMWC efficiency is high and, therefore, it is questionable what benefits are gained from increasing on-farm efficiency.

The installation, maintenance, and reading of meters for the nearly 400 turnouts would represent a prohibitively expensive capital cost to the Company, as well as the assumption of ongoing labor and capital expense. Improved measurement and quantification of deliveries may be possible with improved water level control, as discussed above. This would allow the Company's field staff to begin recording start/stop times and average flow rates for each delivery order.

CVP Purchases

NCMWC's contract for Project Water provides up to 22,000 ac-ft/yr for use in July, August, and September. The Company's use of Project Water is described in greater detail in TM 3. The Company has historically used most of its Project Supply during drought years, and in critical months for normal and drought years. For the purposes of this initial screening study, it is assumed that the amount and timing of Project Water available to NCMWC will remain the same. However, the cost of the water is expected to increase.

Wildlife Refuges in the Sacramento Valley

Water Conveyance and Delivery System Background

All construction work related to conveyance and distribution facilities has been completed at the three Sacramento River National Wildlife Refuges (NWR) (Sacramento, Delevan, and Colusa), and a long-term conveyance agreement with GCID is in place. There are no physical or contractual obstacles to the delivery of the full Level 4 quantity to these NWRs. However, the Colusa NWR does not have an Incremental Level 4 supply, and Sacramento and Delevan NWRs are currently managed and operated in a manner that does not generally require full Level 4 water supply. At this time, there is no immediate need to acquire long-term, reliable Incremental Level 4 water for these refuges, beyond the 6,300 ac-ft already available.

The Sutter NWR does not currently receive any Incremental Level 4 water. Generally, Sutter NWR relies on appropriative water rights held by the U.S. Fish and Wildlife Service for its basic operating water supply. This water is diverted directly from the East Borrow Channel of the Sutter Bypass. Some water is also provided to the Sutter NWR by Sutter Extension Irrigation District for those lands that are inside the Sutter Extension service area. Full delivery of Level 4 water supply cannot be accomplished until additional pumping and/or conveyance facilities are constructed or improvements are made to existing facilities of Sutter Extension Irrigation District or conveyance systems are improved. Negotiations with Sutter Extension Irrigation District have been inactive for the past couple of years but may be resumed later this year. However, it is not expected that additional deliveries of water to the Sutter NWR will be required in the next 2 or 3 years.

The CVPIA Water Acquisition Program is not currently delivering any Incremental Level 4 water to Gray Lodge Wildlife Management Area. Gray Lodge Wildlife Management Area receives some Level 2 water by exchange through the Biggs-West Gridley Irrigation District. (Oroville water is provided by the state to Biggs-West Gridley for delivery to the refuge and then replaced by the CVP in the Sacramento River.) Full delivery of the Incremental Level 4 quantity will not be physically possible until improvements are made to the Biggs-West Gridley distribution system or to some other conveyance system that can serve Gray Lodge. A construction and long-term conveyance agreement is now in place between Reclamation and Biggs-West Gridley, and Level 4 deliveries may commence in the next couple of years.

Acquisition Strategies for the Sacramento Valley

Three general sets of options or alternatives for acquisition of Incremental Level 4 water for the Sacramento Valley refuges that could be developed if funds are available, assuming the refuges have the need for the water and the conveyance and delivery capacity exists to deliver full Level 4 supplies follow:

1. Short-term (longer than annual, up to 5 years) contracts for water acquisition by transfer or exchange with local water suppliers or water rights holders (e.g., GCID or other

SRSCs for Sacramento and Delevan NWRs, the Joint Districts, or other Feather River diverters for Sutter NWR and Gray Lodge Wildlife Management Area).

2. Partnership or some level of participation in an interagency or federal/state/local program such as the SVWMA, the Phase 8 settlement agreement, or a CALFED program such as Environmental Water Program or Environmental Water Account (including multiple use of fish flows).

3. Groundwater pumping (without direct recharge) or conjunctive use where groundwater is available and of suitable quality. This might require funding for wells or related facilities improvements or construction.

Given that 6,300 ac-ft of Incremental Level 4 water has already been obtained, the Sacramento Valley refuges will eventually require an additional 20,000 ac-ft (more or less and inclusive of losses) of Incremental Level 4 water over the next several years. Within approximately the next 5 years, the quantity needed will be less, probably on the order of 5,000 to 10,000 ac-ft. This estimate is based on the current operation and management regimes in place at the Sacramento Valley refuges, and the timeline for the negotiation and completion of the construction necessary to provide the ability to delivery full Level 4 water supplies to Sutter NWR and Gray Lodge Wildlife Management Area.

References

California Department of Water Resources (DWR). 2000. *North of Delta Offstream Storage Investigation Progress Report*.

California Department of Water Resources (DWR). Undated. "Conjunctive Water Management." Public information brochure.

U.S. Bureau of Reclamation (Reclamation). 1997. *Water Measurement Manual.* Third edition. Page 4-6 Item J and Table 4-2.

Appendix A
Sample District Evaluation Data Sheets

Sacramento River BWMP Groundwater Development Capital and O&M Cost Worksheet

District: **RD 1004**

Note: District currently has no wells. Policy is to allow private development as necessary.

Development Scenarios

ALT1	Replace Annual Project Supply =	15,000	AF
ALT2	Replace Critical Period Project Supply =	15,000	AF
ALT3	Replace 25% drought =	14,100	AF

Unit Costs and Economic Parameters

Unit Well Cost:	$22.00	$/dia-in-ft
Pump+motor Eff	0.7	
Unit Power Cost	0.09	$/kWh
Ext Interest Rate	7.0%	
Analysis Period	20	years
Annual O&M	3%	of well capital cost
Electrical Supply Cost	$10	per linear ft.
Electrical Supply Need	1000	linear ft./well
Pipeline Need	1000	linear ft/well
Unit Pipeline Cost	$5	per diam-in per linear ft
Pipeline Sizing Basis	7	ft/sec flow velocity
Pipe C factor	130	

Operating Window

ALT1:	180	days
ALT2:	90	days
ALT3:	180	days

Average Basin Groundwater Characteristics

water quality:	good	
static depth to gw:	10	ft
typical screen depth	500	ft
typical well flowrate =	2,000	gpm
typical well diam. =	16	in
typical well depth =	500	ft

Required Pipeline Diam.	12	in
Pipe Head Loss per 100 feet	0.92	ft/100 ft of pipe
Total Pipe Head Loss	9.2	ft

Capital and O&M Costs per Alternative

ALT.	Well Flow Rate (gpm)	# wells	Expected Drawdown (ft)	Total Lift (ft)	Well Capital Cost ($)	Pipeline Capital Cost ($)	Cost to Deliver Power ($)	Total Capital Cost ($)	Annual O&M ($)	Annual Power ($)	EUAC ($)	Cost per AFY ($)/AF	Likelihood of Adverse Impacts
ALT1:	2,000	10	90	119	$1,760,000	$600,000	$100,000	$2,460,000	$52,800	$249,964	$534,971	$36	Moderate
ALT2:	2,000	19	125	154	$3,344,000	$1,140,000	$190,000	$4,674,000	$100,320	$307,184	$848,697	$57	Substantial
ALT3:	2,000	9	90	119	$1,584,000	$540,000	$90,000	$2,214,000	$47,520	$224,968	$481,474	$34	Moderate

Impact Explanation:

Moderate -- likely to have significant, but manageable impacts on surrounding water uses; good likelihood that this yield goal can be met

Substantial -- large and possibly unacceptable impact on surrounding water uses; yield goals may not be achievable according to site-specific conditions

Severe -- Severe impacts on surrounding water users is likely; high likelihood that yield goals are not achievable or may result in unacceptable impacts

NOTE: Pumping of large amounts of groundwater is likely to impact many other aspects of the hydrologic system including yield of existing wells, return flows to drains or ditches for recovery, and water levels in surface water bodies. The impacts are dramatically increased by the cumulative effect of multiple new wells. A simple estimate was made of the cumulative drawdown in wells spaced at reasonable distances within the contractor service area using general estimates of aquifer characteristics. The adverse impacts ratings are based on the estimated drawdown and are intended to give a general estimate of the impact of the pumping on surrounding water uses.

*, **A site-specific study is needed to more accurately estimate reasonable yield and impact expectations if groundwater development is to be considered further.**

SRBWMP Drain Water Reuse Assessment Worksheet

District: PCGID

SUMMARY OF EXISTING DRAIN REUSE

Average annual drain reuse- (total amount pumped back into canals/laterals): 28,000 afy

Notes: all drain pumps now metered. District has seen increase in drain pumping in last few years due to changes in cultural practices like increased drain down of fields for ground-application of fertilizers etc...

Average irrigation season drain outflow from district: NA afy

not available

Methods of estimation for above: (Measured flows, pump operations history, operators/managers estimate)

District meters on drain pump

Current Drain reuse as % of :

Project Supply (afy)	25,000	112%
Avg. Diversions (afy)	52,000	54%
On Farm Req. (afy)	47,000	60%

Total annual cost, or unit cost per AF:

Unknown. Assume power costs are approximately $2.50/af. Assume all pumped reuse, avg of 28,000 afy, so power cost approx $70,000

Estimated % of drain water leaving district that is re-used BEFORE reentering Sac River-

Estimated 100% of drain water used due to heavy drain pumping by downstream users along the Colusa Basin drain

POTENTIAL FUTURE DRAIN REUSE

Requirements/agreements for downstream drain users supply-

Old "5 party" agreement replaced by new agreement with Colusa Drain Mutual Water Company (GCID, PID, MID, PCGID). Committed to maintaining approximately same quantity and quality of drainwater leaving districts as presently. Marc Van Camp is resource for information, was heavily involved in working out the arrangement.

Previous/on-going studies on salinity, drain water quality, etc-

District has started drain water sampling program this year. No previous studies available.

District assessment of upper limit of reuse as % of total diversion-

Current use is near maximum. No increase in supply expected because most water comes from GCID and PCGID's internal system. Some mismatch between drain supply and irrig demand could be addressed with drain regulating storage or greater diversion capacity

Proposed primary diversion (pumping) points and distribution facilities-

Possibly add increased pumping capacity with new pumps at same main drain pumping locations.

If no district estimate, assume 50% of current drain discharge leaving district could be captured for reuse

Assume approximately 3,000 AFY (10%) increase may be possible with 2 new (20) cfs pumps, operating 60 days average. Restrictions include impacts on d/s drain users, State WRCB licensing for new pumping.

Future Increase in Drain Use : 3,000 afy

Cost Summary

Initial Capital Cost: ($140/af)	$420,000
Annual O&M Cost: ($9/afy)	$27,000
Total Annual Cost: ($22/afy)	$66,000

Sacramento River BWMP Canal Seepage and Concrete Lining Calculations Worksheet

District: MFWC

Typical Seepage Rates

Soil Type	Loss Rate (in/day)
Clay	3
Silty	10
Loam	11
Sandy	19
Alluvium	16
Lined Canal	*3*

Analysis Inputs

Concrete Lining[1]	$20 yd^2
Interest Rate	7.0%
Payback Period	20 years
Avg. Irrig Season	180 days

Canal/Lateral Reach	Reach U/S MP	Reach D/S MP	Length (ft)	BW (ft)	SS H:V	Depth (ft)	Wet Perimeter (ft)	Total area (ft^2)	Soil Type	Ave loss rate (in/day)	Total Season Loss (AF)	Annual Loss with Lining (AF)	Avoided Loss (AF)	Capital Cost ($)	Cost per AF per YR ($/afy)
North Lateral															
1			10500	3	1.5	5	21.0	220,791	silt	10	760	228	532	$490,646	$87
										Subtotal =	760	228	532	$490,646	$87
Railroad Main															
1			7900	3	1.5	5	21.0	166,119	silt	10	572	172	400	$369,154	$87
										Subtotal =	572	172	400	$369,154	$87
#3 Main Lateral															
1			7900	3	1.5	5	21.0	166,119	alluvium	16	915	172	744	$369,154	$47
										Subtotal =	915	172	744	$369,154	$47
#4 Main Lateral															
1			7900	4	1.5	6	25.6	202,503	alluvium	16	1116	209	907	$450,007	$47
										Subtotal =	1116	209	907	$450,007	$47
			34,200					755,533				Total =	2,583	$1,678,962	$61

[1]CONCRETE LINING = SLIP FORM OR SHOTCRETE

SRBWMP Conveyance System Automation Evaluation Worksheet

District : PCGID

I. Operational Spills are 10 % of total diversions (assumed, no spill data)

Total Diversions:	52,000	AF/yr
Assumed Current Operational Spills:	5,200	AF/yr

II. Current Operational Status/Level of Modernization

Current level of Service:

	Rotation: Users get water once every so many days, on a regular basis.
X	Arranged: Users call in water orders 24-48 hours in advance.
	Demand: Users can take water at any time
	Combination (describe)

Current Level of Modernization:

	Gates: Radial or other automated water-level maintaining
X	Water level/flow recorders
X	SCADA Systems
X	VFD's on Main Pump Stations
X	Automated Drain Pumps

Current program to link up Sidds Landing PS, other PCGID and PID pumping plants, drain pumps, water level monitoring, etc.. to central SCADA panel at PID office. See DR Burt/USBR study. Initial SCADA components, VFD's at SLPS in place this season.

III. Proposed Operational Upgrades

Gates: Radial or other water-level maintaining

Location	**Size**	**Type**	**Capital Cost**	**Notes**
6 laterals- headgates	60 cfs ea gate	MOSG	$58,000	(1) 42-inch gate each site, $9,700 ea. SCADA below
		subtotal =	$58,000	

SCADA Systems

Location	**Type**		**Capital Cost**	**Notes**
3 drain pumps	monitor/control		$45,000	monitor lateral and drain depth, cycle drain pump, $15K ea
6 headgates	monitor/control		$90,000	Monitor/control flow/position, (6) locations, $15K ea
		subtotal =	$135,000	

VFD's

Location	**Capacity**		**Capital Cost**	**Notes**
				Installed on main pump stations already
		subtotal =		
		Total Cost	**$193,000**	

IV. Est Cost of Prevented Spills

Estimated Reducion in Spill as % of Diversion	3%	(2/3 of total %spill reduction, other 1/3 from measurement)
Total annual AFY reduced spills	1,560	
Unit Cost ($/AFY)	**$12**	20 years at 7%

SRBWMP Water Measurement Assessment Worksheet

Contractor **PCGID**

Ext Interest Rate 7.0%

Analysis Period 20 years

EXISTING MEASUREMENT AND METERING

Operations Level		Measured?	Device/Method (meter,weir, etc.)
River Diversions (Sidds Landing)		yes	meters
Wells		yes	meters
Main Canal Flows		yes	stage-discharge relationships
Lateral Flows		yes	gates- head/position tables
Drain Pumps		yes	meters
Field Turnouts	# of turnouts 250	yes	head-orifice

POTENTIAL FUTURE MEASUREMENT IMPROVEMENTS

	Location/Ops Level	Measurement Device Type	Installation Cost	
1	River Branch Canal	(2) Replogle flumes (300 cfs)	$152,000	(2) at $76K ea
2	5 main laterals	(5) Repogle flumes (150 cfs)	$205,000	(5) at $41K ea
3				
4				
5				

Total Cost = $357,000

Conveyance:

Average annual diverstions =	52,000 ac-ft	
Existing Op. Spills (% of diversion) =	10%	(% due to operational spills only. Not including seepage)
Future Efficiency =	5%	(lesser of 5% or 1/2 of current op. Spills %, minimum 5%
Volume Saved =	860 afy	[total inflow *(current ops spill% - 5%) x 0.33]
Average annual unit cost =	$39 $/ac-ft	(annualized at 7% over 20 years)

Field Metering:

Average on-farm efficiency =	64%	(from DWR DAU data)
Average on-farm delivery =	47,000 afy	(from TM-2 data)
Crop water requirement =	30,080 afy	(on-farm efficiency x on-farm requirement)
Potential on-farm efficiency =	70%	(assumed max for comparison purposes only)
Delivery needed with improved eff. =	42,971 afy	(CWR/potential efficiency)
Volume saved =	4,029 afy	(savings = CWR x (1/current eff. - 1/potential eff.)
Capital costs =	$700,000	125 meters @ $4,000 $/unit
		125 meters @ $1,600 $/unit
Total annual costs =	$223,575	(annualized cap cost + $630 per meter annual O&M)
Annual water cost =	$55 $/ac-ft	(CRF = 0.094)

Appendix B
Capital and O&M Unit Costs

Capital and O&M Unit Costs

PREPARED FOR: Sacramento River Basinwide Management Plan

PREPARED BY: Greg Norby/CH2M HILL

DATE: January 18, 2000; revised according to U.S. Bureau of Reclamation comments for the BWMP September 30, 2004

Scope and Purpose

This technical memorandum summarizes the cost data and methodology used to provide cost opinions for use in *Technical Memorandum No. 5 – Water Supply and Management Options* (TM-5). Order-of-magnitude cost opinions were prepared for facilities and equipment required for each water supply and management option. The resulting cost opinions are approximate estimates made without detailed engineering data. The estimates were founded on cost curves, bid tabs from similar water conveyance and storage projects, product price quotes from equipment suppliers, and preliminary estimated quantities of major facility components. It is normally expected that an estimate of this type would be accurate within +50 percent to -30 percent. For complex projects such as off-stream storage, total project costs from previous studies were used.

The cost estimates shown here have been prepared for guidance in conceptual-level project evaluation, using the information available at the time of the estimate. The final costs of any specific projects and the resulting feasibility will depend on the actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, and other variable factors. As a result, the final project costs will vary from the estimates presented here. Because of these factors, the project feasibility, benefit cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper evaluation and adequate funding.

Cost Opinion Data

Table 1 lists the capital and operation and maintenance (O&M) costs. The unit costs for each item listed do not include related costs associated with implementation of a particular project. Major cost items not specifically accounted for include temporary and/or permanent right-of-way and easements, clearing and grubbing, contractor mark-up, and engineering, administration, and permitting costs. To approximately account for these unknown costs, unit capital costs typically reflect a 30 percent contingency, unless noted otherwise. The total project costs, including capital and O&M, were annualized on a uniform 20-year project life and an interest rate of 7 percent.

TABLE 1
Capital and O&M Cost Summary

General Category	Item	Capital Cost Unit	Capital Cost Unit Cost	Annual O&M Cost Unit	Annual O&M Cost Unit Cost	Notes
Water Measurement	Flowmeters		Note	% capital	5%	Size range from 12" to 60" flowmeters. Cost equation: Cost = $258 + $66.7*(dia. Inches)
	Long-throated flumes	Ea.	Note	% capital	2%	Cost Curve: Cost (1000$) = 5.9 + 0.23* (Capacity in cfs)
	Turn-out meter only	Ea.	$1,600	Ea.	$630	Meter installation on existing pipe outlet. O&M includes total annual cost of meter reading, repair, calibration, etc.
	New CHO and meter	Ea.	$4,000		$630	Includes new headwalls, culvert, CHO structure, meter
	Canal stage recording station	Ea.	$13,000	Ea.	5%	Includes SCADA components
Canal Lining	Concrete lining of existing canal	Yd2	$20	% capital	1%	
Drain Water	Check structures, pumps, ditches, etc.	Acre-ft/year	$140	acre-ft/year	$9	Unit cost is total for all typical facilities: diversion, pumping, conveying drain water
	Single drain pump level controller	Ea.	$2,000	% capital	5%	Local float switch for turning pump on/off based on canal and/or drain ditch level
Canal Gates	Motor-operated slide gate–retrofit into existing structure	Ea.		% capital	5%	Size range from 36" to 60" gates. Cost equation: Cost = $230*(size in inchs)
	Radial Gate–new structure and gate	Ea.	See note	% capital	5%	Size based on flow capacity. Cost equation: Cost (k$) = 0.063*(capacity cfs) + 163.
Extraction Wells	Complete well installation	dia-in/lf	$22	% capital	3%	Includes complete well development and all related equipment. O&M does not include electrical power cost
SCADA Components	Level switch controller	Ea.	$2,000	% capital	5%	
	Motor operated canal gate controls	Ea.	$15,000	% capital	5%	
	Pump station monitoring control	pump station	$20,000	% capital	5%	
	Office SCADA central monitoring and control console	Ea.	$20,000	% capital	2%	Includes computer, software, and communication links to remote stations

TABLE 1
Capital and O&M Cost Summary

		Capital Cost		Annual O&M Cost		
General Category	**Item**	**Unit**	**Unit Cost**	**Unit**	**Unit Cost**	**Notes**
Pump Stations	New or expanded pump station	hp	$1,400	% capital	3%	O&M excludes power costs
	Variable frequency drive (VFD)	hp	$100	N/A	N/A	
Pipelines	New conveyance pipeline	dia-in/lf	$5	% capital	2%	
Powerlines	Overhead service to pump stations, wells, etc.	lf	$10	N/A	N/A	No regular O&M costs to district. Covered by electrical charges
Electrical Power Rates		N/A	N/A	kWh	$0.09	

Appendix C
Methodology Technical Memoranda

Methodology and Background for District-level Groundwater Development Screening Analysis

PREPARED FOR: Sacramento River Basinwide Management Plan

PREPARED BY: Greg Norby/CH2M HILL
Maurice Hall/CH2M HILL

DATE: January 17, 2000; revised according to U.S. Bureau of Reclamation comments for the BWMP September 30, 2004

Purpose and Scope

This technical memorandum presents the goals, methodology, and limitations of the initial screening analysis of district-level groundwater development options for each Settlement Contractor (SC) for the Sacramento River Basinwide Management Plan. This is a screening- or reconnaissance-level analysis intended to provide a starting point for further discussions and analysis of groundwater development options for each SC. Results from this analysis have been incorporated into *Technical Memorandum No. 5 – Water Management and Supply Options* (TM-5). For each SC, a range of potential groundwater development options will be summarized by yield, cost, and possible impacts. Standard worksheets documenting the analysis and a final version of this technical memorandum will be included as appendices to TM-5. *The screening analysis results should NOT be viewed as presenting specific recommendations for actual groundwater development at a particular district*. Rather, the primary goal is to provide *order-of-magnitude estimates* of potential groundwater development quantities, associated unit costs, possible impacts, and major factors that may influence the feasibility of groundwater development for use in comparing groundwater development with the range of other water management and supply options presented in TM-5.

Analysis Methods, Assumptions, and Limitations

Given the inherent uncertainty in any assessment of groundwater that does not include actually drilling and developing wells, and the numerous complex hydrogeologic and water management issues impacting groundwater in the Sacramento Basin, the analysis does not attempt to determine specific development limits, such as "safe yield." Rather, the analysis starts from the assumption that the primary purpose of district-level groundwater development would be to supplement existing surface water supplies. The following basic evaluation process steps were conducted for each SC service area. Each step is discussed in greater detail below:

1. Select a potential target development level based on a specific management goal such as replacement of project water or critical year base supply cutbacks.
2. Lay out a hypothetical wellfield using spacing, well characteristics, and hydrogeologic characteristics based on available data and reasonable assumptions.

3. Evaluate the possible regional impacts from increased drawdown in groundwater levels within an SC service area.

4. Summarize the preliminary evaluation of the development goal in terms of yield, cost, and severity of regional impacts for use in ranking against other water supply and management options.

Possible Management Goals for Groundwater Development

An initial range of possible management "goals" were selected as a basis for the evaluation. Three uniform groundwater supply development options were considered for each SC area, according to their project and base water supplies:

Option 1: Replace the contractor's project water supply *in quantity only*, over a 6-month pumping window.

Option 2: Replace the contractor's critical months project supply within a pumping window equal to the contractor's critical month period (typically 2 or 3 months), thereby replacing project water *in both quantity and timing*.

Option 3: Supplement groundwater for the contractor's 25 percent cutback in base supply during a critical year, over a 6-month pumping window.

Actual groundwater development programs could have a range of target yields and operational strategies based on more specific local programs, and these three options are used as a simplified uniform starting point for comparison purposes only.

Methodology Limitations and Simplifying Assumptions

General information on hydrogeologic conditions such as aquifer transmissivity, depth to groundwater, typical well sizes and depths, pumping rates, and overall annual quantities of groundwater use were gathered from the Department of Water Resources (DWR) data and information provided by the districts. It is important to emphasize that the aquifer characteristics are general estimates based on regional-scale studies and reasonable simplifying assumptions. Simplifications in the analysis include the following:

- Each contractor service area is considered independently**.** Concurrent development of new groundwater resources in neighboring districts overlying common groundwater basins would result in increased drawdown, and corresponding increases in associated costs and impacts resulting from interference between wells across service area boundaries.

- Estimates of aquifer properties were taken from general basin-scale reports. Changes in local conditions may result in dramatic variations in well performance, both positive and negative.

- The analysis does not include the impacts on drawdown of surface water sources such as the Sacramento River that may have a hydrologic connection to the groundwater basin. Given the limited nature of available data in the Sacramento Valley, consideration of these impacts would require a significant amount of additional analysis. Regardless, stream/aquifer interaction, particularly with respect to transfers, would require evaluation prior to project implementation. Subsequent monitoring would be necessary to ensure minimal local impacts and to verify the quantity of water transferred.

- Impacts on other aspects of the water delivery and supply system are not considered and are difficult to estimate without detailed, site-specific modeling. Examples of the types of impacts that might be expected are summarized in the *Impacts of Groundwater Development* section below.

Table 1 (located at the end of this technical memorandum) summarizes the information sources, unit costs, and key assumptions used to develop the screening estimates.

Layout of Uniform Wellfields

To obtain an estimate of drawdown in each contractor service area, a hypothetical wellfield layout was performed within an SC service area. The maximum wellfield size was estimated from the contractor service area, assuming a fairly uniform grid of equally spaced wells. To keep the method standardized between districts, a standard well size, pumping rate, and spacing was selected. For the drawdown calculations, wells were arranged in as many linear rows as necessary to obtain the target yield. If service area dimensions allowed, only one row of wells was used, but additional rows of wells were added if necessary until the required number of wells was reached. This gave a rectangular wellfield with a length approximately equal to the "length" of the service area and a width equal to the well spacing (3,000 to 4,000 feet) times the number of rows of wells. A general Theis drawdown equation approximation was then used to calculate the drawdown at each well resulting from the combined influence of all the wells in the field.

Classification of Drawdown Impacts

The impact classification for each scenario is based on the maximum drawdown in the well field. According to the maximum estimated drawdown, a relative impact rating of *moderate, substantial, or severe* was assigned to each scenario. The interpretation of the ratings is as follows:

- **Moderate** – If the maximum calculated drawdown was less than 100 feet, the likely impact of the scenario was categorized as moderate. In this case, it is assumed *that there is a good likelihood that the target yield for the wellfield can be attained, and with proper management, the impacts may be acceptable*.

- **Substantial** – If the maximum calculated drawdown was more than 100 feet and less than half of the well depth or 250 feet, the impact was categorized as substantial. In this case, *impacts to surrounding groundwater uses are likely to be large and possibly unacceptable*. In addition, because the assumptions used in the calculations are highly generalized, a reasonable likelihood exists that the target yields for scenarios with this impact category will not be achievable according to specific local conditions.

- **Severe** – If the maximum estimated drawdown for a scenario was more than one-half of the well depth, an impact rating of severe was assigned to that scenario. The proposed pumping in these cases is *likely to result in severe impacts to surrounding groundwater users, and yield goals may be approaching or exceeding the yield limit of the aquifer*.

Required Steps for Further Evaluation of Specific Groundwater Proposals

The following is a summary of further steps, *beyond the scope of the Basinwide Management Plan*, that could be taken to further evaluate specific groundwater development options. It is important to keep in mind that local conditions may be either more or less favorable for groundwater development, making impacts more or less significant and correspondingly increasing or decreasing the expense of pumping. Even within the same water-bearing formation, aquifer properties can vary over large ranges, which limits the validity of general evaluations. A reasonable next step in assessing the potential role of groundwater should include a more detailed, service area-specific feasibility study to do the following:

- Provide detailed assessment of local conditions that will affect the potential groundwater yield and resulting impacts.
- Identify other more specific operational scenarios more suited to individual SC needs (for instance, pumping only to support specific crop and irrigation types, or to supplement and improve the quality of drain water).
- Evaluate the potential for coordinated groundwater development within the framework of a specific local AB-3030 plan, for example.

If the general cost estimate or other conditions in a service area indicate that further development of groundwater resources might be desirable, a site-specific evaluation is the important next step before further investment.

A first step in a site-specific evaluation of groundwater resources should include a detailed study of local well logs and evaluation of the performance of existing wells in the area. Pump tests using one or more existing or newly installed wells can be performed to more accurately define local aquifer properties such as transmissivity and the influence of local surface waters such as the Sacramento River, and to further evaluate the impacts of increased pumping. Computer modeling can then be conducted to refine estimates of impacts and yield.

Possible Impacts from Increased Groundwater Development

In planning development of groundwater, consideration should be given to some basic characteristics of groundwater movement and storage that control how much groundwater can be withdrawn and what the impacts of withdrawal may be. Following is a brief description of where groundwater that may be pumped from wells ultimately comes from and what impacts might be expected from new development of groundwater.

The Source of Groundwater

The groundwater that is pumped from wells is stored in the open spaces within an aquifer material, such as the cracks in a hard rock aquifer or the spaces between sand grains in a valley fill aquifer such as that found in the Sacramento Valley. When well pumping begins, the water from the surrounding aquifer begins to flow into the well because pumping has lowered the pressure, or water level, by the removal of water. The water level in the surrounding aquifer material is lowered as this water flows into the well and is withdrawn. This process forms what is commonly called the “cone of depression” around the well and represents the modified pressure or water level resulting from removal of water from storage in the aquifer.

Just as with any water reservoir, water cannot be indefinitely withdrawn without some source of replenishment. In the case of groundwater, the replenishment of the groundwater is recharge, which may be from a number of immediate sources, but must ultimately come from rainfall into a drainage basin or from some other transfer of water from outside the drainage basin. In the case of the Sacramento Valley aquifer, the major immediate sources or potential sources of recharge to the aquifer include:

- Infiltration of rainfall, which occurs almost exclusively in the winter months.
- Leakage from surface water distribution systems such as canals and reservoirs.
- Leakage from the Sacramento River or its tributaries.
- Groundwater flow from adjacent geologic material in the surrounding foothills.
- Infiltration of applied water from irrigated agriculture.

In each of these cases, the ultimate source of the water is from rain (or snow) falling onto the watershed of the Sacramento River or from transfers of water from outside the Sacramento watershed. Therefore, groundwater does not actually increase the overall amount of water available over multiple years. Its proper development may, however, offer an apparent new source of water by allowing pumping during low rainfall years (and recharging during high rainfall years) and similarly by spreading water availability within the year.

Potential Impacts of Increased Groundwater Development

As the cones of depression from new wells spread and groundwater levels drop, there will be an increased tendency for water to flow out of surface water bodies such as streams, reservoirs, and the Sacramento River and recharge the groundwater. Similarly, areas where groundwater has historically discharged to the surface, such as drains and some wetlands, will receive less water from groundwater discharge as groundwater levels decline. With continued pumping, the spreading cones of depression of adjacent wells will eventually intersect, so that the drawdowns in the wells themselves are compounded and groundwater levels may be lowered significantly over large areas. In addition to the impacts discussed below, the cumulative drawdown dramatically increases energy costs because the annual cost of pumping the groundwater is a large portion of the cost of groundwater development. For example, the energy required to pump water from 500 feet below the ground surface is roughly five times that required to pump from 100 feet.

The current system of water use and distribution has developed slowly over time, and the delivery and conveyance systems have come to rely on groundwater levels being near current, somewhat predictable, levels for proper operation. For example, canal seepage rates might be influenced by shallow groundwater levels that reduce the potential seepage rate. Lowering the groundwater in these areas could increase average seepage rates from these canals. Also, existing groundwater wells are installed to operate under current average groundwater levels and might require relocation or deeper development depths if average levels were to decrease. Increased pumping of groundwater may impact the current system, and these impacts must be anticipated, kept to acceptable levels, and managed to ensure adequate supplies and to allow adjustment of the system to new conditions.

Improperly managed new groundwater development will generally result in lower groundwater levels, and a number of impacts can be expected:

- Lower levels and reduced yield in existing wells.
- Lower groundwater inflow to drains and ditches that have come to rely on groundwater inflow for water supply and recycling.
- Increased leakage from canals and ditches where high groundwater levels have historically reduced and/or prevented leakage.
- Increased leakage from flooded fields where historic groundwater levels have been at or near the ground surface during part or all of the year.
- Increased loss of river- and streamflows to groundwater.
- Drying of fields or other areas that have historically remained wet during part or all of the year because of high water tables.
- Loss of "subirrigation" water sources in fields with historically high groundwater levels.
- Lower levels in some wetlands and surface water bodies that have historically depended on groundwater inflow for all or part of their water source.

If lower groundwater levels persist for long periods of time, as is the case when recharge cannot keep up with pumping, subsidence of the ground surface may also result. Such subsidence has occurred in portions of the geologically similar San Joaquin Valley as a result of persistent lowering of groundwater levels.

The overall rate at which pumped groundwater is replaced by recharge from the various sources determines the "safe yield" of the aquifer, or the amount that can be withdrawn indefinitely without continued lowering of the water levels. Note, however, that new water is not created, and the increase in recharge necessary to prevent continued drawdown must necessarily come from water that would otherwise be flowing down the river, evaporating from a wetland, filling a drainage ditch, or other similar scenarios.

TABLE 1
Summary of Groundwater Assessment Assumptions

Parameter	Assumption/Value
Groundwater Development Scenarios	
Alternative 1	Replace annual project supply within 6-month irrigation season
Alternative 2	Replace critical period project supply within critical 2- or 3-month period
Alternative 3	Replace 25% of base supply – drought scenario
Hydrogeologic Parameters and Well Characteristics	
Aquifer Transmissivity and Static Groundwater Levels	DWR Bulletin 118-86
Existing Well Characteristics	DWR and district data
Uniform Properties of New Wells	
Well Depth	500 feet
Well Diameter	16 inches
Well Screened Interval	400 feet
Well Spacing	3,000 to 4,000 feet
Well Grid Sizing	Determined by the uniform well spacing and approximate total area within the district boundaries available for well placement
Unit Costs and Economic Assumptions	
Unit Well Costs	$22.00 per diameter-inch per foot depth
Pump + Motor Efficiency	70%
Unit Power Cost	$0.09 per kWh
Electrical Supply Cost	$10 per linear foot
Electrical Supply Need	1,000 linear feet of powerlines per well
Unit Pipeline Cost	$5 per diameter inch per linear foot
Unit Pipeline Need	1,000 linear feet per well to connect well with surface distribution system
Pipeline Sizing Basis	Maximum 7 ft/sec flow velocity
Pipe C Factor	130
Capital Interest Rate	7.0%
Cost Analysis Period	20 years
Annual O&M Costs	3% of well capital cost

Sacramento River BWMP Groundwater Development Capital and O&M Cost Worksheet

District: **RD 1004**

Note: District currently has no wells. Policy is to allow private development as necessary.

Development Scenarios

ALT1	Replace Annual Project Supply =	15,000	AF
ALT2	Replace Critical Period Project Supply =	15,000	AF
ALT3	Replace 25% drought =	14,100	AF

Operating Window

ALT1:	180	days
ALT2:	90	days
ALT3:	180	days

Average Basin Groundwater Characteristics

water quality:	good	
static depth to gw:	10	ft
typical screen depth	500	ft
typical well flowrate =	2,000	gpm
typical well diam. =	16	in
typical well depth =	500	ft

Unit Costs and Economic Parameters

Unit Well Cost:	$22.00	$/dia-in-ft
Pump+motor Eff	0.7	
Unit Power Cost	0.09	$/kWh
Ext Interest Rate	7.0%	
Analysis Period	20	years
Annual O&M	3%	of well capital cost
Electrical Supply Cost	$10	per linear ft.
Electrical Supply Need	1000	linear ft./well
Pipeline Need	1000	linear ft/well
Unit Pipeline Cost	$5	per diam-in per linear ft
Pipeline Sizing Basis	7	ft/sec flow velocity
Pipe C factor	130	

Required Pipeline Diam.	12	in
Pipe Head Loss per 100 feet	0.92	ft/100 ft of pipe
Total Pipe Head Loss	9.2	ft

Capital and O&M Costs per Alternative

ALT.	Well Flow Rate (gpm)	# wells	Expected Drawdown (ft)	Total Lift (ft)	Well Capital Cost ($)	Pipeline Capital Cost ($)	Cost to Deliver Power ($)	Total Capital Cost ($)	Annual O&M ($)	Annual Power ($)	EUAC ($)	Cost per AFY ($)/AF	Likelihood of Adverse Impacts
ALT1:	2,000	10	90	119	$1,760,000	$600,000	$100,000	$2,460,000	$52,800	$249,964	$534,971	$36	Moderate
ALT2:	2,000	19	125	154	$3,344,000	$1,140,000	$190,000	$4,674,000	$100,320	$307,184	$848,697	$57	Substantial
ALT3:	2,000	9	90	119	$1,584,000	$540,000	$90,000	$2,214,000	$47,520	$224,968	$481,474	$34	Moderate

Impact Explanation:

Moderate -- likely to have significant, but manageable impacts on surrounding water uses; good likelihood that this yield goal can be met

Substantial -- large and possibly unacceptable impact on surrounding water uses; yield goals may not be achievable according to site-specific conditions

Severe -- Severe impacts on surrounding water users is likely; high likelihood that yield goals are not achievable or may result in unacceptable impacts

NOTE: Pumping of large amounts of groundwater is likely to impact many other aspects of the hydrologic system including yield of existing wells, return flows to drains or ditches for recovery, and water levels in surface water bodies. The impacts are dramatically increased by the cumulative effect of multiple new wells. A simple estimate was made of the cumulative drawdown in wells spaced at reasonable distances within the contractor service area using general estimates of aquifer characteristics. The adverse impacts ratings are based on the estimated drawdown and are intended to give a general estimate of the impact of the pumping on surrounding water uses.

* **A site-specific study is needed to more accurately estimate reasonable yield and impact expectations if groundwater development is to be considered further.**

Methodology for Evaluation of Drain Water Use

PREPARED FOR: Sacramento River Basinwide Management Plan

PREPARED BY: Greg Norby/CH2M HILL

DATE: January 18, 2000

Purpose and Scope

This technical memorandum summarizes the methods used to evaluate existing and potential increased drain water use, as a water management option for implementation by Settlement Contractors (SC) districts for the Sacramento River Basinwide Management Plan. Increased drain water use is one option under the standard list of water management options addressed in *Technical Memorandum No. 5 – Water Management and Supply Options* (TM-5). A more comprehensive discussion of drain water use is presented in TM-5 under *Drain Water Use*. This evaluation was conducted at the reconnaissance, or conceptual, level and provides approximate estimates of existing and future drain water use, and associated costs for use in comparison with other water management and supply options available to each SC.

Data Sources

In reviewing existing drain water use and assessing potential future use, the following sources of information were used:

- Existing reports prepared by SC staff, independent agencies (NRCS), or consultants.
- District drain water pumping data
- Discussions with SC operations staff, review of facility maps and typical drain water system operations

Evaluation Process

The drain water use was evaluated by the following main steps:

1. Review existing drain water use, drain water sources (internal and external), annual quantity, seasonal pattern in supply and demand, location and operation of drainage capture facilities.
2. Review potentially limiting factors such as water quality, legal agreements, etc.
3. Estimate current cost per acre-foot, typical power cost for pumping.
4. Determine end location of drainage leaving district, for example discharge to Sacramento River or flow into regional drain.

5. From information from above steps, estimate an upper limit on annual drain water use based on one or more of the following factors: supply, water or soil quality, legal restrictions.
6. For potential increased drain use, determine required new facilities such as drain pumps, ditches, and check structures.
7. Estimate total annual cost, and unit cost, of additional drain water use.

See the attached sample worksheet for details.

SRBWMP Drain Water Reuse Assessment Worksheet

District: PCGID

SUMMARY OF EXISTING DRAIN REUSE

Average annual drain reuse- (total amount pumped back into canals/laterals): 28,000 afy

Notes: all drain pumps now metered. District has seen increase in drain pumping in last few years due to changes in cultural practices like increased drain down of fields for ground-application of fertilizers etc...

Average irrigation season drain outflow from district: NA afy

not available

Methods of estimation for above: (Measured flows, pump operations history, operators/managers estimate)

District meters on drain pump

Current Drain reuse as % of :

Project Supply (afy)	25,000	112%
Avg. Diversions (afy)	52,000	54%
On Farm Req. (afy)	47,000	60%

Total annual cost, or unit cost per AF:

Unknown. Assume power costs are approximately $2.50/af. Assume all pumped reuse, avg of 28,000 afy, so power cost approx $70,000

Estimated % of drain water leaving district that is re-used BEFORE reentering Sac River-

Estimated 100% of drain water used due to heavy drain pumping by downstream users along the Colusa Basin drain

POTENTIAL FUTURE DRAIN REUSE

Requirements/agreements for downstream drain users supply-

Old "5 party" agreement replaced by new agreement with Colusa Drain Mutual Water Company (GCID, PID, MID, PCGID). Committed to maintaining approximately same quantity and quality of drainwater leaving districts as presently. Marc Van Camp is resource for information, was heavily involved in working out the arrangement.

Previous/on-going studies on salinity, drain water quality, etc-

District has started drain water sampling program this year. No previous studies available.

District assessment of upper limit of reuse as % of total diversion-

Current use is near maximum. No increase in supply expected because most water comes from GCID and PCGID's internal system. Some mismatch between drain supply and irrig demand could be addressed with drain regulating storage or greater diversion capacity

Proposed primary diversion (pumping) points and distribution facilities-

Possibly add increased pumping capacity with new pumps at same main drain pumping locations.

If no district estimate, assume 50% of current drain discharge leaving district could be captured for reuse

Assume approximately 3,000 AFY (10%) increase may be possible with 2 new (20) cfs pumps, operating 60 days average. Restrictions include impacts on d/s drain users, State WRCB licensing for new pumping.

Future Increase in Drain Use : 3,000 afy

Cost Summary

Initial Capital Cost: ($140/af)	$420,000
Annual O&M Cost: ($9/afy)	$27,000
Total Annual Cost: ($22/afy)	$66,000

Seepage Loss and Lining Evaluation Methodology

PREPARED FOR: Sacramento River Basinwide Management Plan

PREPARED BY: Greg Norby/CH2M HILL

DATE: January 18, 2000; revised according to U.S. Bureau of Reclamation comments for the BWMP September 30, 2004

Purpose and Scope

This technical memorandum summarizes the method used to evaluate canal lining as a water management option for implementation by Settlement Contractor (SC) districts in response to the Sacramento River Basinwide Management Plan (SRBWMP). Canal lining is one option under the standard list of management options addressed in *Technical Memorandum No. 5 – Water Management and Supply Options* (TM-5). A more general discussion of canal lining and related issues is presented in the main body of this report. The basic purpose of canal lining is to increase conveyance efficiency by minimizing canal seepage losses. Canal lining may also be proposed for other reasons, such as increasing capacity or reducing maintenance costs related to annual cleaning and shaping of earthen ditches. However, the focus of TM-5 is limited to consideration of the quantity of seepage avoided, capital and operation and maintenance (O&M) costs for lining, and identification of potential implementation issues the may influence the overall feasibility of canal lining.

Limitations of the Analysis

The extent and complexity of the SRBWMP study area limit the level of analysis for canal lining evaluation that can be conducted within the project scope of work. This analysis was conducted at the reconnaissance, or conceptual, level and is intended only to provide order of magnitude estimates of seepage losses, potential lining benefits, and related costs for use in comparison with other water management and supply options available to each SC. Canal seepage is a very complex process that can vary widely by location and by season. Factors influencing the rate of seepage loss include soil characteristics (physical and chemical), sedimentation processes, canal geometry and flow characteristics, canal operational patterns, groundwater depth, water levels in adjacent fields or ditches, and numerous other factors. Further evaluation of lining projects will require site-specific evaluations of each of these factors to determine conservation benefits, project costs, and the economic value of the lining.

Estimation of Seepage Losses

Seepage losses and potential canal lining were evaluated for each SC using one of the following methods and are discussed in the following sections. The methods rely primarily on existing information or reports, as no site-specific investigations were undertaken as part of the SRBWMP efforts. The methods are ranked in order of highest to lowest preference in terms of the expected accuracy of the results. Only main canals were considered for lining in this study. Future evaluations for specific projects may consider lining of laterals and smaller ditches.

Previous Seepage Studies–Studies have been conducted by some SCs, or by outside agencies, to evaluate seepage losses and canal lining options within a specific SC service area. Where available, these studies were reviewed for methodology, results, and recommendations. The conclusions and recommendations from these reports were used to obtain basic data for total annual seepage losses and the location and quantity of potential canal lining.

Estimate of Seepage using Mass Balance–In some cases, detailed water measurement using a mass balance approach by a district provided a basis for estimating seepage losses. By comparing total canal inflows to measured deliveries, operational spills, and estimated sources minor losses such as evaporation, an estimate of the canal seepage could be made.

Estimation by District Staff –Various districts have observed local areas of high seepage losses at some canal reaches during many years of operations. These same canal reaches have also been observed during shutdown periods to have sandy or other porous soils that typically result in high seepage losses. In these cases, discussions with district staff helped to identify the potential problem areas. Estimates of seepage losses were made based on average canal geometry and assumed infiltration rates from the observed soil types.

Canal Geometry and Soils Infiltration Rate–An estimate of seepage losses was made for some main canals using assumed average soil infiltration rates and canal geometry to estimate the total area for seepage, the loss rate per unit area, and total seasonal quantity of seepage.

Lining Costs and Net Benefits

A uniform conceptual level cost for canal lining was developed using cost data from recent canal lining projects in the Sacramento and San Joaquin Valley. For a given lining option, total capital cost was estimated using the total lining area and the unit cost of $20/yd^2. The total capital cost was annualized using a uniform project life and interest rate. The quantity of avoided seepage loss on an annual basis was estimated as the difference between the unlined losses and the estimated losses with a lined canal in the same reach. Lined canals are not typically water-tight, and do experience seepage losses through seems and cracks in the lining. The unit cost of the "conserved water" was then estimated in terms of $ per acre-foot per year, using the annualized cost of lining and the quantity of avoided loss. See the attached worksheet for details of this procedure.

Data Sources and References

- Christopher, J.N. 1981. *Comments on Canal Seepage Measuring and Estimating Procedures*. USBR Engineering and Research Center (ERC).
- Haskell, W.C. 1994. *Statistical Characterization of Seepage Losses in Open Channels*. Colorado State University.
- USBR (1987). *Irrigation Facility Sizing Criteria Review*. USBR ERC.
- USBR. Linings for Irrigation Canals. USBR ERC

Methodology for Evaluation of Conveyance System Automation

PREPARED FOR: Sacramento River Basinwide Management Plan

PREPARED BY: Greg Norby / CH2M HILL

DATE: January 18, 2000

Purpose and Scope

This technical memorandum summarizes the method used to evaluate conveyance system automation as a water management option for implementation by Settlement Contractor (SC) districts in response to the Sacramento River Basinwide Management Plan (SRBWMP). Conveyance system automation is one option under the standard list of management options addressed in *Technical Memorandum No. 5—Water Management and Supply Options* (TM-5). A more general discussion of conveyance system automation and related issues is presented in the main body of TM-5. The purpose of conveyance system automation, from a conservation perspective, is to increase conveyance efficiency by reducing operational spills caused by a mismatch between supplies (total inflow) and demands (turn-outs). Conveyance system automation also may be proposed for other reasons, such as increasing delivery flexibility and level of service. However, the focus of TM-5 is limited to consideration of the reduction in operational spills, capital and operation and maintenance (O&M) costs for improved operations monitoring and control, and identification of potential implementation issues that may influence how conveyance system automation is implemented for a specific SC.

Limitations and Key Assumptions

This analysis was conducted at the reconnaissance, or conceptual, level and is intended only to provide order-of-magnitude estimates for operational spills, potential reductions in operational spills, and related costs for use in comparison with other water management and supply options available to each SC. Implementing system automation improvements requires detailed analysis of specific service area conditions. Measurement data on operational spills were available for only a few districts. In most cases, spills were estimated from consideration of key features such as the system facilities and operation methods, discussions with district staff, and information in technical references.

Operational spills were considered primarily as a percentage of total inflow. The minimum practical spill quantity was assumed to be 5 percent of inflows. This percent assumption was based on open channel distribution system characteristics and limitations in the ability to more closely control canal flows to match turn-out flows. Automation is closely related to, and relies upon, water measurement. For simplifying the allocation of costs and water savings, it was assumed that the target reduction in spills, for example from 10 percent to 5 percent resulted from a combination of automation (two-thirds of total reduction) and measurement (one-third of total reduction). Water measurement improvements are evaluated separately in TM-5.

Evaluation Process

The evaluation process for automation costs and benefits includes the following steps:

1. Estimate current operational spills as percent of total inflow to canal system.
2. Assess the existing operating practices and level of automation. Review existing studies on automation (USBR and Cal Poly IRTC studies) and district plans for improvements.
3. Determine key facilities (new or existing) to be automated, review with district.
4. Estimate quantity of avoided operational spills based on reduction from current percent spills to 5 percent spills.
5. Estimate the total capital costs, annualized cost, and the unit cost of reduction in operational spills.

See the attached sample worksheet for details.

Improving conveyance system automation may also have secondary benefits for on-farm efficiency by increasing water delivery scheduling for each irrigator, allowing more precise timing of irrigation operations to match crop water demands.

Typical Automation Improvements

Table 1 lists the standard automation upgrades considered for each SC.

TABLE 1
Standard Automation Improvements by Operations Level

Operations Level	Improvement
Supply (inflows)	• Pump Stations–New pumps, variable frequency drives (VFD) on new or existing pumps, SCADA tie-in. • Drain lift pumps–Water level sensors and automatic controls, SCADA tie-in.
Distribution	• Radial (Drum) Gates–for water level or flow rate control. • Motor-operated slide gates–for water level or flow rate control. New structures or retrofit of existing gates. • SCADA tie-in for new or improved existing control structures.
Supervision and control	• SCADA system–office computer with software, communication equipment, monitoring and/or control at pump stations, canal control structures, key flow measurement points

Unit Costs of Improvements

Costs for installation of the standard improvements were developed using equipment supplier price quotes, cost data from recent projects, and standard planning-level unit costs derived from past project experience and construction cost estimates. See Appendix B for a table of unit costs.

SRBWMP Conveyance System Automation Evaluation Worksheet

District : PCGID

I. Operational Spills are 10 % of total diversions (assumed, no spill data)

Total Diversions:	52,000	AF/yr
Assumed Current Operational Spills:	5,200	AF/yr

II. Current Operational Status/Level of Modernization

Current level of Service:

	Rotation: Users get water once every so many days, on a regular basis.
X	Arranged: Users call in water orders 24-48 hours in advance.
	Demand: Users can take water at any time
	Combination (describe)

Current Level of Modernization:

	Gates: Radial or other automated water-level maintaining
X	Water level/flow recorders
X	SCADA Systems
X	VFD's on Main Pump Stations
X	Automated Drain Pumps

Current program to link up Sidds Landing PS, other PCGID and PID pumping plants, drain pumps, water level monitoring, etc.. to central SCADA panel at PID office. See DR Burt/USBR study. Initial SCADA components, VFD's at SLPS in place this season.

III. Proposed Operational Upgrades

Gates: Radial or other water-level maintaining

Location	Size	Type	Capital Cost	Notes
6 laterals- headgates	60 cfs ea gate	MOSG	$58,000	(1) 42-inch gate each site, $9,700 ea. SCADA below
		subtotal =	$58,000	

SCADA Systems

Location	Type		Capital Cost	Notes
3 drain pumps	monitor/control		$45,000	monitor lateral and drain depth, cycle drain pump, $15K ea
6 headgates	monitor/control		$90,000	Monitor/control flow/position, (6) locations, $15K ea
		subtotal =	$135,000	

VFD's

Location	Capacity		Capital Cost	Notes
				Installed on main pump stations already
		subtotal =		
		Total Cost	**$193,000**	

IV. Est Cost of Prevented Spills

Estimated Reducion in Spill as % of Diversion	3%	(2/3 of total %spill reduction, other 1/3 from measurement)
Total annual AFY reduced spills	1,560	
Unit Cost ($/AFY)	**$12**	20 years at 7%

Methodology for Evaluation of Water Measurement Improvements

PREPARED FOR: Sacramento River Basinwide Management Plan

PREPARED BY: Greg Norby/CH2M HILL

DATE: January 17, 2000

Purpose and Scope

This technical memorandum summarizes the method used to evaluate improved water measurement as a management option for implementation by Settlement Contractor (SC) districts for the Sacramento River Basinwide Management Plan. Improved water measurement is one option under the standard list of management options addressed in *Technical Memorandum No. 5 – Water Management and Supply Options* (TM-5). A more comprehensive discussion of water measurement and related issues is presented in the main body of TM-5. The purpose of improved water measurement, from a conservation perspective, is to increase both conveyance efficiency and on-farm efficiency. Improved water measurement has other potential benefits. However, the focus within TM-5 is limited to consideration of the increased conveyance and on-farm efficiency, related capital and operation and maintenance (O&M) costs, and identification of potential implementation issues that may influence how improved water measurement is implemented for a specific SC.

Limitations and Key Assumptions

This analysis was conducted at the reconnaissance, or conceptual, level and provides approximate estimates of existing conveyance and on-farm efficiencies, potential future efficiency, and the related costs for use in comparison with other water management and supply options available to each SC. Implementing water measurement improvements requires detailed analysis of specific service area conditions. Water measurement was considered at two general levels. The first is measurement within the supply and distribution system, such as river pump station, lateral flows, and drain flows. The second is measurement of farm, or field-level delivery.

Improvements in the supply and distribution system efficiency were assumed to be achieved by some combination of improved water measurement and increased conveyance system automation. The operational spills component of total conveyance system efficiency was used as the basic measure of improved efficiency. The assumed target improvement was to reduce operational spills to approximately 5 percent of total inflows. For simplifying the allocation of costs and water savings, it was assumed that the target reduction in spills, for example from 10 percent to 5 percent, resulted from a combination of automation (two-thirds of total reduction) and measurement (one-third of total reduction).

Field turn-out measurement is intended to increase field-level efficiency. Existing average field efficiency for each SC was obtained from Department of Water Resources (DWR) DAU data. A uniform target improvement was selected, to 70 percent average field efficiency, for comparison purposes only. Actual field-level efficiency is affected by many complex factors that are beyond the scope of this analysis. The increased field efficiency would likely be achieved by a combination of improved measurement, incentive pricing, and on-farm improvements. There are several methods for measuring field delivery, as discussed in TM-5 under *Water Measurement.* To allow uniform comparison of costs and water savings between SCs, it was assumed that improved field measurement would be done using propeller flowmeters with totalizers installed at all turn-outs.

Evaluation Process

Water measurement costs and benefits were evaluated by the following steps:

1. Review the SC's existing water measurement program at each level of operations, including the types of measurement devices or methods used, and data recording practices.
2. Determine potential improvements for each operations level, using a standard list of available measurement methods.
3. Estimate the improved efficiency, total costs, and annualized unit cost for the conserved water.

See the attached sample worksheet for details.

Standard Water Measurement Improvements

Table 1 lists the standard water measurement improvements considered for each SC.

TABLE 1
Standard Water Measurement Improvements by Operations Level

Operations Level	Improvement
Supply-river diversions, wells	Flowmeters with totalizers.
Main Canals	Long-throated flumes with continuous stage recorders
	New continuous stage recorders at existing control structures
Laterals	Head gate stage recorders
	Flowmeters with totalizers
	Long-throated flumes with continuous stage recorders
Drain Pumps	Flowmeters with totalizers
Field Turn-outs	Constant-head-orifice setup with flowmeter and totalizer

Unit Costs of Improvements

Costs for installation of the standard improvements were developed using equipment supplier price quotes, cost data from recent projects, and standard planning-level unit costs derived from past project experience and construction cost estimates. See Appendix B for a table of unit costs.

SRBWMP Water Measurement Assessment Worksheet

Ext Interest Rate 7.0%

Analysis Period 20 years

Contractor PCGID

EXISTING MEASUREMENT AND METERING

Operations Level		Measured?	Device/Method (meter,weir, etc.)
River Diversions (Sidds Landing)		yes	meters
Wells		yes	meters
Main Canal Flows		yes	stage-discharge relationships
Lateral Flows		yes	gates- head/position tables
Drain Pumps		yes	meters
Field Turnouts	# of turnouts 250	yes	head-orifice

POTENTIAL FUTURE MEASUREMENT IMPROVEMENTS

	Location/Ops Level	Measurement Device Type	Installation Cost	
1	River Branch Canal	(2) Replogle flumes (300 cfs)	$152,000	(2) at $76K ea
2	5 main laterals	(5) Repogle flumes (150 cfs)	$205,000	(5) at $41K ea
3				
4				
5				

Total Cost = $357,000

Conveyance:

Average annual diverstions =	52,000 ac-ft	
Existing Op. Spills (% of diversion) =	10%	(% due to operational spills only. Not including seepage)
Future Efficiency =	5%	(lesser of 5% or 1/2 of current op. Spills %, minimum 5%
Volume Saved =	860 afy	[total inflow *(current ops spill% - 5%) x 0.33]
Average annual unit cost =	$39 $/ac-ft	(annualized at 7% over 20 years)

Field Metering:

Average on-farm efficiency =	64%	(from DWR DAU data)
Average on-farm delivery =	47,000 afy	(from TM-2 data)
Crop water requirement =	30,080 afy	(on-farm efficiency x on-farm requirement)
Potential on-farm efficiency =	70%	(assumed max for comparison purposes only)
Delivery needed with improved eff. =	42,971 afy	(CWR/potential efficiency)
Volume saved =	4,029 afy	(savings = CWR x (1/current eff. - 1/potential eff.)
Capital costs =	$700,000	125 meters @ $4,000 $/unit
		125 meters @ $1,600 $/unit
Total annual costs =	$223,575	(annualized cap cost + $630 per meter annual O&M)
Annual water cost =	$55 $/ac-ft	(CRF = 0.094)

Appendix D
SVWMA Proposed Projects

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Redding Sub-basin

PROJECT 2A

Anderson-Cottonwood Irrigation District Churn Creek Lateral Improvements

1. Project Description

Project Type:	System improvement
Location:	Shasta County
Proponent(s):	Anderson-Cottonwood Irrigation District (ACID or District)
Project Beneficiaries:	ACID, downstream users, the environment, the Sacramento-San Joaquin Delta
Total Project Components:	Replacement of open ditch and undersized pipe reaches (totaling about 8,800 linear feet) with new 60-inch-diameter pipeline, plus design and construction of either an inverted siphon or elevated flume across the Sacramento River near the South Bonnyview Road bridge
Potential Supply:	19,000 acre-feet per year (ac-ft/yr)
Cost:	$14.4 million
Current Funding:	$100,000 through California Department of Water Resources (DWR) Water Conservation Grant, earmarked for feasibility studies
Short-term Components:	Replacement of open ditch and undersized pipe reaches east of the Sacramento River (totaling approximately 7,300 linear feet) with new 60-inch-diameter pipeline
Potential Supply (by 2003):	9,000 ac-ft/yr
Cost:	$5.4 million
Current Funding:	$100,000 through California Department of Water Resources (DWR) Water Conservation Grant, earmarked for feasibility studies
Implementation Challenges:	Water rights implications, environmental regulatory compliance, determination of seepage losses, construction period, construction right-of-ways, river crossing

Key Agencies: U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Fish and Game (CDFG), National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA), U.S. Army Corps of Engineers (COE), State Lands Commission

Summary

The purpose of this evaluation is to technically evaluate a project that would improve a portion of ACID's irrigation system, replacing the Churn Creek Lateral and the Bonnyview Diversion on the Sacramento River to increase water use efficiency. The associated improvements would increase delivery reliability and eliminate conveyance losses within the affected reach of the system. Figure 2A-1 depicts the area of discussion.

The current conveyance facilities, constructed prior to 1920, include an open ditch and undersized pipe section delivering water to the Churn Creek Bottom area on the east side of the river. The existing Bonnyview Diversion was constructed to restore deliveries to the east side of the river after a flood in 1937 destroyed an elevated flume over the Sacramento River. This diversion, known by the District as the Churn Creek Pumping Plant, had a capacity of 75 cubic feet per second (cfs) when originally constructed, which was consistent with historical demands and deliveries on the east side of the river. However, as a result of facility refurbishment, the current Churn Creek Pumping Plant has a maximum capacity of about 60 cfs.

When implemented, the project would replace the open ditch and undersized pipe sections of the Churn Creek Lateral with a 60-inch-diameter pipeline. In addition, the Churn Creek Pumping Plant would be removed, and the section of the lateral east of the river would be supplied via an inverted siphon or new flume across the river. This in effect would restore the original system and move the Sacramento River diversion for the Churn Creek Lateral upstream 6.5 river miles to the ACID Diversion Dam in downtown Redding near the North Market Street Bridge.

Short-term Component

For the purposes of this project evaluation, Phase 1 of the project is defined as the work east of the Sacramento River to replace this portion of the Churn Creek Lateral with new pipeline. Phase 2 is defined as a siphon or flume river crossing and replacement of the portion of the Churn Creek Lateral west of the river. The Churn Creek Pumping Plant would stay in service until Phase 2 to maintain the water supply into the Churn Creek Lateral. It is assumed that environmental compliance requirements for Phase 1 would be minimal because the work would occur within the footprint of the canal and have little or no direct short- or long-term environmental impacts. The Phase 2 river crossing, however, may require additional time because of what are perceived to be more challenging environmental compliance issues, including potential impacts to anadromous fish and riparian vegetation.

Phase 1, involving approximately 7,300 linear feet of pipeline, is expected to be completed and fully utilized within 2 years of project funding (to be completed no later than December 2003). For Phase 1, reconnaissance, feasibility studies, and preliminary design are anticipated to require 5 months. Design, permitting, and environmental documentation are anticipated to require an additional 5 months. Phase 1 would yield essentially all of the water conservation benefits.

Long-term Component

Phase 2 would consist of design and construction of an additional 8,800 linear feet of pipeline, removal of the Churn Creek Pumping Plant, and either an inverted siphon or elevated flume across the Sacramento River near the South Bonnyview Road bridge. Reconnaissance, feasibility studies, and preliminary design are anticipated to require 5 months concurrent with Phase 1. Design, permitting, and environmental documentation are anticipated to require an additional 9 to 12 months. Construction would probably be completed during the late summer of 2003, but final connections to the adjacent Churn Creek Lateral (completed several months earlier) would probably not be made until after the irrigation season. Therefore, it is expected that Phase 2 would be officially complete and in operation by April 2004. Although the ACID Manager and Board of Directors recognize the value of phasing this project relative to short- and long-term funding and conservation benefits, they have stated a desire for assurances that both phases would ultimately be funded and implemented.

2. Potential Project Benefits/Beneficiaries

The proposed construction of new facilities is expected to generate numerous benefits for both the local and regional water users. The beneficiaries of this program include ACID, downstream users, the environment, and the Sacramento-San Joaquin Delta. The following benefits are discussed in this section.

- Water Supply Benefits
- Water Management Benefits
- Environmental and Water Quality Benefits
- Energy Savings

Water Supply Benefits

The proposed project would provide the capability to more efficiently manage diversions from the Sacramento River. It would reduce diversions, thereby increasing in-stream flows, and also would reduce evapotranspiration (ET) and seepage losses. Water supply benefits include:

- **Piping—**The piping component would drastically reduce seepage in the Churn Creek Lateral. A 1982 study by the Soil Conservation Service (now called the Natural Resource Conservation Service) indicated that seepage along the east reach of the river may be as much as 8,700 ac-ft/yr. Additional losses have occurred along the lateral on the west side of the Sacramento River. Although the amount of seepage is unknown, it is assumed to be significant along the approximately 1.7-mile segment of the lateral on the west side of the river. Assuming an additional 10,000 ac-ft/yr west of the river, indicated by the relative length of the reach, this project would eliminate the seepage losses and produce approximately 19,000 ac-ft/yr of new water.

- **Water shortages—**Several Redding Basin municipal and industrial (M&I) Central Valley Project (CVP) water service contractors face shortages during dry years. The project could produce water that could be used to meet water needs. The project would potentially increase the seasonal supply in the Sacramento River downstream of the diversion point. This water could then be made available for other beneficial uses under appropriate short-term or long-term water transfer arrangements with ACID.

Water Management Benefits

Water management benefits include:

- **System efficiency—**The predominant goal of the project is to increase water use efficiency and conserve water. The installation of underground piping of ACID's Churn Creek Lateral would substantially improve the District's ability to more efficiently utilize their supply. The District, its patrons, and adjacent landowners would benefit by virtue of the new pipeline eliminating seepage onto adjacent property and requiring less maintenance.
- **Capacity—**When originally constructed, the Churn Creek Pumping Plant had a 75-cfs capacity. When the facility was refurbished, its capacity decreased to a maximum of 60 cfs. Implementations of the project would enable the system to provide a 75-cfs capacity, consistent with historical demands and deliveries on the east side of the river.

Environmental and Water Quality Benefits

As ACID's primary source of supply, the Sacramento River would be directly and most beneficially influenced by the District's efficient use of its water supply. The potential 19,000 ac-ft/yr decrease in surface water diversions has the potential for increasing available seasonal in-stream flows to the Sacramento-San Joaquin Delta. This additional water would contribute to addressing Delta water quality concerns that have been at the core of CALFED and other programs' efforts for the past several years. These and other potential environmental benefits associated with this project would be quantified throughout the various stages of the project, from the feasibility study through final design. Beyond flow augmentation, two of the other environmental benefits that have been identified at this level of investigation include:

- **Removal of an existing river diversion—**This project would result in the removal of the Churn Creek Pumping Plant, which would eliminate any potential for fish entrainment or impingement.
- **Restoration/creation of aquatic habitat—**The footprint of the Churn Creek Pumping Plant, upon its removal, would revert to natural aquatic and riparian habitat.

Energy Savings

The three 300-horsepower pumps in the Churn Creek Pumping Plant would be eliminated. These pumps presently consume approximately 770,000 kilowatt hours per year. Given the present power crisis in California, the elimination of this pumping plant and its energy requirements provides a significant benefit to all Californians.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

The overall project (Phase 1 and 2 combined) is expected to cost approximately $14.4 million, including construction, design, environmental compliance, construction management, and contract administration. Table 2A-1 shows the preliminary costs of implementation.

TABLE 2A-1
Planning-level Project Costs: Phase 1
Anderson-Cottonwood Irrigation District Churn Creek Lateral Improvements

Item	Quantity	Units	Unit Price ($)	Total Cost ($ x 1000)	Assumptions
Pipeline	7,300	Feet	420	3,066	60-inch-diameter reinforced concrete pipe at $7 per diameter inch per foot length
Delivery Turnouts	6	Turnout	20,000	120	Six east of river
			Subtotal ->	**3,186**	
Contingencies and Allowances (30 %) ->				956	
Total Construction Costs ->				4,142	
Environmental Mitigation (5%) ->				207	
Engineering, Environmental, Construction Management and Admin. (25%) ->				1,036	
			Total Project Cost ->	**5,385**	

Project costs would be borne by the primary project beneficiaries, including Delta water quality interests, ACID, and, to a lesser extent, agricultural interests in the Redding area.

Typical annual operations and maintenance (O&M) costs for a project of this nature would be about 1 percent of initial capital costs, or about $138,000 each year. These costs would consist of inspection and maintenance of the structures and the new pipeline.

TABLE 2A-2
Planning-level Project Costs: Phase 2
Anderson-Cottonwood Irrigation District Churn Creek Lateral Improvements Project

Item	Quantity	Units	Unit Price ($)	Total Cost ($ x 1000)	Assumptions
Canal Turnout Structure	1	Structure	50,000	50	70-cfs turnout
Pipeline	8,800	Feet	420	3,696	60-inch-diameter reinforced concrete pipe at $7 per diameter inch per foot length
South Bonnyview Road Crossing	1	Structure	369,000	396	Length – 200 feet
Delivery Turnouts	10	Turnout	20,000	200	10 west of river
Sacramento River Crossing	1	Structure	990,000	990	Length – 750 feet
			Subtotal ->	**5,332**	
			Contingencies and Allowances (30 %) ->	1,600	
			Total Construction Costs ->	6,932	
			Environmental Mitigation (5%) ->	347	
			Engineering, Environmental, Construction Management and Admin. (25%) ->	1,733	
			Total Project Cost ->	**9,012**	

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem. Additionally, the project could provide environmental benefits by eliminating the need for the pumping plant, which would eliminate any potential for fish entrainment or impingement. Regional benefits in the form of reduced energy consumption could also accrue from project implementation.

Construction-related impacts would occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. It is likely that the appropriate level of environmental documentation necessary for this project would be a Mitigated Negative Declaration.

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **Regional Water Quality Control Board**—Large amounts of earthwork would be required for the construction of the 60-inch-diameter pipe. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act**—Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers**—The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Reclamation Board**—The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)**—Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **California Department of Fish and Game**—If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration agreement may be required.
- **Local governments and special districts**—Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

Project implementation would occur in several incremental stages, each of which would pose significant challenges. Many of these challenges would be inherent to any project of this size. The project would need to be developed in a manner that supports the objectives of the local and regional water management plans. The following point of discussion address some of the anticipated implementation challenges for this project:

- **Water rights implications**—The District's water rights would have to be guaranteed and preserved. Although the District would be expecting to decrease their annual surface water diversions, it should not be assumed that they would accordingly relinquish a comparable amount of their water rights.

- **Construction period—**The construction of the river crossing would be influenced by river conditions, the allowable construction period as determined by endangered species issues, and cofferdamming challenges. It is expected that the allowable construction window within the river would be very short in duration, probably during the summer months when the river is flowing at a relatively high rate because of downstream irrigation uses.

6. Implementation Plan

Extensive engineering and environmental investigations are necessary to further evaluate this project. The implementation plan is shown on Figure 2A-2.

Tasks Common to Phase 1 and 2

1.1 Feasibility study—Initial effort would focus on collecting and reviewing information to evaluate alternatives, identify project constraints, and develop budget-level cost estimates. Preliminary geotechnical data would also be gathered to confirm the locations and extent of seepage problems. The feasibility study is estimated to require 3 months to complete.

1.2 Environmental reconnaissance—This task would provide for biological field surveys, resource database review, and other reconnaissance necessary to determine permitting requirements and the appropriate level of environmental documentation required for implementation of the project. This task would also support selecting an alignment of the river crossing portion of the lateral during the preliminary design task by identifying any sensitive areas or issues of environmental concern. The environmental reconnaissance is estimated to require 3 months to complete.

2.1 Preliminary design—This task would make use of the information collected earlier to establish sites for turnouts, alignment of the river crossing, pipe materials, and type of river crossing (siphon versus flume). Sufficient design would be completed to determine budget estimates of construction cost and to establish the preferred alternative for subsequent NEPA/CEQA compliance. The preliminary design is estimated to require 2 months to complete.

Tasks Specific to Phase 1 Only

2.2 Permitting and environmental documentation—This task would consist of an extension of environmental reconnaissance, resulting in verification that Phase 1 has no significant affect on the environment. This would be determined through completion of environmental checklists per NEPA and CEQA. Phase 1 permitting and environmental documentation is estimated to require 3 months to complete.

2.3 Final design—The new pipeline would be evaluated and designed according to hydraulic and site conditions It is anticipated that the new pipeline would be 60-inch-diameter reinforced concrete. Construction plans and specifications would be developed to facilitate bidding for one construction contract. Phase 1 final design is estimated to require 5 months to complete.

3.1 Construction—This task would include the construction/installation of the pipeline east of the Sacramento River. This task would also include the effort and cost of securing temporary easements, if necessary, to allow for construction. Construction is estimated to require 6 months to complete, presumably during the winter months (i.e., non-irrigation season) when the facility is out of service**.**

3.2 Construction management and inspection—This task would provide for the services of an engineering consultant to administer the construction contract and inspect the work for compliance with the contract documents. Services would include processing the contractor's pay requests, reviewing construction submittals, materials testing, and startup procedures. Construction management and inspection is estimated to parallel construction in terms of schedule.

Tasks Specific to Phase 2 Only

2.2 Permitting and environmental documentation—This task would include preparation of an environmental document (anticipated to be an environmental assessment/initial study [EA/IS]) in accordance with NEPA and CEQA, respectively. Phase 2 permitting and environmental documentation is estimated to require up to 12 months to complete.

2.3 Final design—The river crossing would be designed for either a siphon or flume configuration. Major considerations during design would include the need to construct the crossing very quickly, coffer damming requirements and constraints, river conditions, and expected scour and required pipe protection. Consideration would be given to both open trenching and tunneling methods. The new pipeline reach west of the river would be evaluated and designed according to hydraulic and site conditions. Like the reach east of the river, it is anticipated that the new pipeline would be 60-inch-diameter reinforced concrete. Construction plans and specifications would be developed to facilitate bidding for one construction contract, assumed to be executed after the completion of Phase 1. Phase 2 final design is estimated to require 6 months to complete.

3.1 Construction—This task would include the construction/installation of the new pipeline west of the river, the river crossing, demolition of the existing pump station, and connection to the upstream end of the Phase 1 pipeline. This task also includes the effort and cost of securing temporary easements, if necessary, to allow for construction. It is anticipated that construction of the river crossing would be limited to an approximate 3-month period during the late summer to minimize impacts on migrating salmonids, and to provide the most stable river flows available during the calendar year**.** The pipeline reach associated with Phase 2 may need to be constructed during the winter months to avoid interference with irrigation deliveries, unless irrigation flows can be bypass pumped for short periods.

3.2 Construction management and inspection—This task would provide for the services of an engineering consultant to administer the construction contract and inspect the work for compliance with the contract documents. Services would include processing the contractor's pay requests, reviewing construction submittals, materials testing, and startup procedures. Construction management and inspection is estimated to parallel construction in terms of schedule.

Other Tasks Common to Phases 1 and 2

4.1 Operation and maintenance—O&M of all new facilities and equipment is proposed to be accomplished by the District. O&M is considered in this proposal to be an in-kind, cost-sharing service in perpetuity.

5.1 Contract management and administration—This task would incorporate management of project costs and schedule, administering grant funds, developing work plans, coordinating with other entities and agencies, and overseeing activities of the project team. Contract management and administration is estimated to require 1.75 years to complete from the start of the project to final completion of Phase 2 construction.

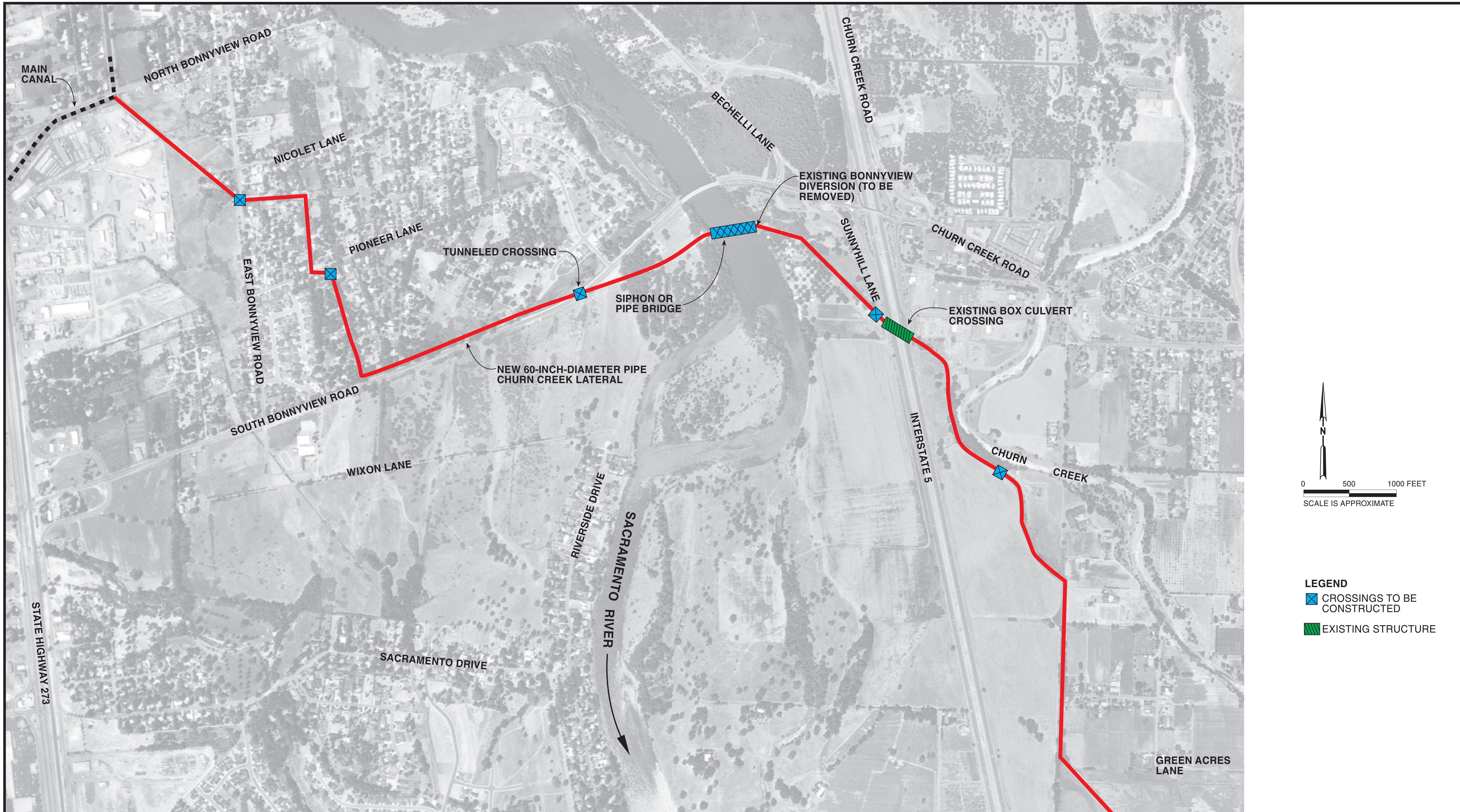
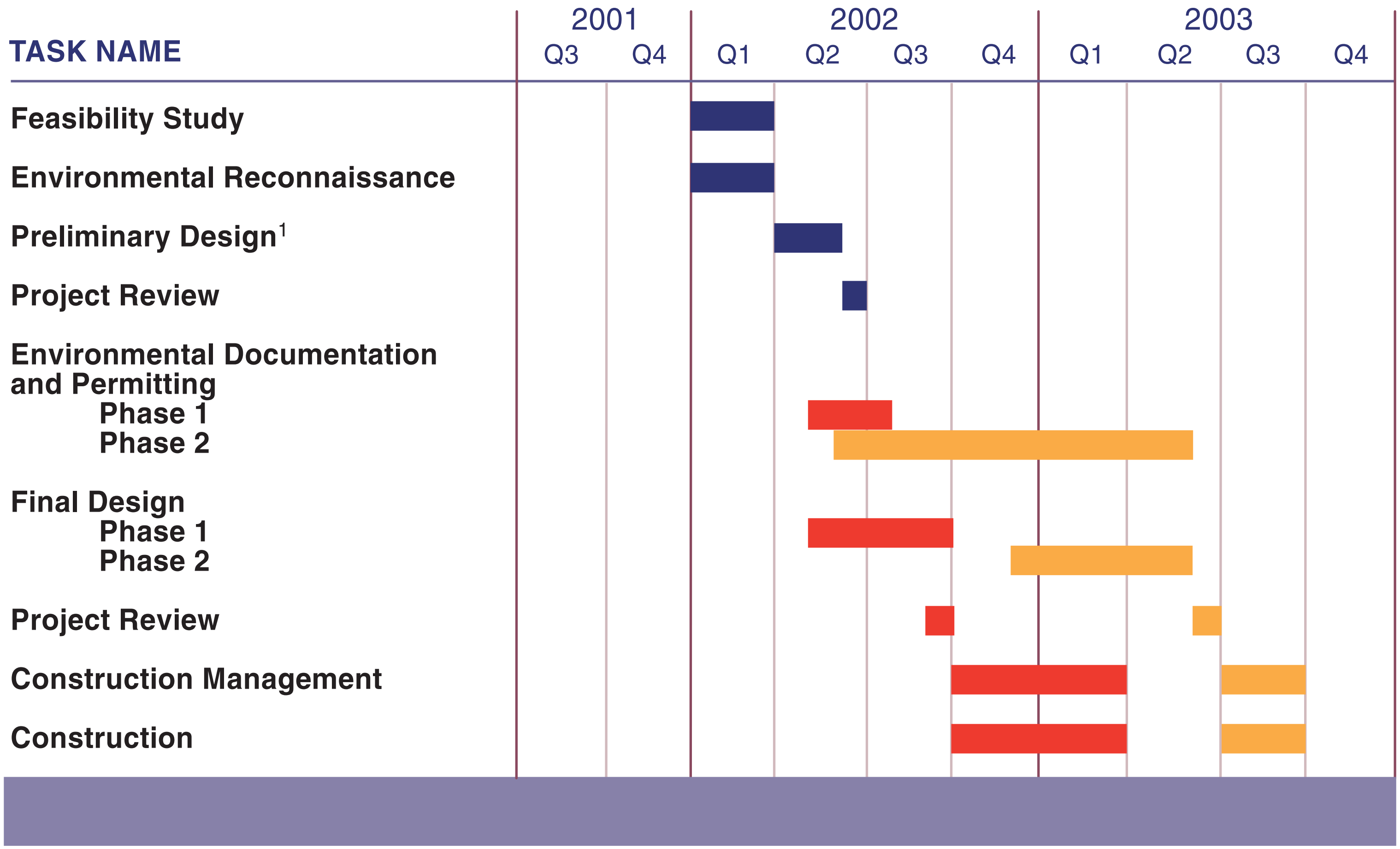


FIGURE 2A-1
PROJECT LOCATION MAP
ACID CHURN CREEK LATERAL IMPROVEMENTS
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI



[1]Cost associated with review is included in design cost.

LEGEND

- PHASES 1 AND 2
- PHASE 1 ONLY
- PHASE 2 ONLY

W072001014RDD_54 (10/25/01)

FIGURE 2A-2
PRELIMINARY IMPLEMENTATION SCHEDULE
ACID CHURN CREEK LATERAL IMPROVEMENTS
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

Project 2A—Draft CEQA Environmental Checklist

Project 2A—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________ ____________________
Signature Date

______________________________ ____________________
Printed Name For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	☒
III. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to a less than significant level.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project construction scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☒	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☒	☐	☐
See response to IV (a) above.				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace vegetation removed during construction, which would reduce the impact to a less than significant level.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☒	☐	☐
See response to IV (a) above.				
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
Increases in turbidity would be likely to occur during any in stream construction work. Additionally, there is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan and the implementation of BMPs to reduce any impacts to waterways in and around the project area.				
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

PROJECT 2B

Anderson-Cottonwood Irrigation District Conjunctive Use Program

1. Project Description

Project Type:	Conjunctive water management
Location:	Shasta and Tehama counties
Proponent:	Anderson-Cottonwood Irrigation District (ACID or District)
Project Beneficiaries:	GCID, in- and out-of-basin users, environment, Delta
<u>Total Project Components:</u>	Short-term components, installation of production wells
Potential Supply:	10,000 acre-feet per year (ac-ft/yr)
Cost:	$5.1 million
Current Funding:	$300,000 (CALFED grant)
<u>Short-term Components:</u>	Monitoring wells, model development, pilot well development
Potential Supply (by 2003):	5,000 ac-ft/yr
Cost:	$3 million
Current Funding:	$300,000 (CALFED grant)
Implementation Challenges:	Groundwater data analysis, water rights implications, environmental regulatory compliance
Key Agencies:	ACID, Shasta and Tehama counties, local landowners, U.S. Bureau of Reclamation (USBR), California Department of Water Resources (DWR), environmental interest groups, Sacramento-San Joaquin Delta

Summary

ACID is a Sacramento River Settlement Contractor. The district has natural flow rights of 165,000 ac-ft/yr from the Sacramento River and a contract of 10,000 ac-ft/yr from the Central Valley Project (CVP). ACID diverts water from the Sacramento River at its main diversion at Caldwell Park in Redding and from a small pump station below the South Bonnyview Bridge. The water is conveyed to agricultural water users through ACID's 35-mile-long Main Canal and its lateral canals. The Main Canal extends south from Redding into northern Tehama County. The ACID distribution system is shown on Figure 2B-1.

This project would provide new groundwater production wells adjacent to the ACID canal. The wells would be operated during dry years to reduce surface water diversions from the Sacramento River. The surplus surface water would be used to augment municipal and irrigation supplies in surrounding communities, and export to the Delta.

Phase 1 of the project includes the construction of monitoring wells at up to 12 locations along the ACID canal. These wells determine conjunctive use potential and associated potential impacts. Phase 2 would include construction of two or three production wells accompanied by additional monitoring and evaluation, followed by a full-scale program to produce a 10,000 ac-ft/yr supplemental supply. After Phase 2, the District would use monitoring wells to evaluate the potential to expand the scope of the program to a maximum of 40,000 ac-ft/yr for beneficial water uses elsewhere in the basin.

Short-term Component

The short-term component is broken into two phases, the first would perform a study of the conjunctive use area. The second phase would be to install pilot production wells to test the model created in Phase 1, and at the same time would provide water to users in the District.

Phase 1 – Groundwater Monitoring

Phase 1 includes developing the schedule and rates of groundwater pumping, location and depths of monitoring wells and recovery wells, and criteria for evaluating the project. The 12 proposed monitoring wells would be located along the existing ACID Main Canal and canal laterals. All of the wells would be located in Shasta County, between the cities of Anderson and Cottonwood, west of the Sacramento River. These wells would be constructed in strategic areas near existing large-diameter production wells to monitor pumping influences from these wells. The data from these monitoring wells would be used to refine the existing groundwater model of the basin. The groundwater model would be used in the next phase of the conjunctive use program.

Phase 2 – Pilot Production Wells

The aquifer that is proposed to be used for this conjunctive use project is very prolific. In the area proposed for the wellfield, the alluvial aquifer is at least 1,200 feet thick and exceeds 2,000 feet in some locations. The aquifer consists of interbedded alluvial deposits consisting principally of sand and gravel. Recharge of the aquifer would occur naturally by deep percolation precipitation, deep percolation of applied water, seepage from the ACID canal, and interception of flowing groundwater. Since the recharge occurs naturally, the availability and reliability of recharge is excellent.

The local groundwater and surface water quality is excellent. Both groundwater and surface water are currently used for irrigation of crops and pasture. Most of the applied water comes from diversions of the Sacramento River, which contains a total dissolved solid level of 200 milligrams per liter (mg/L).

Phase 2 would also include the installation of six pilot production wells. From current aquifer information, the wells are predicted to produce up to 5,000 ac-ft/yr when complete. The groundwater model would be tested with the new production wells, and the model would determine if the rest of the project is feasible.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

Once the groundwater modeling is finished and tested, the next step would be the completion of the production wells. The area is expected to have capacity for 13 production wells producing 1,000 gpm each. The wells are predicted to produce a total of 10,000 ac-ft/yr.

2. Potential Project Benefits/Beneficiaries

Local Benefits

The project would have a direct positive impact on the reliability and flexibility of the local water supply by supplementing CVP surface water supplies in surrounding communities. CVP supplies would be subjected to substantial cutbacks with increasing frequency following full implementation of the Central Valley Project Improvement Act (CVPIA).

Delta Water Quality

The project would provide environmental benefits primarily through reduced Sacramento River diversions and increased in-stream flows during critical dry years and the peak water demand season of mid-summer. Since the project would be located at the head of the Sacramento watershed below Shasta Dam, the full length of the river could potentially benefit from these reduced diversions. The reduced diversion would translate directly in a potential increase in the Delta supply. Surplus water would be stored in the aquifer during wet years, and exported to the Delta during dry years. Delta outflow demands are not directly influenced by this project. The increased flow of good-quality water would increase the water quality in the Delta.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Tables 2B-1 and 2B-2 are planning-level estimates of project costs.

TABLE 2B-1
Planning-level Project Costs: Short-term
Anderson-Cottonwood Irrigation District Conjunctive Use Program

Description	Quantity	Units	Unit Price ($)	Total Cost (x 1,000)	Assumptions
Monitoring Wells	12	Wells	50,000	$600	12 wells at 100 ft
Production Wells	6	Wells	200,000	$1,200	16 in casing, 500 ft depth
			Subtotal ->	**$1,800**	
Contingencies and Allowances (30%) ->				$540	
Total Construction Costs ->				$2,340	
Environmental Mitigation (5%) ->				$120	
Engineering, Environmental, Construction Management and Admin. (25%) ->				$585	
Short-term Project Cost ->				**$3,045**	

TABLE 2B-2
Planning-level Project Costs: Long-term
Anderson-Cottonwood Irrigation District Conjunctive Use Program

Description	Quantity	Units	Unit Price ($)	Total Cost (x 1,000)	Assumptions
Production Wells	6	Wells	200,000	$1,200	16 in casing, 500-ft depth
Contingencies and Allowances (30%) ->				$360	
Total Construction Costs ->				$1,560	
Environmental Mitigation (5%) ->				$80	
Engineering, Environmental, Construction Management and Admin. (25%) ->				$390	
Long-term Project Cost ->				**$2,030**	
Short-term Project Cost ->				$3,045	
Long-term Project Cost ->				$2,030	
Total Project Cost ->				**$5,075**	

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment, notably through the artificial manipulation of groundwater levels. In some areas of the state, these types of projects have resulted in public concern and controversy, which tends to heighten scrutiny of the environmental effects of such projects. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. Because of the controversial nature of the groundwater and Endangered Species Act (ESA) issues, it is likely that the appropriate level of environmental documentation necessary for this project would, at a minimum, be a Mitigated Negative Declaration.

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **State Lands Commission—**Project would need to consult with State Lands Commission on the public agency lease/encroachment permitting for use of state lands.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft California Environmental Quality Act (CEQA) environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

Key Stakeholders

Table 2B-3 lists the key stakeholders that are expected to be associated with or impacted by this conjunctive use project. Also, listed are the anticipated roles, concerns, and/or issues corresponding to each stakeholder.

TABLE 2B-3
Stakeholder Roles and Issues
Anderson-Cottonwood Irrigation District Conjunctive Use Program

Stakeholder	Role/Concerns/Issues
Anderson-Cottonwood Irrigation District	• Project components and direct beneficiary
Shasta County	• Significant interest in regional drainage and flooding
Tehama County	• Significant interest in regional drainage and flooding
	• Early stages of groundwater management and developing county objectives
Local landowners	• Impacts on groundwater levels both short and long term
USBR, DWR	• Water rights
Environmental interest groups	• In-stream flow impacts, fishery impacts, land use, and water quality impacts
Sacramento-San Joaquin Delta	• Possible increased inflows

The project implementation would occur in two stages, both of which would have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. The following lists some of the implementation challenges anticipated to be associated with this project.

Public Perception

Landowners have significant concern regarding possible groundwater overdraft. While the aquifer recharge aspects of this project may go a long way to alleviate these concerns, overdraft likely would remain a concern throughout the various stages of this project from feasibility analysis through construction and very likely continue thereafter. Monitoring and modeling of groundwater levels would not only be an essential part of this project technically, but also politically. Further, public concern accompanies any water delivery project during these water-tight times with regard to whom any project may or, just as importantly, may not benefit. As a result, many counties have passed ordinances and set numerous groundwater management objectives. To that end, the county has set strict guidelines for such water management programs as water transfers that dictate the priority of transfers taking into consideration primarily the intended recipient of the water.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities such as CDFG, RWQCB, and DWR. The governmental agencies would have strong interests associated directly with the project and indirectly as it may affect other interests in the area. It is highly probable that because of the complexity and far-reaching implications of the project that competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Projects

Numerous parties are examining similar projects throughout the valley. To optimize the effectiveness of these projects, coordination between the projects would be required from the onset. The strongest motivation for such an effort is three-fold: (1) to avoid duplication of effort and as a result efficiently utilize available funds, (2) to avoid the nullification of project benefits through competing projects, and perhaps most importantly, (3) to optimize the benefits of these projects to the watershed.

Lack of Sufficient Groundwater Data

In many areas, there is limited groundwater information available, or the information that is available is unreliable. The sudden increase in short-term pumping during peak months may have an impact on the stability of the groundwater level. Implementation of Phase 1 would help refine the existing groundwater model of the basin.

Groundwater Data Analysis

It would be necessary to establish working parameters for any groundwater use program. Monitoring and possibly modeling would be key components to determining a safe yield quantity for a successful and publicly acceptable program.

Water Rights Implications

ACID participation would be predicated on the operation of such a program and would occur within the guise of the District's existing water rights. Decreases in surface water diversions would be anticipated in some years, while full contract quantities would be used in other years.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Habitat for known ESA-listed species such as the valley elderberry longhorn beetle and the giant garter snake is present within the project area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Land Acquisition

It is probable that land would have to be acquired for the monitoring wells and production wells. Some landowners may be resistant to the land purchases.

6. Implementation Plan

Extensive engineering and environmental investigations are necessary to further evaluate this project. The following major steps would be required to implement the project. Each step depends on successful completion of the previous supporting steps and findings that support further actions. Figure 2B-2 shows an assumed implementation schedule based on typical time requirements for each step in a project of this scale.

Task 1.1 Groundwater modeling—The existing groundwater model is calibrated, and accurately replicates current and past groundwater levels in the basin. However, with the significant increases in short-term pumping, some uncertainty surrounding the model exists. To address the uncertainty of the model, the following key parameters would be evaluated:

- Increased canal seepage
- Increased capture of deep percolation
- Mitigation of high groundwater levels
- Impacts of surface streams
- Drawdown in groundwater levels and the effects on nearby wells
- Effects of riparian habitat
- Cost of pumped groundwater

The key result of this task would be to identify those properties of the hydrologic system that cause the greatest effect on project results.

Task 1.2 Monitoring and data collection—The data collection and monitoring would emphasize the use of existing wells and facilities to reduce costs. The data collection and monitoring would focused on reducing the uncertainty identified above. The effects of pumping would be evaluated by monitoring from several large municipal and industrial wells (City of Anderson, Shasta Paper Mill, Wheelabrator Energy, and the Cottonwood Water District).

The elements of this phase (monitoring and data collection) include:

- Location, design, and construction details for the new monitoring wells
- Identification of existing wells that could be used to supplement the monitoring program
- Identification of existing municipal, industrial, and agricultural production wells that significantly affect groundwater levels in the area
- Planned monitoring techniques and frequency for the monitoring and production wells
- Installation of flow monitoring devices on existing production wells
- Installation of monitoring devices to record fluctuation in groundwater levels in new and existing wells during maximum demand for a period of up to 8 months

Monitoring would continue through the summer months and into the fall to document the rebound of water levels after summer pumping.

Task 1.3 Model re-calibration—Using the above data, the provided three dimensional model would be re-calibrated to simulate the effects of short-term pumping. The model would replicate the response of the aquifer to the stresses imposed by municipal, industrial, and agricultural wells. This refinement would improve the model's ability to forecast future groundwater levels.

Task 2.1 Environmental assessment/environmental impact report (EA/EIR)—Phase 2 of the implementation plan would complete the required NEPA/CEQA investigation and documentation. Specific permitting requirements would be addressed.

Task 2.2 Installation of conjunctive use wells—Up to six large-diameter production wells would be installed and tested within the first 2 years of the project. The wells would be sited to utilize existing infrastructure as available(e.g., near existing monitoring wells and lateral extensions of the ACID Main Canal). Once the wells were installed they would be tested for up to 3 months, and the effects of pumping would be measured and compared against predicted responses from the groundwater model. Using the accumulated data, the model would be further refined to replicate the effects of pumping. The final report would include the final design for complete production wellfield construction and operation of the conjunctive use wellfield.

Task 2.3 Expansion of program—This task would include an incremental expansion of the pilot program to the full 10,000 ac-ft/yr conjunctive use program over a period of 4 to 5 years. It is expected that two to three new wells would be installed each year. The groundwater model would continually be refined throughout this period. The new wells would be located adjacent to existing ACID canals and laterals. Figure 2B-1 shows the potential layout of the wells.

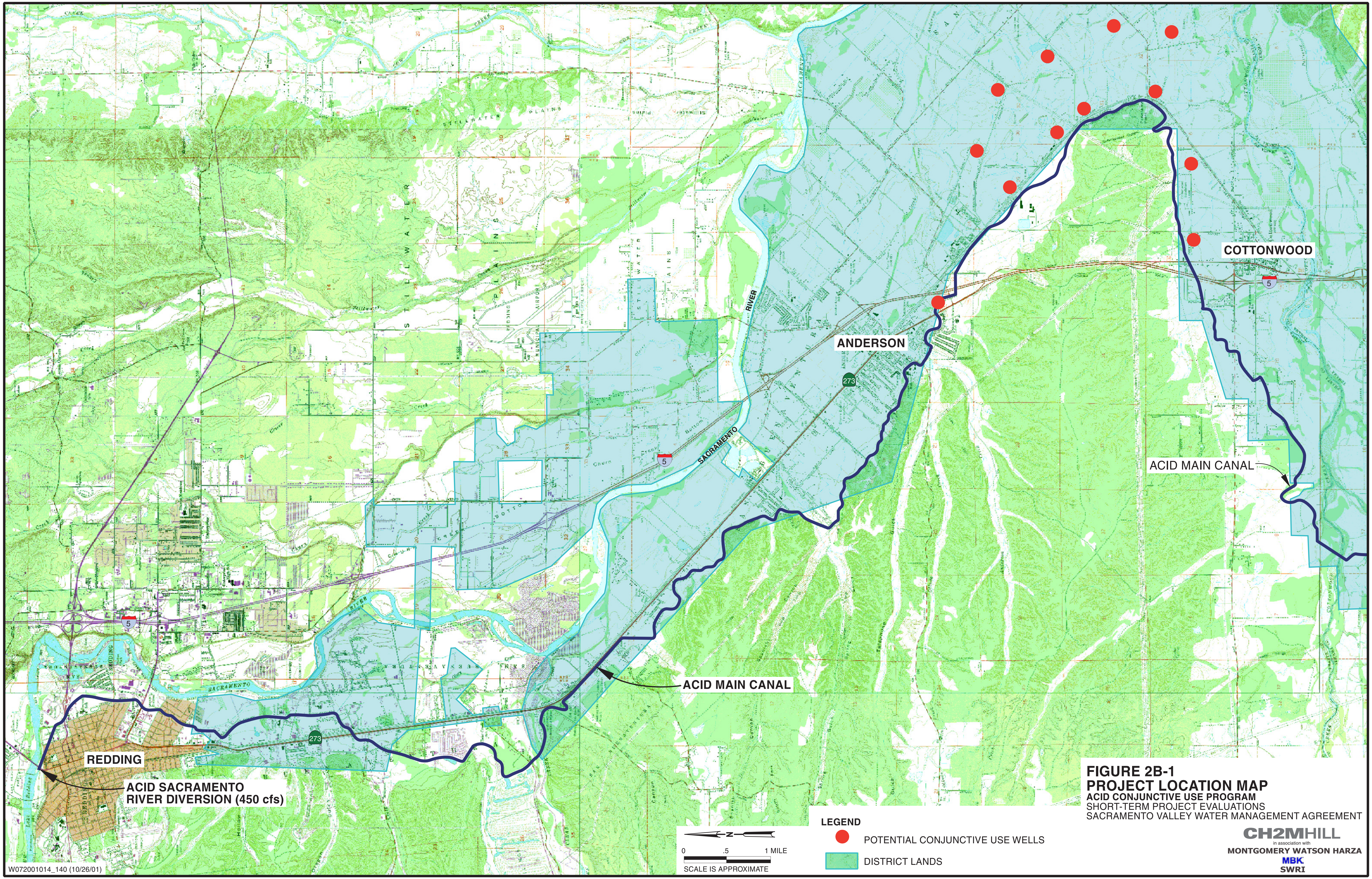
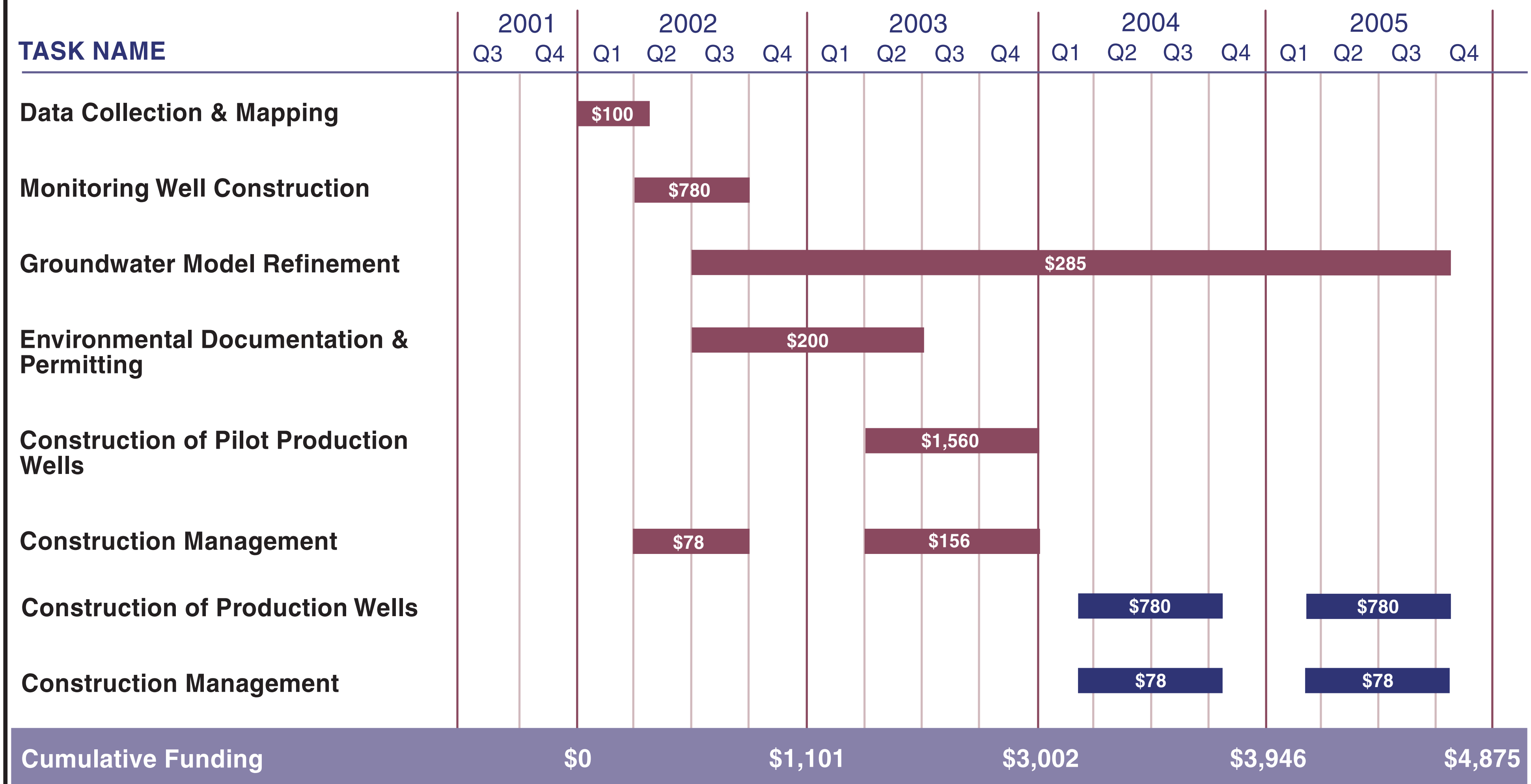


FIGURE 2B-1
PROJECT LOCATION MAP
ACID CONJUNCTIVE USE PROGRAM
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT



LEGEND

SHORT-TERM

LONG-TERM

FIGURE 2B-2
PRELIMINARY IMPLEMENTATION SCHEDULE
ACID CONJUNCTIVE USE PROGRAM
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_42(10/26/01)

Project 2B—Draft CEQA Environmental Checklist

Project 2B—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature	Date
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☒	☐
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☒	☐
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to less than significant level.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☐	☒	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☐	☐	☒
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☒	☐
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☐	☒	☐
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☒	☐	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIll. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
There is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan and the implementation of BMPs to reduce any impacts to waterways in and around the project area.				
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☒	☐	☐	☐
There are serious concerns about the long-term draw-down of the groundwater table and land subsidence, particularly in dry years. Model development would help in determining the effects of increased groundwater pumping. The impact that groundwater withdrawal would have on existing groundwater supplies is as yet undetermined; however, it is potentially significant because of the complexity of the issue.				
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☒	☐
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☒	☐
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

PROJECT 2C

Anderson-Cottonwood Irrigation District Main Canal Modernization Project

1. Project Description

Project Type:	System improvement
Location:	Shasta County
Proponent(s):	Anderson-Cottonwood Irrigation District (ACID or District)
Project Beneficiaries:	ACID, downstream users, environment, Sacramento-San Joaquin Delta
Total Project Components:	Short-term component, lining of approximately 2 miles of the Main Canal in high seepage areas
Potential Supply:	20,000 acre-feet per year (ac-ft/yr)
Cost:	$4 million
Current Funding:	$100,000
Short-term Components:	Flow measurement, control facilities, telemetry (supervisory control and data acquisition [SCADA])
Potential Supply (by 2003):	10,000 ac-ft/yr
Cost:	$2.7 million
Current Funding:	$100,000 through California Department of Water Resources Water (DWR) Use Efficiency Program grant, earmarked for feasibility studies
Implementation Challenges:	Access through adjacent properties to ACID right-of-way for construction, line of site SCADA facilities, environmental impacts of construction, 5-month construction window coinciding with the rainy season
Key Agencies:	DWR, National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), U.S. Bureau of Reclamation (USBR), City of Redding, City of Anderson, Shasta County, and environmental interest groups

Summary

The purpose of this evaluation is to technically evaluate a project that would improve ACID's conveyance system to increase water use efficiency. The District proposes to construct 13 new flow control and measurement structures with telemetry throughout the ACID conveyance system in an effort to continuously control and monitor system flows. Also, the project would initiate the lining of critical canal sections with high seepage, thereby improving water management within the District and conceivably throughout the sub-basin.

The District diverts water from the Sacramento River in Redding, California. The primary water source is a gravity diversion from the river at the seasonal ACID diversion dam in Redding. The District also operates a pump station on the river several miles downstream to supply a lateral canal. ACID's distribution system includes approximately 35 miles of Main Canal, about 98 percent of which is unlined. The Main Canal flows through six inverted siphons to provide crossings of streams such as Clear Creek, and also three flume sections across smaller streams and lowland areas. Several wasteways are located along the canal route, which return water to the Sacramento River and local streams when flow exceeds the capacity of the canal. Figure 2C-1 depicts the Main Canal system and locations of the proposed facilities associated with this project.

The ACID Main Canal Modernization Project is a two-phase project intended to facilitate improved water management. The District is unmetered and has flow measurement capabilities at only one location on the Main Canal. Water management has historically been limited to management of the headgate near the river and manual control structures downstream, with surpluses spilling at the various wasteways. Also, the canal seepage is significant in certain sections near natural creek and drainage channels where soils are fast draining and the canal contributes directly to the underlying groundwater basin.

Short-term Component

The entire project is expected to be completed and fully in service within 3 years of project approval. The project has been split into two phases because of what are perceived to be different environmental compliance requirements for different elements of the work. The first phase of the project would be to install flow measurement devices, water control facilities, and telemetry along the Main Canal. It is assumed that environmental compliance requirements would be minimal because the work would occur within the footprint of the canal or its laterals and have little or no direct short- or long-term environmental impacts. However, if it is determined during early environmental evaluations of this or other Sacramento Valley Water Management Agreement projects that reduction in spills to adjacent drainages as a result of improved water management is a significant environmental consequence, the timeframe for project implementation may be extended.

Phase 1 reconnaissance, feasibility studies, and preliminary design are anticipated to require 5 months. Design, permitting, and environmental documentation are anticipated to require an additional 5 months, holding to the assumption of limited environmental compliance requirements. The benefits of the project would be realized during the 2003 irrigation season when construction is completed. Implementation of this phase would entail the necessary site selection, design, construction, construction management, and post-construction monitoring associated with the following facilities:

- **13 water control structures—**Facilities located along the ACID Main Canal, combining new construction and retrofit of existing structures, are as follows:
  - Replacement of motor for existing radial gate headworks structure.
  - Construction of three new concrete control structures with motor-operated slide gates or radial gates. General locations and design flows that have been identified for the three new control structures are as follows:

    North of Anderson near Clear Creek, 300 cubic feet per second (cfs)
    South of Anderson near Anderson High School, 250 cfs
    North of Cottonwood, near Gas Point Road and Interstate 5, 100 cfs
  - Replacement of nine turnouts on the Main Canal with new concrete structures and motor-operated slide gates.
- **13 measurement flumes—**Structures at each of the 13 new/retrofit structures listed above.
- **13 SCADA facilities—**Automation through the installation of SCADA facilities integrated with the 13 water measurement and control structures.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The second phase of the project would complete the lining of critical sections of the Main Canal. It is assumed that environmental documentation requirements would be more significant because of the potential effects on surface water and groundwater adjacent to the canal. The canal lining component would be completed in the second construction window available to the district, between the 2003 and 2004 irrigation seasons. Phase 2 reconnaissance , feasibility studies, and preliminary design are anticipated to be concurrent with the Phase 1 studies. Design, permitting, and environmental documentation are anticipated to require an additional year. The benefits of the project would be realized during the 2004 irrigation season when construction is completed. Implementation of this phase would entail the necessary site selection, design, construction, construction management, and post-construction monitoring associated with the following facilities:

- **2 miles of canal lining—**Concrete lining in the high seepage, sandy areas of the canal, presumably about 2 miles long. It is expected that approximately 1 mile of lining would be constructed just upstream of Clear Creek, with the other 1-mile section adjacent to Spring Gulch.

2. Potential Project Benefits/Beneficiaries

The proposed construction of new facilities is expected to generate numerous benefits for both local and regional water users. The benefactors of this program include ACID, downstream users, the environment, and the Sacramento-San Joaquin Delta. The following benefits are discussed in this section:

- Water Supply Benefits
- Water Management Benefits
- Environmental and Water Quality Benefits

Water Supply Benefits

The proposed project would provide the capability to more flexibly and efficiently manage the amount and timing of diversions from the Sacramento River. It would reduce diversions, thereby increasing instream flows, and also would reduce spill, evapotranspiration (ET), and seepage losses. Water supply benefits would include:

- **Water control, automation, and measurement—**The new/retrofitted canal structures would automatically adjust to changing canal water levels, as influenced by fluctuations in Sacramento River flows and downstream irrigation needs. The resulting reduction in operational spills would reduce both diversion from the river and ET losses in the drainage courses receiving the spills. The flow measurement component would enhance the District's capability to track river diversions, quantify losses and conservation benefits, and schedule and synchronize diversions with grower needs. It is estimated that through improved control, automation, and measurement, annual diversions from the Sacramento River may be reduced by as much as 7.5 percent, or 10,000 ac-ft, as a result of reducing operational spills through this project.

  It is recognized that a portion of ACID's historical spills return to the river through natural or constructed watercourses, a portion that, therefore, may not add "new" flow to the river. However, the associated delay and water quality degradation are undesirable and further warrant control of the spills. The significant portion that does not return to the river is lost to the system through evaporation and transpiration en route to the river. Thus, the reduction in operational spills through improved control and automation would decrease non-productive ET and increase river flows by a corresponding amount.

  ACID is the largest purveyor among the 14 members of the Redding Area Water Council (RAWC), which is working on a regional plan to solidify the Redding Basin's water resources through the year 2030. Improved control and measurement capabilities would enhance the District's contribution to this initiative.

- **Canal lining—**The canal lining component would drastically reduce seepage in critical areas. Concrete lining in the high seepage, sandy areas of the canal, presumably about 2 miles long, may reduce seepage by about 10,000 ac-ft/yr. This reduction estimate is based on canal dimensions and a seepage loss rate of 17 inches per day for a 180-day irrigation season. The loss rate of 17 inches per day reflects the seepage difference between an unlined canal in sandy soil (20 inches per day) and a concrete-lined canal (3 inches per day). The resulting seepage estimate for the project, therefore, represents an "avoided loss" by upgrading to concrete lining.

Seepage along ACID's Main Canal contributes in part to groundwater. Because the canal is elevated above surrounding terrain over the majority of its length, a significant portion of the seepage also resides at or near the ground surface outside the canal. This portion ultimately evaporates or is transpired by nearby grass and vegetation. The canal lining element of the project also would benefit adjacent landowners in certain areas along the canal that are adversely affected by canal seepage.

Water Management Benefits

Water management benefits include:

- **System efficiency—**The predominant goal of the project is increased system efficiency. The automation of ACID's Main Canal would substantially improve the District's ability to more efficiently utilize their supply. The automated check structures would enable District staff to micromanage water delivery and prevent the majority of the inevitable operational spills that are often associated with manual structures. The District and its patrons would benefit by virtue of new, automated facilities and canal lining providing improved control, flexibility, and reliability along with less maintenance.
- **System flow measurement**—The new structures could be incorporated with ongoing efforts by the District to more accurately define system inflows and outflows. Measurement and tracking of flows add a necessary dimension to the management of water supply by allowing the owner to more accurately define its water use.

Environmental and Water Quality Benefits

As ACID's primary source of supply, the Sacramento River would be directly and most beneficially influenced by the District's efficient use of its water supply. The potential 20,000-ac-ft/yr decrease in surface water diversions has the potential for increasing available seasonal in-stream flows to the Sacramento-San Joaquin Delta. This additional water would contribute to addressing Delta water quality concerns that have been at the core of CALFED and other programs' efforts for the past several years. These and other potential environmental benefits associated with this project would be quantified throughout the various stages of the project, from feasibility study through final design.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Table 2C-1 presents a planning-level estimate of project costs.

TABLE 2C-1
Planning-level Project Costs: Phase 1
Anderson-Cottonwood Irrigation District Main Canal Modernization Project

Item	Quantity	Units	Unit Price ($)	Total Cost (x 1,000)	Descriptions
Radial Gate	1	Motor	$30,000	$30	Motor replacement
Concrete Control Structures	3	Gate	$200,000	$600	Three radial gates
Canal Turnouts	9	Turnout	$25,000	$225	Nine turnouts
SCADA	1	System	$268,000	$268	
Measurement Devices	9	Flume	$20,000	$180	Repogle flumes installed on the laterals, 60 cfs ea.
	5	Flowmeter	$1,000	$5	Flowmeters for the drain pumps
	4	Flume	$64,500	$258	Repogle flumes installed on the Main Canal at the mid-points, 200 cfs, 300 cfs
			Subtotal ->	**$1,566**	
			Contingencies and Allowances (30%) ->	$470	
			Total Construction Costs ->	$2,040	
				$100	
			Environmental Mitigation (5%) ->		
			Engineering, Environmental, Construction Management and Admin. (25%) ->	$510	
			Total Project Cost ->	**$2,650**	

TABLE 2C-2
Planning-level Project Costs: Phase 2
Anderson-Cottonwood Irrigation District Main Canal Modernization Project

Item	Quantity	Units	Unit Price ($)	Total Cost (x 1,000)	Descriptions
Canal Lining	40,667	Square yards	$20	$800	40,667 square yards
			Subtotal ->	**$800**	
			Contingencies and Allowances (30%) ->	$240	
			Total Construction Costs ->	$1,040	
			Environmental Mitigation (5%) ->	$50	
			Engineering, Environmental, Construction Management and Admin. (25%) ->	$260	
			Total Project Cost ->	**$1,350**	

Project costs would be borne by the primary project beneficiaries, including Delta water quality interests, ACID, and, to a lesser extent, agricultural interests in the Redding area.

Typical annual operations and maintenance (O&M) costs for a project of this nature would range from about 5 percent of initial capital costs. Annual O&M costs would include power for the gates at the control structures, power for the SCADA facilities, inspection and maintenance of the structures and the canal lining, and data collection and reporting related to the measurement facilities. Annual operations and maintenance costs would approach $25,000 per year, plus an estimated $100,000 expense after 15 years to upgrade or recondition structures and canal lining.

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible and efficient water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment. Key issues that are anticipated relate primarily to the proposed canal lining, and could include secondary groundwater recharge impacts and elimination of habitat adjacent to and within the canal prism. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. Depending upon the controversial nature of the groundwater and Endangered Species Act (ESA) issues, it is likely that the appropriate level of environmental documentation necessary for this project would, at a minimum, be a Mitigated Negative Declaration.

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Large amounts of earthwork would be required for the construction activities. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction. In addition, National Pollutant Discharge Elimination System (NPDES) stormwater-related approvals may be required.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)—**The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.

- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

The project implementation would occur in several incremental stages, each of which would have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. The following lists some of the implementation challenges anticipated to be associated with this project.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Habitat for known ESA-listed species such as the valley elderberry longhorn beetle and the giant garter snake is present within the project area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Access to Project Site

It is probable that access through adjacent properties to the ACID right-of-way would be required for construction. Private property owners may be reluctant to allow such access, and this could potentially cause difficulties to construction activities.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities such as USFWS, USBR, and DWR. The governmental agencies would have strong interests associated directly with the project and indirectly as it may affect other interests in the area. It is highly probable that because of the complexity and far-reaching implications of the project competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Projects

Numerous parties are examining similar projects throughout the valley. To optimize the effectiveness of these projects, coordination between the endeavors would be required from the onset. The strongest motivation for such an effort is three-fold: (1) to avoid duplication of effort and as a result efficiently utilize available funds, (2) to avoid the nullification of project benefits through competing projects, and perhaps most importantly, (3) to optimize the benefits of these projects to the watershed.

6. Implementation Plan

Extensive engineering and environmental investigations are necessary to further evaluate this project. The implementation plan is shown on Figure 2C-2.

Tasks Common to Phases 1 and 2

1.1 Data collection and mapping—Initial effort would focus on collecting and reviewing existing information to assist in pinpointing locations to install gate structures, measurement flumes, and SCADA equipment. Preliminary geotechnical data would also be gathered to confirm the locations and extent of seepage problems. Data collection and mapping is estimated to require 5 months to complete.

1.2 Environmental reconnaissance—This task would provide for biological field surveys, resource database review, and other reconnaissance necessary to determine permitting requirements and the appropriate level of environmental documentation required for implementation of each phase of the project. This task would also support site selection in the preliminary design task by identifying any sensitive areas or issues of environmental concern. The environmental reconnaissance is estimated to require 3 months to complete.

Tasks Specific to Phase 1 Only

2.1 Preliminary design—This task would make use of the information collected earlier to establish sites for improvements and types of facilities to be used. Sufficient design would be completed to determine budget estimates of construction cost and to establish the preferred alternative for subsequent NEPA/CEQA compliance. Preliminary design is estimated to require 4 months to complete.

2.3 Permitting and environmental documentation—This task is expected to consist of an extension of environmental reconnaissance, resulting in verification that Phase 1 has no significant affect on the environment. This would be determined through completion of environmental checklists per NEPA and CEQA. Phase 1 permitting and environmental documentation is estimated to require 3 to 5 months to complete.

2.2 Final design—Facilities would be evaluated and designed according to site-specific hydraulic and site conditions, and sized appropriately for existing in-channel flows. The new control structures are expected to be standard concrete canal checks with radial gates or motor-operated slide gates (MOSG) mounted on breastwalls. The turnouts are expected to require new concrete headwalls with MOSG. It is expected that Replogle flumes would be used for measurement. Construction plans and specifications would be developed to facilitate bidding for one or multiple construction contracts. The final design is estimated to require 4 months to complete.

3.1 Construction—This task would include the construction/installation of all control and measurement facilities, and SCADA systems. This task also includes the effort and cost of securing easements, if necessary, to allow for construction. It is expected that most of the construction activity would need to occur between November and March, when ACID is not delivering irrigation water. Construction is estimated to require 5 months to complete.

3.2 Construction management and inspection—This task would provide for the services of an engineering consultant to administer the construction contract and inspect the work for compliance with the contract documents. Services would include processing the contractor's pay requests, reviewing construction submittals, materials testing, and startup procedures. For scheduling purposes, construction management and inspection would occur concurrent with construction.

Tasks Specific to Phase 2 Only

2.1 Preliminary design—This task would make use of the information collected earlier to establish sites for improvements. Sufficient design would be completed to determine budget estimates of construction cost and to establish the preferred alternative for subsequent NEPA/CEQA compliance. Meetings would be held with any affected landowners to ensure cooperation and coordination prior to proceeding further at each location. Preliminary design is estimated to require 5 months to complete.

2.2 Permitting and environmental documentation—This task would likely require preparation of an Environmental Assessment/Initial Study (EA/IS) in accordance with NEPA and CEQA, respectively. Key issues that are anticipated were described in Section 4. Permitting and environmental documentation is estimated to require 12 months to complete.

2.3 Final design—Lining is expected to be reinforced shotcrete, but other methods/products, such as clay, may be evaluated for cost and performance. Construction plans and specifications would be developed to facilitate bidding for one or multiple construction contracts, depending on the actual number and length of separate reaches of lining. The final design is estimated to require 5 months to complete.

3.1 Construction. This task would include the construction/installation of the canal lining. This task would also include the effort and cost of securing easements, if necessary, to allow for construction. It is expected that most of the construction activity would need to occur between November and March, when ACID is not delivering irrigation water. Construction is estimated to require 5 months to complete.

3.2 Construction management and inspection—This task would provide for the services of an engineering consultant to administer the construction contract and inspect the work for compliance with the contract documents. Services would include processing the contractor's pay requests, reviewing construction submittals, materials testing, and startup procedures. For scheduling purposes, construction management and inspection would occur concurrent with construction.

Other Tasks Common to Phases 1 and 2

4.1 Operation and maintenance (O&M)—O&M of all new facilities and equipment is proposed to be accomplished by the District. O&M is considered in this proposal to be an in-kind, cost-sharing service in perpetuity.

5.1 Contract management and administration—This task would incorporate management of project costs and schedule, administering grant funds, developing work plans, coordinating with other entities and agencies, and overseeing activities of the project team. Contract management and administration is estimated to require 2.25 years to complete from the start of the project to final completion of construction.

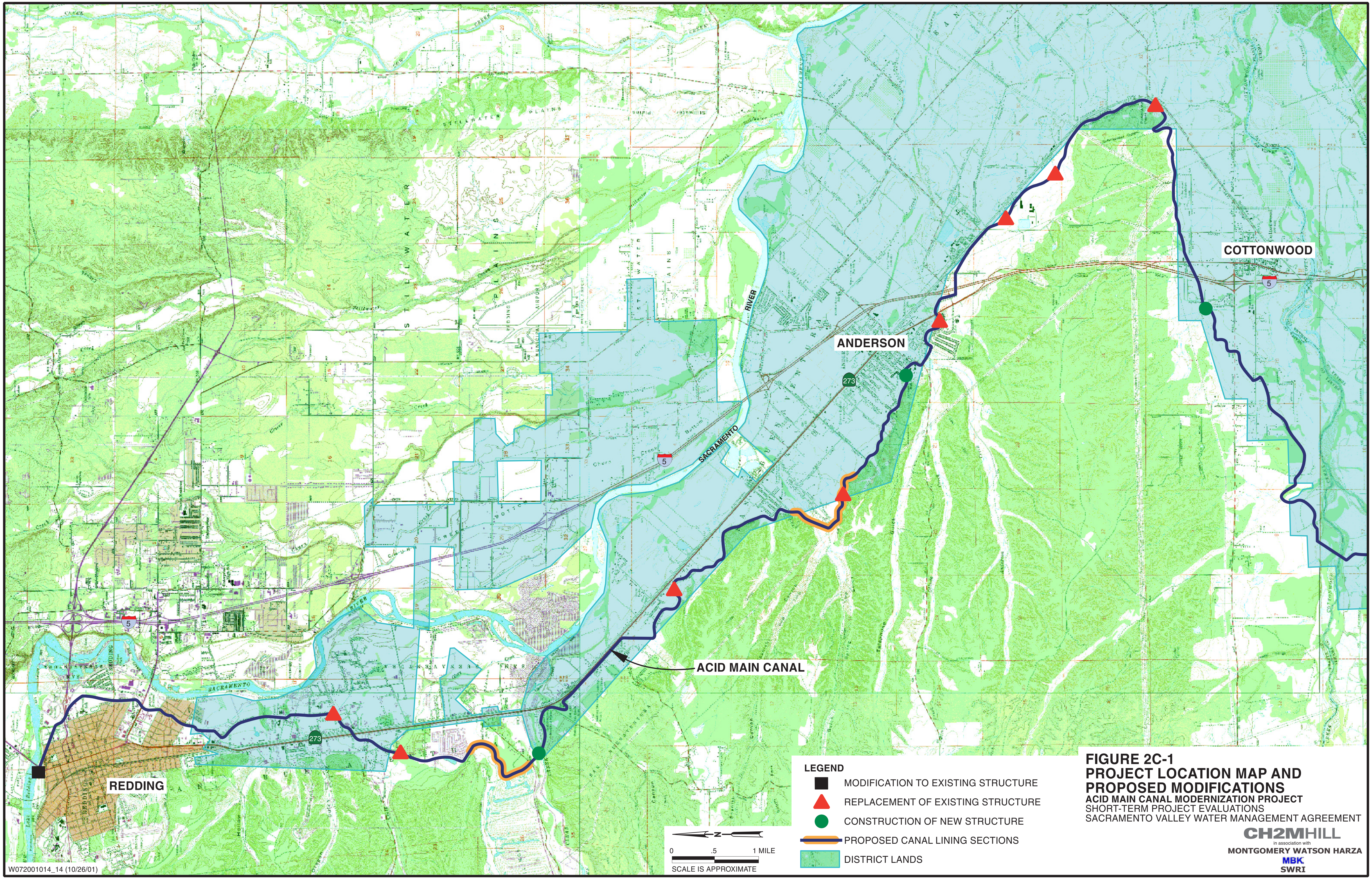


FIGURE 2C-1
PROJECT LOCATION MAP AND PROPOSED MODIFICATIONS
ACID MAIN CANAL MODERNIZATION PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

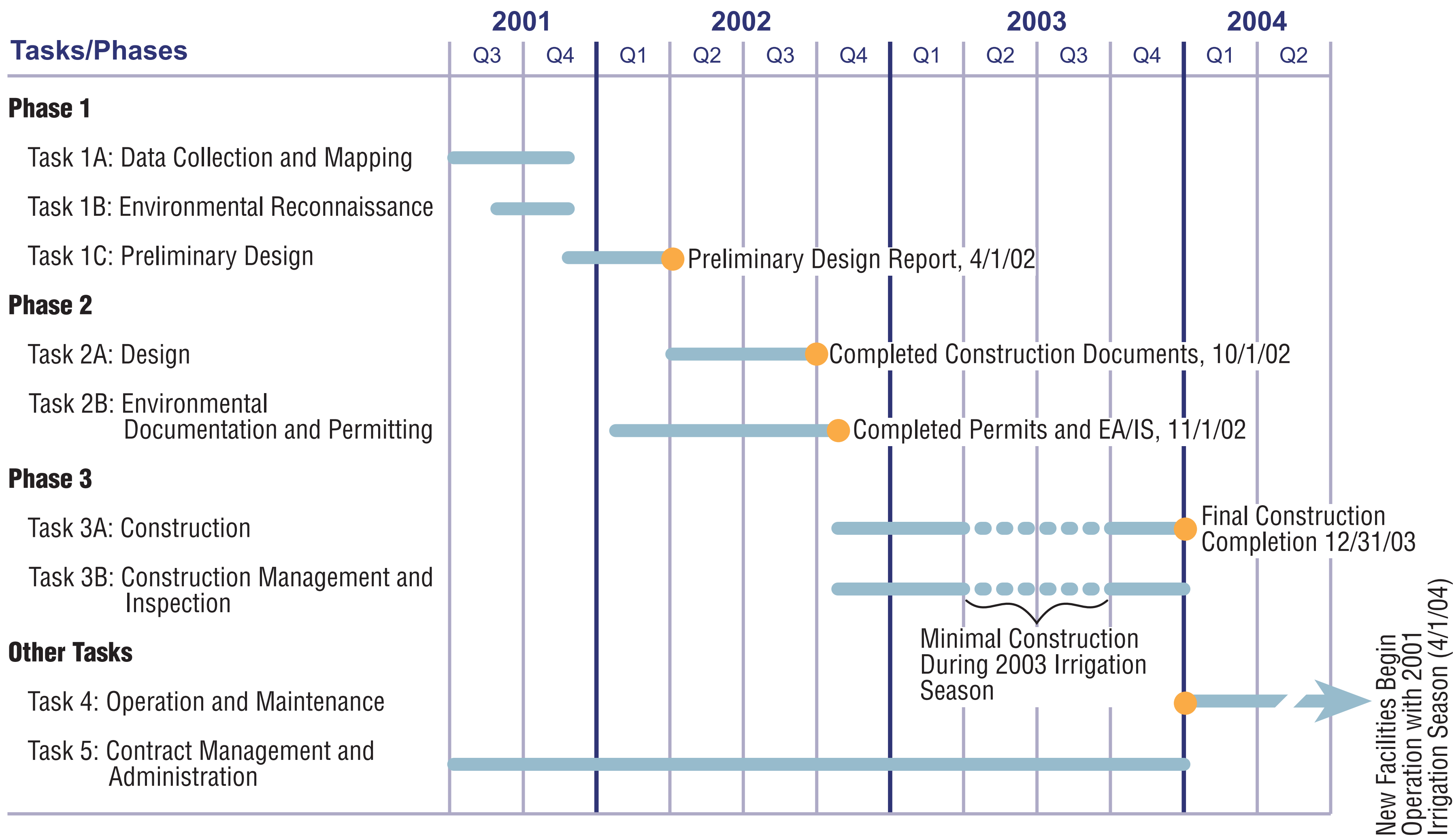


FIGURE 2C-2
PRELIMINARY IMPLEMENTATION SCHEDULE
ACID MAIN CANAL MODERNIZATION PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014_74 (10/26/01)

Project 2C—Draft CEQA Environmental Checklist

Project 2C—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________	______________________________
Signature	Date
______________________________	______________________________
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMP) during construction would reduce the amount of emissions and reduce the impact to a less than significant level.				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
See response to III (a) above.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☒	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☒	☐	☐
See response to IV (a) above.				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace any vegetation removed during construction, which would reduce the impact to a less than significant level.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☒	☐	☐
See response to IV (e) above.				
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☒	☐	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements? Increases in turbidity would be likely to occur during any in-stream construction work. Additionally, there is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan and the implementation of BMPs to reduce any impacts to waterways in and around the project area.	☐	☒	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☒	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>XI. NOISE</u>—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
<u>XII. POPULATION AND HOUSING</u>—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
<u>XIII. PUBLIC SERVICES—Would the project:</u>				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
<u>XIV. RECREATION—Would the project:</u>				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
<u>XV. TRANSPORTATION/TRAFFIC</u>—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
<u>XVI. UTILITIES AND SERVICE SYSTEMS</u>—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

Colusa Sub-basin

PROJECT 5A

Glenn-Colusa Irrigation District Regulatory Reservoirs and Off-canal Storage Feasibility Study

1. Project Description

Project Type:	Groundwater/surface water planning
Location:	Glenn and Colusa counties
Proponent(s):	Glenn-Colusa Irrigation District (GCID or District)
Project Beneficiaries:	GCID, in- and out-of-basin users, environment, Delta
Total Project Components:	Feasibility study as a short-term component that could potentially lead to a large-scale project with off-canal storage basin and regulatory reservoir
Potential Supply:	Depends on outcome of feasibility study, but potentially could lead to project with water supply benefits of 5,000 to 35,000 acre-feet per year (ac-ft/yr)
Cost:	$750,000 for the feasibility study
Current Funding:	$100,000 Water Use Efficiency grant
Short-term Components:	Feasibility study to investigate the feasibility of off-canal storage and/or regulatory reservoir
Potential Supply (by 2003):	None
Cost:	$750,000
Current Funding:	$100,000 Water Use Efficiency grant
Implementation Challenges:	No significant implementation challenges at the feasibility study level
Key Agencies:	GCID; Glenn, Colusa, and Tehama counties; local landowners; U.S. Bureau of Reclamation (USBR); California Department of Water Resources (DWR); environmental interest groups, U.S. Fish and Wildlife Service (USFWS); California Department of Fish and Game (CDFG); Sacramento-San Joaquin Delta

Summary

The purpose of this memorandum is to present a project that proposes to address the feasibility of adding off-canal storage and regulating reservoirs to GCID's conveyance system to increase water use efficiency through reduction of operational spills, take advantage of storm peaks, and utilize excess winter flows.

GCID is located in the central portion of the Sacramento Valley on the west side of the Sacramento River, as illustrated on Figure 5A-1. The District's service area extends from northeastern Glenn County near Hamilton City to south of Williams in Colusa County. The east side of the District stretches toward the Coast Range and Tehama-Colusa Canal Authority (TCCA). Its main facilities include a 3,000-cubic foot per second (cfs) pumping plant and fish screen structure, a 65-mile Main Canal, and approximately 900 miles of laterals and drains.

With 175,000 acres, GCID is the largest irrigation district not only in the Colusa Sub-basin, but also in the Sacramento Valley itself. The soils within this area generally consist of clay-like characteristics and are considered some of the most prime soils for agriculture in the world. The low infiltration rates of the tight soils are conducive to furrow and border irrigation. To that end, rice is the District's predominant crop. Typical years include more than 75 percent of its irrigated acreage in rice. Other crops include but are not limited to vine crops (e.g., melons), tomatoes, sunflowers, prunes, almonds, and walnuts.

The Sacramento River serves as the principal water source for the District. Its diversion, the largest surface water diversion on the river, lies at the head of the District, just north of Hamilton City. The District has the ability to supplement its supply with groundwater from local production wells through a voluntary conjunctive use program. The extensive canal system conveys water year-round as part of its commitment to its stakeholders and neighboring wildlife refuges.

GCID Water Management

Recently, GCID's ability to divert their full entitlement was reduced because of the endangered species limitations associated with the District's previous fish screen operation. In addition, several years were classified as "critical years," and contract supplies were reduced to 75 percent of entitlements. The District managed several programs to supplement these reduced supplies, including the conjunctive use program mentioned above. Other programs included a water conservation program, which at one time required water use patrols around the District, and a water reuse program.

An aggressive drainwater recapture program, which includes both groundwater seepage and tailwater runoff from cultivated fields from within GCID's service area, is a part of the District's overall water management program. GCID recaptures this water with both gravity and pump systems. Recaptured water is delivered to either laterals or the Main Canal for reuse. Currently, GCID recycles approximately 155,000 ac-ft annually.

GCID has used its water management programs to significantly reduce its surface water diversions and irrigation demands. Within the last decade, GCID diversions have been reduced by an estimated 25 percent, due in large part to conservation practices and such factors as precision farming techniques. Furthermore, the District is continuously striving to increase the efficiency of its system through automation and water reuse.

The current state of the GCID conveyance system can result in unintentional, yet often unavoidable, tailender problems such as spills. GCID Main Canal spills, combined with Colusa Basin Drain flows, can range from 100 cfs to 2,000 cfs weekly. The District has been improving its system in recent years to more efficiently utilize the water supply and prevent unnecessary outflows such as spills. Managing and controlling flow fluctuation could yield flow benefits of hundreds of acre-feet daily.

Regulating reservoirs and off-canal storage could improve management of existing water supplies by storing flows that may be made available throughout the system during periods of lower demand. The storage reservoirs would be able to exploit high winter flows, stormwater waves that undulate down District lands, and stormwater peaks.

Short-term Component

The large-scale nature of a project that proposes large earthen basins to be added to the GCID system does not lend itself to a short-term component or pilot project that could produce water for in- or out-of-basin use by 2003. A feasibility study must be conducted with a possible design and construct component and initiation of the National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) process. The feasibility study should address basic project components that would be essential to design (e.g., site location, feasible storage capacities), construction (e.g., environmental surveys, permitting), and implementation (e.g., public involvement) of a successful off-canal storage and/or regulating reservoir project. The feasibility study would likely include the following tasks:

- Data Collection—Necessary information regarding existing system hydraulics including cross-drainage, system in-flows and out-flows, and local hydrology should be collected as part of the first project task. Other valuable information that should be included in this informtaion gathering process would be soil investigations to assist in proper siting of possible earthen basins. Field data would be necessary to build and execute a working system model.
- Mapping—Accurate analysis and modeling of the area would require system mapping. Mapping data could be obtained via a combination of District survey efforts and aerial survey.
- Modeling—Off-canal storage and regulatory reservoir(s) would be significant additions to the GCID system with significant impacts to system operation and possibly to regional hydrology. A model should be built and executed to evaluate the impacts to the region and the District's system. Model output would be essential in helping to site the project, determine economic feasibility, and assist with initial environmental and permitting requirements.
- Data Analysis—Data should be analyzed with respect to economic, technical, and political feasibility.
- Report—A final report should be issued complete with recommendations so that the next phase of the project (preliminary design) could be immediately initiated in the

event the feasibility study finds that off-canal storage and/or regulatory reservoir(s) would be a viable project.

Pending the outcome of the proposed feasibility study, GCID could potentially implement an off-canal storage and regulating reservoir program within 8 to 10 years of project approval. Such a project is believed to be able to yield a maximum of 35,000 ac-ft annually. This yield is dependent upon project scope and annual conditions. Project scope options include at its most expansive, two storage components, or at its most fundamental, one storage component. Estimated storage capacities range from 5,000 ac-ft for a regulating reservoir to 30,000 ac-ft for an off-canal storage reservoir.

The feasibility study would likely examine the following project aspects that have been considered on a conceptual level. Implementation of the feasibility study is discussed further in Section 6.

Facilities

The major facilities for this program could include:

- **Off-canal Storage Basin**
  - **Location**—Downstream of the GCID Main Canal terminus.
  - **Possible Footprint**—An estimated 3,500 acres with 12-foot-high berms.
  - **Capacity**—With a 2-foot freeboard, storage capacity would approximate 35,000 ac-ft, with a possible yield for available supply estimated at 30,000 ac-ft.
  - **Existing Land Use**—Agriculture is the predominant land use in the area, yet it is troubled with regular flooding from stormwater cross-drainage, area creeks (e.g., Sand Creek and Freshwater Creek), and the Colusa Basin Drain. The area's susceptibility to flooding may make the land more accessible for purchase.
  - **Design Considerations**—The storage basin would be earthen with minimal cut and fill. Infiltration rates are perceived to be conducive for storage. Groundwater is relatively shallow throughout the District. The average depth to the water table in this area is 15 feet. The basin would be gravity fed from the GCID Main Canal with possible contributions from the Tehama-Colusa (TC) Canal.
- **Regulating Reservoir**
  - **Location**—Near the half-way point of the District's Main Canal, upstream and adjacent to the TCCA-GCID Intertie (GCID Main Canal mile post 37.22R).
  - **Possible Footprint**—An estimated 800 acres with 12-foot berms extending on either side of the Main Canal.
  - **Capacity**—With a 2-foot freeboard, storage capacity would approximate 8,000 ac-ft, with a possible yield for available supply estimated between 5,000 and 7,000 ac-ft.
  - **Existing Land Use**—The majority of this land is used for sheep ranching (the west side of the Main Canal), and a small percentage is dedicated to farming (the east side of the Main Canal).

  - **Design Considerations**—The storage basin would be earthen with minimal cut and fill. Infiltration rates are perceived to be conducive for storage. Groundwater is relatively shallow throughout the District. The average depth to the water table in this area is 15 feet. The basin would be gravity fed from the GCID Main Canal and possibly from the TC Canal via the Intertie, a waste gate near the site of the regulating reservoir.

- **Conveyance Facilities**
  - New turnout structures and conveyance systems would deliver excess surface water supply from the GCID Main Canal to the basins. The size, length, and layout of these facilities are dependent upon flow rates, basin design and characteristics, and detailed location.

Facility Operations

As part of the District's water management effort, the operation of this project should be closely coordinated with other management efforts such as system flow measurement and canal automation. The basin operations could include:

- **Off-canal Storage Reservoir**
  - **Reservoir Inflows**—Most likely to occur October through April when irrigation demand is lower; sources would likely include stormwater, Sacramento River and its tributaries, and groundwater delivered via the GCID and TC main canals
  - **Reservoir Outflows**—Most likely to occur April through October during the hotter, more arid months; recipients would likely include any user downstream of the reservoir in or out of basin; any release from the reservoir would likely occur via the Colusa Basin Drain
  - **Operations Considerations**—The District has expressed willingness to operate and maintain this facility as part of its system; it may be possible that a separate entity would prefer jurisdiction over the inflows to and releases from this reservoir
- **Regulating Reservoir**
  - **Reservoir Inflows**—Most likely to occur October through April when irrigation demand is lower; sources would likely include stormwater, Sacramento River and its tributaries, and groundwater delivered via the GCID and TC main canals
  - **Reservoir Outflows**—Most likely to occur April through October during the hotter, more arid months; recipients would likely include any user downstream of the reservoir in or out of basin, especially District landowners along the last half of the canal; any release from the reservoir would likely occur via the GCID Main Canal and the Colusa Basin Drain; outflow from the regulating reservoir could contribute to the off-canal storage at the end of the system
  - **Operations Considerations**—The District would operate and maintain this facility as part of its system

Long-term Component

This project proposes a feasibility study to examine the benefits and viability of off-stream storage and regulating reservoirs within the GCID system. There is no long-term component of the feasibility study. However, a long-term project is anticipated to evolve from the feasibility study.

2. Potential Project Benefits/Beneficiaries

The expected beneficiaries of this program include GCID, downstream users, the environment, and the Sacramento-San Joaquin Delta. Although no direct benefits will result from the feasibility study, benefits to in- and out-of-basin users could be derived from a project that results from the study. The following benefits are discussed in this section:

- Water Supply
- Water Management
- Delta Water Quality
- Environment
- Groundwater Recharge
- GCID Operations

Water Supply

The most significant benefit and predominant goal of the project is to capture and store water supply that may not otherwise be exploited, e.g., pulse flows from winter storms. Water supply benefits are expected to include:

- **Increased In-stream Flows—**The majority of the water supply benefits would most likely be derived from increased in-stream flows. The Off-canal Storage Reservoir would retain water from sources that may not typically provide supply when there is demand, e.g., winter flood flows. By offering another source of supply during high demand (e.g., irrigation season) to downstream water purveyors, diversions from the Sacramento River could consequently be reduced by an equal amount, up to 30,000 ac-ft. The decreased surface water diversions could be mutually beneficial to in-basin and out-of-basin users. During dry years, the additional river flows afforded by the decreased diversions would provide much-needed habitat for aquatic and riparian species, increased available supply to downstream users, and increased inflows to the Delta. The reservoirs would allow an increase in system flexibility, affording the District flexibility with diversions that could thereby increase in-stream flows when most needed.

- **Increased Reliability of Supply—**This project could provide stakeholders and refuges with increased reliability of supply during critical dry years when the possibility exists that allowable surface water supplies could be decreased. Although the reservoir is likely to be low during prolonged periods of drought (more than 1 or 2 years), the initial availability of supply would provide a maximum of 30,000 ac-ft otherwise unavailable to downstream users.

- **Aquifer Recharge—**The reservoirs would be unlined natural earth basins, which would naturally recharge groundwater through infiltration.

Water Management

This project may potentially provide water management benefits primarily by increasing conveyance efficiency, providing flexibility in the timing of surface water diversions primarily on the Sacramento River, increasing the ability to store and target releases of surface water supplies, and providing increased flexibility and reliability through management of both surface- and groundwater supplies.

The project would accumulate pulse flows, which are a result of normal operations, farm releases, and weather, in the system that may not otherwise be efficiently utilized. These flows have been estimated at a maximum of 2,000 cfs weekly. The reservoirs would be able to handle the excess flows to enhance the water management capability of the District and downstream users. Downstream water users would be able to improve their water management decisions by using increased regulation and storage of pulse flows.

Water Quality

Water quality benefits of the project generally stem from increased in-stream flows and water retention. Improvements to both temperature and constituent properties of the river and outflows from the reservoirs would be the most probable results of the increased in-stream flows and water storage. These benefits would need to be evaluated and modeled on a regional basis to determine impacts on water quality in the Sacramento River and the Delta. Depending upon implementation and configuration of the project, there may be temperature improvements to the GCID intra-district supply. The regulating reservoir could essentially increase the temperature of the supply, making the water more desirable for downstream rice farmers.

Environment

The environmental benefits associated with this project would be quantified throughout the various stages of the project, from feasibility study through final design. Some environmental benefits that have been identified at this level of investigation include:

- **Sacramento-San Joaquin Delta—**The decrease in surface water diversions and addition of artificial groundwater basin recharge has the potential for increasing available seasonal in-stream flows to the Delta. The downstream users' potentially decreased diversions, a maximum of 30,000 ac-ft, is a quantifiable number that directly reflects the potential increased available supply in the Sacramento River.
- **Aquatic/Riparian Habitat—**The reservoirs would provide habitat for local wildlife such as waterfowl by essentially creating a human-made wetland. It has been suggested that the Off-canal Storage Reservoir could incorporate islands specifically designed to attract waterfowl and provide safe breeding grounds for said birds. Furthermore, improved in-stream flows would generate expected fisheries benefits, both in terms of water quality and sheer volume of water. Flow management could yield environmental benefits by achieving the Quantifiable Objective (QO) of reducing salmonid attraction flows into the Sacramento River at Knights Landing.
- **Firmer Supply to Refuges—**Although in dry years environmental entities such as wildlife refuges are not among the top two priorities for water delivery, they do benefit from an increased reliability in supply.

Glenn-Colusa Irrigation District Operations

The load-shedding component of the reservoirs maximizes the pumping of water supplies into storage during off-peak energy consumption periods and the releasing of flows during on-peak periods, thereby enabling the system to shed load demands on the power grid.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Table 5A-1 presents an order-of-magnitude project cost estimate. Future stages of the project, from feasibility study to final design would include progressively detailed cost estimates for the new facilities.

TABLE 5A-1
Planning-level Project Costs
Glenn-Colusa Irrigation District Regulatory Reservoirs and Off-canal Storage Feasibility Study

Item	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)
Field Tests	15	Acres	6,000	$25
Hydraulic Modeling and Mapping	400,000	Cubic yards	8	$330
Data Collection	400,000	Cubic yards	12	$25
Data Analysis	2	Structure	75,000	$50
Report	1	Structures	75,000	$15
			Subtotal	$445
			Contingencies and Allowances (30%) ->	$134
			Total Costs ->	$579
			Environmental Mitigation (5%)	$29
			Engineering, Environmental, Construction Management and Admin. (25%) ->	$145
			Total Project Cost ->	**$753**

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem. Additionally, the project could provide environmental benefits at the reservoir site by providing waterfowl habitat. Regional benefits in the form of reduced energy consumption could also accrue from project implementation.

Project implementation would also result in impacts to the environment, notably through the conversion of open space to a reservoir. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. It is likely that the appropriate level of environmental documentation necessary for this project would be an environmental impact statement/environmental impact report (EIS/EIR).

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board**—Large amounts of earthwork would be required for the recharge basins. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)—**The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Lands Commission—**Project would need to consult with State Lands Commission on the public agency lease/encroachment permitting for use of state lands.
- **State Reclamation Board—**The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)—**Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **Division of Safety of Dams (DSOD)—**Design and configuration of the storage basins may require permitting and compliance with Dam Safety due to the height of the retention walls. DSOD is structured within DWR.

- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

At a reconnaissance level of study, implementation challenges are likely to be minimal. The most significant challenges to the successful and thorough completion of the study could include laying the groundwork for a successful project past the reconnaissance level (e.g., laying the groundwork for public outreach and initiating contact with landowners that might be directly affected by the project). The project that could evolve from the feasibility study would occur in several incremental stages, each of which would have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. Significant environmental issues are related to such a large-scale project, with the environmental issues being paramount. The project would need to be developed in a manner that supports the objectives of local and regional management plans.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities such as GCID, USFWS, USBR, and DWR. The governmental agencies would have strong interests associated with the project and indirectly as it may affect other interests in the area. It is highly probable that because of the complexity and far-reaching implications of the project, competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Water Rights Implications

GCID water rights would have to be guaranteed and preserved. There is concern that a "use it or lose it" mentality may become prevalent during the implementation of the conjunctive use program. Although the District would be expecting to decrease their annual surface water diversions, it should not be assumed that they would be relinquishing a comparable amount of their water rights.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Habitat for known Endangered Species Act-listed species such as the valley elderberry longhorn beetle and the giant garter snake is present within the project area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Land Acquisition

Land would have to be acquired to support the reservoirs and conveyance facilities. Some landowners may be resistant to the land purchases.

Key Stakeholders

Table 5A-2 lists the key stakeholders that are expected to be associated with or impacted by this conjunctive use and recharge project. Also, listed are the anticipated roles, concerns, and/or issues corresponding to each stakeholder.

TABLE 5A-2
Stakeholder Roles and Issues
GCID Regulatroty Reservoirs and Off-canal Storage Feasibility Study

Stakeholder	Role/Concerns/Issues
GCID	• Project proponent and direct beneficiary
Downstream Users (e.g., Reclamation District 108, Sutter Mutual Water Company)	• Possible increased in-stream flows • Possible additional source of supply
Colusa County	• May affect flood flows and drainage
Local Landowners	• Impacts on tailwater supply • Acquisition of possible land easement and/or purchase
USBR, DWR	• Water rights • Integration with other regional management concepts such as off-stream storage
Environmental Interest Groups	• In-stream flow impacts, fishery impacts, land use, water quality impacts
USFWS/CDFG	• Compliance with environmental regulations • Possible habitat created by reservoirs
Sacramento-San Joaquin Delta	• Possible increased inflows

6. Implementation Plan

The following major steps would be required to implement the project. Each step depends on successful completion of the previous supporting steps, and findings that support further actions. Figure 5A-2 shows an assumed implementation schedule based on typical time requirements for each step in a project of this scale.

1.1 Feasibility study, data collection, modeling, and mapping—This step could begin immediately and is intended to develop the specific project components, general features, operating concepts, and potential benefits. It would also determine the basic engineering and economic feasibility of the project. This first step of the project would take approximately 1 year to complete.

1.2 Project concepts report—The purpose of the project concepts report would be to refine the design criteria developed in the hydrologic report, identify and locate specific project features, examine alternatives, and estimate costs in sufficient detail to support an environmental assessment (EA)/EIR. The development of the project concepts report would be completed within 9 months.

1.3 Environmental reconnaissance study—Biological field surveys, resource database review, and other reconnaissance would determine permitting requirements and the appropriate level of required environmental documentation. This task would also identify sensitive areas or issues of environmental concern related to site selection. This task could be completed within 3 months.

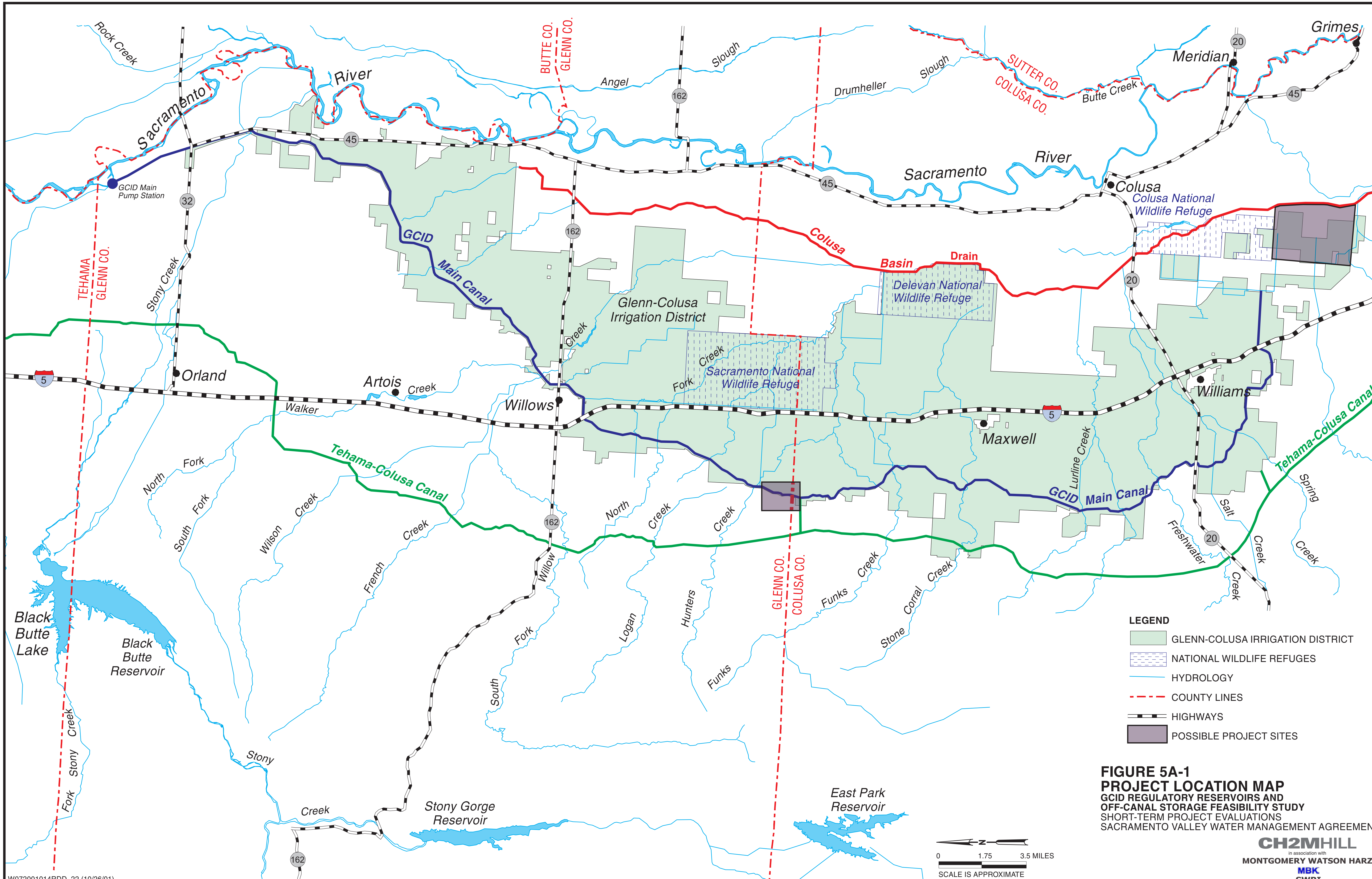


FIGURE 5A-1
PROJECT LOCATION MAP
GCID REGULATORY RESERVOIRS AND OFF-CANAL STORAGE FEASIBILITY STUDY
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

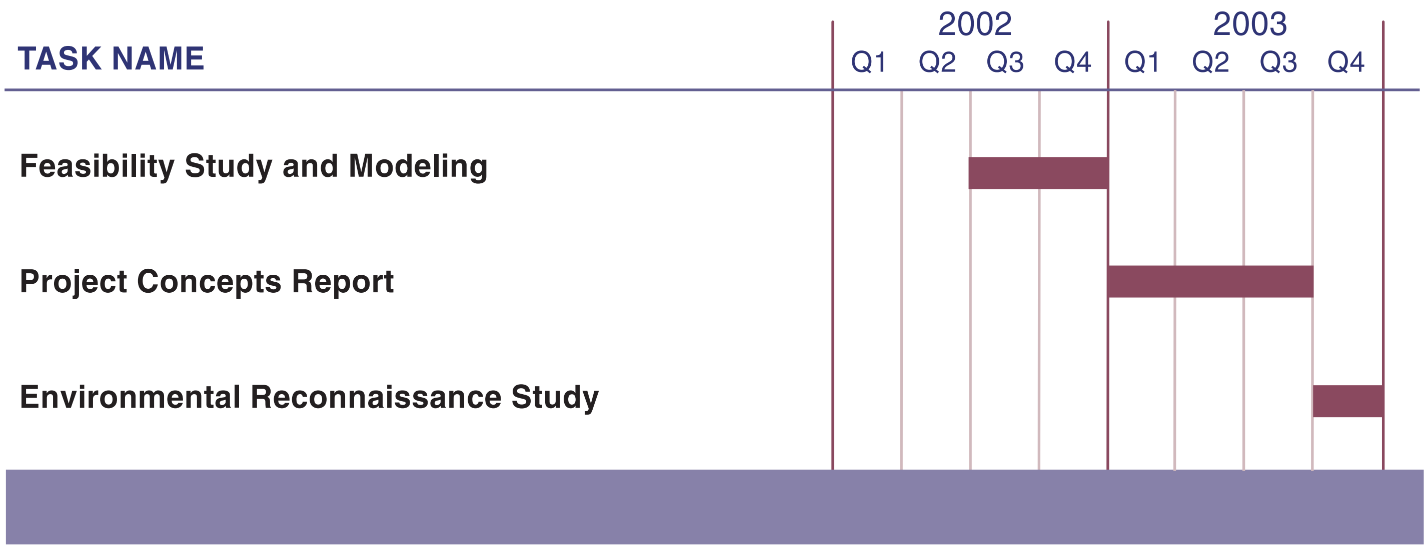


FIGURE 5A-2
PRELIMINARY IMPLEMENTATION SCHEDULE
GCID REGULATORY RESERVOIRS AND
OFF-CANALSTORAGE FEASIBILITY STUDY
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_13 (10/28/01)

Project 5A—Draft CEQA Environmental Checklist

Project 5A—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

_______________________________ _______________________

Signature Date

_______________________________ _______________________

Printed Name For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☒	☐	☐	☐
This project would include one or more off-canal regulating/storage reservoirs in the Colusa Basin (ranging in size from 5,000 acre-feet [ac-f]) to 30,000 ac-ft). The exact location of these reservoirs are yet to be determined. The off-canal storage basin would be generally located downstream of the GCID Main Canal terminus. The regulating reservoir would be located near the half-way point of the District's Main Canal, upstream and adjacent to the TCCA-GCID Intertie. The majority of land around these locations is used for agricultural purposes. These reservoirs may require a permanent conversion of potential Prime Farmland, Unique Farmland, or Farmland of Statewide Importance.				
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☒	☐	☐	☐
See response to II (a) above.				
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☒	☐	☐	☐
See response to II (a) above.				
Ill. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions and reduce the impact to a less than significant level.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☒	☐	☐
See response to III (b) above.				
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☒	☐
IV. BIOLOGICAL RESOURCES—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☒	☐	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Potential conversion of habitat could occur as a result of the project and would have to be mitigated. Additionally, project construction scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☒	☐	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☒	☐	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☒	☐	☐
See response to IV (a) above.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☒	☐	☐	☐
Removal of vegetation would inevitably be required as part of the project construction and implementation. Mitigation measures would be implemented to replace any vegetation removed for the project, which would attempt to reduce the impact to a less than significant level.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☒	☐	☐	☐
See response to IV (e) above.				
V. CULTURAL RESOURCES—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
Iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☒	☐
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
See response to VII (a) above.				
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☒	☐
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>VIII. HYDROLOGY AND WATER QUALITY</u>— Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
Increases in turbidity would be likely to occur during any potential in-stream construction work. Additionally, there is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan, and the implementation of BMPs to reduce any impacts to waterways in and around the project area.				
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐
The basins would be gravity fed. Sources to the reservoirs would be likely to include runoff from storm events. This would be a beneficial impact to surrounding land owners, because this area is currently susceptible to flooding.				
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☒	☐	☐	☐
A 3,500-acre off-canal storage basin would be constructed as part of the project. This basin would have an estimated storage capacity of 35,000 ac-ft. An 800-acre regulating reservoir would also be constructed as part of the project. This reservoir would have an estimated storage capacity of 8,000 ac-ft. Both would consist of 12-foot-high berms surrounding the footprint of each reservoir.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☒	☐	☐
See response to IV (e) above.				
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☒	☐	☐
See response to XI (a) above.				
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☒	☐
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS— Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☒	☐	☐	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☒	☐	☐

PROJECT 5B

Glenn-Colusa Irrigation District Development of Conjunctive Water Management Facilities

1. Project Description

Project Type:	Conjunctive water management
Location:	Glenn and Colusa counties
Proponent:	Glenn-Colusa Irrigation District (GCID or District)
Project Beneficiaries:	GCID, in- and out-of-basin users, environment, Delta
Total Project Components:	Short-term components, development of District-owned/operated network of wells and related facilities
Potential Supply:	100,000 to 110,000 acre-feet per year (ac-ft/yr)
Cost:	$80.3 million
Current Funding:	None
Short-term Components:	Utilization of a network of existing private landowner wells and pilot study/well development
Potential Supply (by 2003):	50,000 to 60,000 ac-ft/yr
Cost:	$2.9 million (cost for landowner well production-only component likely to be $100,000 to $300,000)
Current Funding:	None
Implementation Challenges:	Public perception, coordination among public and private entities, coordination between concurrent and similar regional projects, lack of sufficient groundwater data, water rights implications, environmental regulatory compliance, land acquisition, recharge basins
Key Agencies:	GCID; Glenn, Colusa, and Tehama counties; local landowners; U.S. Bureau of Reclamation (USBR); California Department of Water Resources (DWR); environmental interest groups, U.S. Fish and Wildlife Service (USFWS); California Department of Fish and Game (CDFG); Sacramento-San Joaquin Delta

Summary

GCID is proposing to revise agreements with landowners to institute an annual conjunctive water management program that utilizes existing private wells located within GCID's boundary. The proposed conjunctive water management program would also include the development of a District-owned and -operated network of 35 groundwater production wells along the upper 25 miles of GCID's Main Canal, which overlies the Stony Creek Fan and lies hydraulically downgradient of potential groundwater recharge areas to the northwest.

GCID is located in the central portion of the Sacramento Valley on the west side of the Sacramento River, as illustrated on Figure 5B-1. The District's service area extends from northeastern Glenn County near Hamilton City to south of Williams in Colusa County. The east side of the District stretches toward the Coastal Range and Tehama-Colusa (TC) Canal. The service area's main facilities include a 3,000-cubic foot per second (cfs) pumping plant and fish screen structure, a 65-mile Main Canal, and approximately 900 miles of laterals and drains.

With 175,000 acres, GCID is the largest irrigation district not only in the Colusa Sub-basin, but also in the Sacramento Valley. The soils within this area generally consist of clay-like and loam characteristics and are considered some of the most productive soils for agriculture in the world. The low infiltration rates of the tight soils within much of the District are conducive to furrow and border irrigation. To that end, rice is the predominant cultivated crop and typically accounts for 75 percent of total district irrigated acreage. Other crops include, but are not limited to, tomatoes, vine crops, sunflowers, prunes, almonds, and walnuts.

Glenn-Colusa Irrigation District Water Supply

The Sacramento River serves as the principal water source for GCID. Its diversion, the largest surface water diversion on the river, is located at the northern end of the District, just north of Hamilton City. Other surface water diversions to which GCID holds entitlements and uses to supplement its Sacramento River supply include Stony Creek, Hunters Creek, Stone Corral Creek, Tributary to Funks Creek, and the Colusa Basin Drain. GCID uses its entitlement to these water sources to convey water during the irrigation season, as well as to customers requiring water in the fall and winter months including neighboring wildlife refuges and landowners that require water for rice decomposition.

Restrictions on diversions related to the Endangered Species Act (ESA) prior to completion of the District's new fish screen facility prompted GCID to place more importance on groundwater supply through increased use of the Stony Creek Fan, the predominant aquifer within the District. If necessary, the District has the ability to supplement its operations with groundwater from local production wells. GCID has contracted with more than 100 private landowners who are reimbursed per acre-foot (ac-ft) contributed to GCID's supply. The District manages and operates this voluntary conjunctive water management program, which contributed up to an estimated 63,000 ac-ft (according to District staff) in 1994 in response to reductions in surface water supply.

The GCID annual diversions are bimodal, a reflection of the cultural practices of growing rice. Near the beginning of the irrigation season when farmers are flooding their rice fields, May and June, the District typically meets or exceeds their allotted contractual amounts. The annual peak diversions occur during the hot, dry summer month of July and then gradually decrease until later in the year when a much smaller peak occurs. This last peak is again a result of farmers flooding their rice fields, this time post-harvest for straw decomposition.

Reuse and Downstream Users

As discussed above, GCID's ability to divert their full entitlement was reduced until recently because of the endangered species limitations associated with the District's previous fish screen operation. In addition, 3 years within the last decade were classified as "critical years," and contract supplies were reduced to 75 percent of entitlements. The District managed several programs to supplement these reduced supplies, including the conjunctive water management program mentioned above. Other programs included a water conservation program, which at one time required water use patrols around the District, and a water reuse program.

An aggressive drainwater recapture program, which includes both groundwater seepage and tailwater runoff from cultivated fields from within GCID's service area, is a part of the District's overall water management program. GCID recaptures this water with both gravity and pump systems. Recaptured water is delivered to either laterals or the Main Canal for reuse by both in-District and out-of-District users. Much of GCID's drainwater is captured for use by downstream districts such as the Provident Irrigation District (PID), Princeton-Codora-Glenn Irrigation District (PCGID), and Maxwell Irrigation District (MID). Tailwater can be vital to downstream users' water supply and water management. For example, Colusa Basin Drain Mutual Water Company members (57,000 acres, gross) rely on tailwater from GCID and other upstream water users. Currently, GCID recycles approximately 155,000 ac-ft annually.

Existing Studies and Modeling

At this time, a comprehensive groundwater model of the local aquifers does not exist. However, DWR is currently working with the Orland-Artois Water District (OAWD), Orland Unit Water Users' Association (OUWUA), and GCID to model the use of the Stony Creek Fan in Glenn and Tehama counties. The objectives of this modeling effort include developing an understanding of groundwater sub-basin characteristics, surface water/ aquifer interactions, and interrelationship between the operational parameters of water users within the sub-basin. Preliminary efforts have begun related to identification of project goals and model selection.

Other conjunctive management proposals such as Projects 5E, 8A, and 9A are considering development of a common groundwater resource within the Stony Creek Fan Aquifer. These various projects will be evaluated and developed in a coordinated manner, potentially under the CALFED Integrated Storage Investigation (ISI)-sponsored investigation currently in progress with OAWD, OUWUA, and GCID.

Short-term Component

GCID's development of conjunctive water management facilities is expected to be accomplished in two phases: Phase 1 (short-term component) and Phase 2 (long-term component). Phase 1, by definition of a short-term component, is proposed to be completed by December 2003. Initial project benefits would be realized with water supply expected during the summer of 2003. With expedient organization and administration, the project could contribute to District water supply as early as the summer of 2002. The following components of Phase 1 are discussed in this section:

- Phase 1 Network of Groundwater Wells
- Pilot Study
- Recharge Basin Surveys
- Preliminary Environmental Work

Phase 1 Network of Groundwater Wells

Facility operations during Phase 1 of the project are expected to include full utilization of a network of existing private landowner wells that are currently contracted with the District to supplement GCID supply if necessary. As of this date, an annual groundwater program has not been implemented. In the past, these wells have been employed only when surface water supply was low. However, with this project, the District is proposing to institute a program that would utilize privately owned wells on an annual basis in an effort to increase water supply reliability, as well as potentially reduce Sacramento River diversions and/or make water available for other in- or out-of-basin uses, presumably during the peak irrigation season and during dry years. Phase 1 is expected to yield a maximum supply of 60,000 ac-ft, not including any possible yield from the proposed pilot study discussed below. According to District staff, during June and July 2001, 61 of 180 participating wells produced 33,000 ac-ft of supply. The network was demonstrated to supply up to 63,000 ac-ft in 1994.

The short-term phase of this project would assist in the timing, administrative details, and operational changes with respect to the long-term conjunctive water management program. The infrastructure for this program, primarily the privately owned wells, is already in place. Further, contractual agreements with the participating landowners have been developed but would need to be refined to reflect an annual program.

Monitoring would be a necessary component of the project in order to observe groundwater levels and estimate connectivity between the aquifer, local stream flows, and Sacramento River flows. This monitoring program could be conducted by utilizing existing non-pumping groundwater wells. Data could be collected either periodically by field personnel (one person would be sufficient) and a sounder or continuously by equipping test wells with data loggers and pressure transducers. The method used to conduct monitoring would be based upon specific project requirements (i.e., how many data points are required), intended use (e.g., ongoing modeling efforts may find this data useful), and economics.

Pilot Study

In addition to establishing the first phase of annual groundwater production through a network of private landowner wells, a pilot study is recommended as a precursor to Phase 2. The pilot study would produce vital information to the design and placement of the proposed 35 new production wells, such as drawdown, output, water quality, and interference with other adjacent wells. This information could be gathered using a small network of new wells specifically designed for the purpose of the study with the intention of incorporating these wells into the final project configuration. It is possible that existing agricultural wells in the project area could be used. This possibility would have to be further explored by gathering more information regarding existing wells.

Groundwater wells placed within certain distances of each other can cause interference affecting local water levels and drawdown. Essentially, if wells are placed too close together, drawdown can be exaggerated because of the additive effects of interference. This may or may not be a desirable characteristic because of the anticipated shallow groundwater levels. It may be desirable to pull down water levels over a large area in order to institute artificial recharge. Well interference is just one parameter that the pilot study would need to examine. Any possible negative impacts to local agricultural groundwater well users would be unacceptable.

In determining interference between wells, two different tests could be performed: single aquifer tests or interference tests. The single-well tests include pumping from a single well and recording the pumping rate through time. Drawdown would be recorded in the pumping well and in a number of observation wells. The observation wells could be non-pumping production wells, monitoring wells, or piezometers. This test would provide information regarding the distribution of transmissivity, allowing forecasts of well interference to be produced. Alternatively or possibly additionally, the pilot study could incorporate an interference test where all test wells are operated simultaneously and sequentially turned on and off to determine a particular well's impact on interferences within the well field.

In addition to determining interference, drawdown, and actual production capacity, water samples would be taken periodically throughout the study. This area of Glenn County has historically demonstrated good quality of groundwater. A test well was installed for GCID in 1989 and yielded water quality results with total dissolved solids (TDS) averaging between 200 to 250 milligrams per liter (mg/L). However, with the prospect of new wells and annual use of these wells, water quality would be re-examined to confirm its adequacy for agricultural use. Other water quality parameters that may be of interest would be electrical conductivity (EC) and levels of constituents such as nitrates.

The pilot study would likely require several different types of equipment not only to gather the required information for design, but also to keep the study as non-intrusive as possible in the event that well locations happen to coincide with farmland. The non-intrusive aspect of the study would be especially important if existing wells are utilized. Likely equipment for this study would include data loggers, pressure transducers, and flow meters in addition to sampling equipment.

Finally, the discharge water from the tests would be considered. Significant volumes of water could result from these test depending upon frequency and duration. The water should be conveyed away from the area so as not to recharge the local groundwater levels and thus distort drawdown readings. Ideally, the study would focus on wells adjacent to the Main Canal, as that is the proposed location of the new well field. The discharge water from the tests could then be easily discharged into the Main Canal and add to the short-term component of groundwater supply. This additional supply could contribute up to 2,500 ac-ft, assuming five production wells operated at 3,500 gallons per minute (gpm) each over 30 to 35 pumping days.

Recharge Basin Surveys

Recharge basins are expected to be included as part of the overall project facilities (as discussed below.) The design of these basins will require certain preliminary information including preliminary siting of the basins. The basins should be located up-gradient of the system so as to recharge the aquifer from which the District and possibly neighboring entities would be drawing. High infiltration rates are anticipated to occur around the gravel pits near Stony Creek. Infiltration rates are estimated between 0.2 inches per hour (in/hr) to greater than 10 in/hr. Soils investigations should be conducted to optimize basin location with regard to infiltration rates. The higher these rates, the more conducive to a groundwater recharge program the soil would be.

Development of the recharge basin sites could involve significant earthwork to shape the basins. Ideally, the basins would be located in an area that would minimize any required earthwork to minimize cost. Further, regional hydraulics and hydrology should be evaluated so any impacts the basins may have on area drainage can be anticipated and prevented, perhaps even exploited (e.g., capture winter flood flows). Finally, recharge basins should be located were they would have minimal to no environmental impact.

Preliminary Environmental Work

Any project that proposes significant earthwork, taking land out of agricultural use, or examines conjunctive water management would come under intense scrutiny both politically and environmentally. Public outreach and environmental investigations should begin immediately and should be coordinated with other outreach activities such as those being conducted as part of the Stony Creek Fan Program being coordinated OAWD, OUWUA, and GCID. Environmental requirements are expected to be strict and could require substantial investigation, documentation, and permitting. This aspect of the project should begin with the project's inception to optimize and maintain the project schedule. Groundwater modeling of the region would also be initiated within the short-term component of this project. Efforts would be made to coordinate modeling needs of this project with other modeling efforts already underway on other similar projects within the area.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

With the completion of Phase 1 in December 2003, Phase 2 (long-term component) is expected to begin January 2004 and reach completion by December 2007. Phase 2 is anticipated to proceed only upon satisfactory completion of all elements in Phase 1. The District would not expect to continue with their groundwater program unless the project's working assumptions (e.g., no adverse effects to local groundwater levels) are supported by the initial investigations and monitoring.

The proposed project, which includes a network of District-owned and operated groundwater wells and conveyance facilities would offer GCID the ability to provide a firm supply of groundwater to its users, an estimated maximum of 50,000 ac-ft (in addition to the supply from Phase 1, for a total of approximately 100,000 ac-ft), and potentially reduce Sacramento River diversions by an equal amount simultaneously. The facilities for this project would include the following:

- Groundwater Production Wells
- Distribution Pipelines
- Monitoring Wells
- Recharge Basins
- Surface Water Conveyance System

Groundwater Production Wells

The design and layout of production wells would rely heavily on such factors as comprehensive groundwater modeling, seasonal yields, and operating agreements. As indicated by both anecdotal evidence and preliminary investigations by DWR, the project is estimated to include the installation of 35 groundwater production wells (five of which would be installed during Phase 1 as part of the proposed pilot study), each with a 3,500-gpm capacity. The wells would be located adjacent to the most upstream 25 miles of the GCID Main Canal, drawing from the Stony Creek Fan. Locating the wells along the Main Canal would facilitate the conveyance of the groundwater supply through GCID's system with minimal associated costs and hardware (e.g., additional easements and piping). Wells are assumed to be 200 to 300 feet deep on average with a 30- to 50-foot drawdown. The pilot study mentioned above would likely determine well spacing and design.

Distribution Pipelines

The production wells may discharge directly into the GCID Main Canal or open-channel laterals. In some cases, it may be necessary to convey the groundwater from the wells to distribution facilities. The size and length of these pipelines would depend on the flow rates from the wells and the well location relative to existing or future distribution systems.

Monitoring Wells

A network of monitoring wells would be required to track groundwater levels and provide critical information to ensure groundwater management objectives are being met during operation of the proposed system. The monitoring well data would help track key objectives such as total recharge and extraction volumes, hydraulic gradients and flow directions for the groundwater, and impacts to other parties. Groundwater quality (e.g., TDS) is fairly high in this area and may not need to be monitored. However, it may be beneficial to monitor parameters of political and practical concern such as nitrates.

Recharge Basins

Recharge basins are proposed to be used to accelerate the recharge of water into the groundwater basin, using available excess surface water supplies in wet or average water years.

The recharge basins would be located to provide "inflow" to the basin near its up-gradient area, indicated by the groundwater flow and hydrogeology of the basin. The total acreage of basins required would depend on the targeted annual recharge quantity and the rate of infiltration from the basins to the underlying aquifer. Existing gravel mining sites along Stony Creek may provide suitable areas for such basins. An assumed conceptual-level sizing of the basins was estimated for this evaluation using the following parameters (assuming general soils characteristics of the area):

- An assumed average infiltration rate of 0.5 foot per day (ft/d) (highly dependent upon basin location since infiltration rates in the area can range from 0.1 ft/d to 20 ft/d)
- 120 days of recharge operation during wet years
- 50,000 ac-ft of minimum targeted recharge
- Use of approximately 200 acres of reclaimed existing gravel mining basins adjacent to Stony Creek
- 600 acres of new recharge basins

The recharge basins could potentially serve a second purpose as short-term off-canal storage facilities or drainage recapture/storage facilities.

Surface Water Conveyance System

A new turnout structure and conveyance system would deliver excess surface water supply from the head of GCID Main Canal to the recharge basins. The size, length, and layout of these facilities are dependent upon flow rates, basin design and characteristics, and location.

Facility Operations

GCID would fully implement their conjunctive water management program within 4 years of project approval. The entire project (short-term and long-term project components with possible maximum yields of 60,000 ac-ft and 50,000 ac-ft, respectively) is expected to yield a maximum groundwater supply of approximately 100,000 to 110,000 ac-ft annually over an assumed 100 pumping days. The operations could include the following:

- Wet Year
  - Aquifer recharge—October through May.
  - Groundwater deliveries—Minimal, expected to peak in July.
  - Recharge expected to be less than in an average water year because of higher groundwater tables, saturated soils, and minimal groundwater pumping. However, the season for recharge may in wet years extend into June or start as early as September, increasing the potential for delivery to the recharge basins.

- Average Year
- – Aquifer recharge—November through April.
- – Groundwater deliveries—Increased from wet years, expected to peak in July.
- – Recharge expected to peak during average years from a combination of lower groundwater tables, higher infiltration rates, available supply, and increased groundwater pumping.
- Dry Year
  - – Aquifer recharge—None.
  - – Groundwater deliveries—Maximized, potentially beginning as early as March and ending in September.

2. Potential Project Benefits/Beneficiaries

The proposed conjunctive water management project managed either alone or in concurrence with other potential programs of similar scope within the Stony Creek Aquifer is expected to produce numerous benefits to both local and regional water purveyors. The expected beneficiaries of this program include GCID, downstream users, the environment, and the Sacramento-San Joaquin Delta. The following benefits are discussed in this section:

- Water Supply/Management Benefits
- Environmental Benefits
- Water Quality Benefits

Water Supply/Management Benefits

The viable water supply benefits under this program are expected to be three-fold.

Increased Reliability/Availability of Supply

A groundwater supply of up to 100,000 ac-ft is projected to be developed from full implementation of the short- and long-term components of this project. This would provide GCID customers, including the Sacramento Wildlife Refuge Complex, with increased reliability of supply during critically dry years when the possibility exists that allowable surface water supplies could be decreased to 75 percent of contractual amounts. Increased supply could also be made available to other in- or out-of-basin users, including environmental interests.

Increased In-stream Flows

When implementing the network of production wells, the surface water diversions could be decreased by an equal amount. The decreased surface water diversions could be mutually beneficial to downstream users, native species, and the Sacramento-San Joaquin Delta ecosystem. During dry years, the additional river flows afforded by the decreased GCID diversions would provide water to much-needed habitat of aquatic and riparian species, increased available supply to downstream users, and increased inflows to the Delta.

Aquifer Recharge

During wet and average water years, GCID often does not require their full annual entitlement to meet the needs of their customers. The District could utilize any unused pumping station capacity within their entitlement to supply waters to recharge the Stony Creek Aquifer, thereby accelerating recharge into the basin and offsetting perceived concerns regarding overdraft. The aquifer recharge capacity of the project would likely be limited by economics (cost of the recharge basins) and local groundwater characteristics. A minimum of 50,000 ac-ft of recharge in addition to natural recharge during average and wet years is anticipated.

GCID Operations

The District would not sacrifice flexibility with operational change. The wells would be located along the most upstream 25 miles of the GCID Main Canal. The location not only allows the District to efficiently pull water from the Stony Creek Fan, but also provides adequately timed supply to landowners throughout the District.

The District's ability to measure flows and supply would not be hindered but in some respects enhanced. Flow gages would be installed on each production well to measure the amount of groundwater contributing to GCID supply. This program could be incorporated with ongoing efforts by the District to both automate their conveyance system and more accurately define their system flows and outflows. GCID would be able to use excess winter flow for recharge and take advantage of storm peaks.

Environmental Benefits

As GCID's primary source of supply, the Sacramento River would be directly and most beneficially influenced by the District's operation of an extensive conjunctive water management program. The environmental benefits associated with this project would be quantified throughout the various stages of the project, from the feasibility study through final design. The following preliminary environmental benefits have been identified at this level of investigation:

- Sacramento-San Joaquin Delta—Any decrease in surface water diversions and addition of artificial groundwater basin recharge has the potential for increasing available seasonal in-stream flows to the Delta. Decreased diversions would contribute toward supporting Sacramento River and Delta inflows.
- Aquatic/Riparian Habitat—Improved in-stream flows could generate fisheries habitat benefits depending on the timing of reduced diversions.

Water Quality Benefits

Water quality benefits of the project generally stem from the increased in-stream flows. Improvements to both temperature and constituent properties of the river would be the most probable results of the increased flows. These benefits would need to be evaluated and modeled on a regional basis to determine impacts on water quality in the Sacramento River and the Delta.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Table 5B-1 presents an order-of-magnitude project cost estimate for the short-term project component, Phase 1. Table 5B-2 presents an order-of-magnitude project cost estimate for the long-term project component, Phase 2. Future stages of the project, from feasibility study to final design, would include progressively detailed cost estimates for the new facilities.

TABLE 5B-1
Conceptual Facility Features for Regional Black Butte to TC Canal Pipeline
Glenn-Colusa Irrigation District Development of Conjunctive Water Management Facilities

Item	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)	Assumptions
Pilot Study					
Land Acquisition	4	Acres	5,000	20	
Production Wells	5	Each	160,000	800	300 ft deep, 18-in casing, 3,500 gpm
Monitoring Wells	10	Each	60,000	600	
			Pilot Study Subtotal ->	1,420	
			Miscellaneous Appurtenances (10%) ->	140	
			Sub-total Construction Costs ->	1,560	
			Contingencies and Allowances (30%) ->	470	
			Total Construction Costs ->	2030	
			Environmental Mitigation (5%)	100	
			Environ. Documentation, Design, Project Admin. of Pilot Study (25%) ->	510	
			Phase 1 Administration ->	250	Program management of entire Phase 1 component
			Phase 1 Project Cost ->	**2,890**	

Initial Funding Requirements and Sources

Early phases of the project work would focus on refining the project scope and concepts through a feasibility study and preliminary design effort that should include a comprehensive modeling effort. Some aspects of the initial study work may be funded through existing programs. For example, the ongoing ISI-supported Stony Creek Fan Program is expected to include conceptual development of conjunctive management alternatives in this area, as well as pilot projects to establish better estimates of recharge potential and other key factors. In addition, this Program would include development of a comprehensive integrated groundwater and surface water model. Currently, no other funding sources are in place for this project.

TABLE 5B-2
Planning-level Project Costs
Glenn-Colusa Irrigation District Development of Conjunctive Water Management Facilities

	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)	Assumptions
Production Wells	30	Each	160,000	4,800	300 ft deep, 18-in casing, 3,500 gpm
Monitoring Wells	25	Each	60,000	1,500	
Conveyance Facilities to Recharge Basins					
Land Acquisition	20	Acres	5,000	100	10 mi. long x 10 ft wide
Canal Excavation	400,000	Cubic yards	8	3,200	10-ft base, 2:1 slopes, 2- to 14-ft access roads, 8 ft deep
Canal Embankment	400,000	Cubic yards	12	4,800	Balanced cut and fill
Outlet	2	Structure	75,000	150	SCADA
Turnout	1	Structures	75,000	75	SCADA
			Conveyance System Total	8,330	
Recharge Basin					
Land Acquisition	1,000	Acres	5,000	5,000	800 acres of basins
Excavation	1,300,000	Cubic yards	8	10,400	1 ft overburden removal
Embankment	1,300,000	Cubic yards	12	15,600	Balanced cut and fill
Distribution Pipe (48 inch)	6,000	Linear feet	8	50	
Pump Station	75	Horsepower	1,500	110	
I&C for Monitoring/Telemetry	1	Each	20,000	20	
			Recharge Basin Total	31,180	
			Subtotal ->	45,810	
			Contingencies and Allowances (30%) ->	13,740	
			Total Construction Costs ->	59,550	
			Environmental Mitigation (5%)	2,980	
			Engineering, Environmental, Compliance Construction Management and Admin. (25%) ->	14,890	
			Total Initial Project Cost ->	**77,420**	

SCADA = Supervisory Control and Data Acquisition

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment, notably through the artificial manipulation of groundwater levels. In some areas of the state, these types of projects have resulted in public concern and controversy, which tends to heighten scrutiny of the environmental effects of such projects. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. It is likely that the appropriate level of environmental documentation necessary for this project would be an environmental impact statement/environmental impact report (EIS/EIR).

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Large amounts of earthwork would be required for the recharge basins. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)**—The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Lands Commission—**The project would need to consult with the State Lands Commission on the public agency lease/encroachment permitting for use of state lands.
- **State Reclamation Board—**The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)—**Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration agreement may be required.
- **Division of Safety of Dams (DSOD)**—Design and configuration of the recharge basins may require permitting and compliance with DSOS because of the height of the retention walls. DSOD is structured within DWR.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

Key Stakeholders

Table 5B-3 lists the key stakeholders that are expected to be associated with or impacted by this conjunctive water management and recharge project. Also listed are the anticipated roles, concerns, and/or issues corresponding to each stakeholder.

TABLE 5B-3
Stakeholder Roles and Issues
Glenn-Colusa Irrigation District Development of Conjunctive Water Management Facilities

Stakeholder	Role/Concerns/Issues
GCID	• Project proponent and direct beneficiary
OUWUA	• Significant interest in Stony Creek Fan, exploring similar projects within the area
OAWD	• Significant interest in Stony Creek Fan, exploring similar projects within the area
Glenn County	• Groundwater management objectives, compliance with AB 3030 plans • Significant interest in regional drainage and flooding
Tehama County	• In early stages of groundwater management and developing county objectives; significant interests in Stony Creek Fan
Colusa County	• Significant interests in Stony Creek Fan • Significant interest in regional drainage and flooding
Local landowners	• Impacts on groundwater levels both short-term and long-term • Acquisition of possible land easement and/or purchase
USBR, DWR	• Water rights • Integration with other regional management concepts such as ISI program
Environmental interest groups	• In-stream flow impacts, fishery impacts, upland habitat and ESA issues, land use, water quality impacts
USFWS/NMFS/CDFG	• Compliance with environmental regulations particularly ESA/California ESA • Possible habitat created by recharge basins
Sacramento-San Joaquin Delta	• Possible increased inflows

The project implementation would occur in several incremental stages, each of which could have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. Key environmental issues are related to long-term management of the Stony Creek watershed, with the groundwater impacts and fishery issues being of greatest concern. The project would need to be developed in a manner that supports the objectives of the Stony Creek management plan. The following lists some of the implementation challenges anticipated to be associated with this project.

Public Perception

Landowners have significant concern regarding possible groundwater overdraft. While the aquifer recharge aspects of this project may go a long way to alleviate these concerns, overdraft likely would remain a concern throughout the various stages of this project from feasibility analysis through construction is and very likely to continue thereafter. Monitoring and modeling of groundwater levels would not only be an essential part of this project technically, but also politically. Further, public concern accompanies any water delivery project (particularly during dry years) with regard to whom any project may or may not benefit. As a result, Glenn County has passed several ordinances and set numerous groundwater management objectives. To that end, the county has set strict guidelines for such water management programs as water transfers that dictate the priority of transfers taking into consideration primarily for the intended recipient of the water.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities such as GCID, USFWS, USBR, and DWR. The governmental agencies would have strong interests associated directly with the project and indirectly as it may affect other interests in the area. It is highly probable that because of the complexity and far-reaching implications of the project, competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Projects

Numerous parties are examining similar projects throughout the valley and within the Stony Creek Fan. For instance, the Stony Creek Fan Program currently being conducted by OAWD, OUWUA, and GCID (Project 8A would evaluate the feasibility of developing standard landowner contract forms and groundwater management agreements for selected wells within the OAWD, OUWUA, and GCID service areas). To optimize the effectiveness of said projects, coordination between the projects would be required from the onset. The strongest motivation for such an effort is three-fold: (1) to avoid duplication of effort and as a result efficiently use available funds, (2) to avoid the nullification of project benefits through competing projects, and, perhaps most importantly, (3) to optimize the benefits of these projects to the watershed.

Lack of Sufficient Groundwater Data

A key element in this proposal is the assumption that the drawdown of the groundwater levels in the Stony Creek fan will not have a substantial effect on dry season flows in local streams and the Sacramento River. At present, there is not enough data to support this assumption. Glenn County has limited groundwater information available. A Memorandum of Understanding has been signed by GCID, OUWUA, and OAWD with the intention of eventually producing a working and comprehensive groundwater model for Stony Creek Fan, directly involving Tehama and Glenn counties. This work should be incorporated into this effort since adequate analysis of the proposed system and safe yield estimates cannot be accomplished without detailed knowledge of the area’s hydrogeology.

Water Rights Implications

GCID participation would be predicated on the operation of such a program and would occur within the guise of the District's existing water rights. Decreases in surface water diversions would be anticipated in some years, while full contract quantities would be used in other years.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Land Acquisition

It is probable that land would have to be acquired for the production wells, recharge basins, and conveyance systems. Some landowners may be resistant to the land purchases.

Recharge Basins

Siting of the recharge basins could be politically and environmentally challenging. The basin siting would have to rely heavily on groundwater modeling results, public outreach, and close coordination with environmental interest groups and government agencies (e.g., USFWS).

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

6. Implementation Plan

The following major steps would be required to implement the project. Each step depends on successful completion of the previous supporting steps and findings that support further actions, although the long-term project could be implemented in the absence of the proposed short-term component. Figure 5B-3 shows an assumed implementation schedule based on typical time requirements for each step in a project of this scale.

Phase 1

1.1 Administration and management of privately owned wells—Operations and management of Phase 1 privately owned wells could begin immediately upon project funding. Management plans, objectives, and administrative details would have to be developed. (6 months to 1 year)

1.2 Privately owned wells on-line—Once a network of project administration is in place, Phase 1 would begin to be tested by December 2002, to allow for refinements to new system and potential operational changes. Reliable water supply would be delivered to GCID's system no later than the summer of 2003.

1.3 Pilot study design—A pilot study would need to be designed specifically to address the needs of the project both in short-term and long-term scope. (3 months)

1.4 Pilot study—After testing procedures are selected, equipment purchased, and the study is fully configured, the pilot study would be run to lay the foundation for design and implementation of Phase 2. (3 months in 2002 and 3 months in 2003 for two sets of data)

1.5 Feasibility study and conceptual design of Phase 2—The District would analyze the details of facility operations concurrently with Phase 1 operations. Feasibility studies, preliminary environmental surveys/investigation, and conceptual design would develop specific project components, general features, operating concepts (long-term), and potential benefits. (9 months)

1.6 Other studies (e.g., groundwater modeling)—These supporting studies would provide more detailed evaluation of specific aspects of the project, such as groundwater impacts. (1 year)

Phase 2

2.1 Preliminary design—The preliminary design would involve engineering design of the major facilities to a 30-percent design level. This level of design would include such details as sizes, locations, and footprints of all major facilities. This information would support key implementation steps such as right-of-way acquisition, soils testing, mapping, and permitting and environmental studies. Possible review by resource agencies and local sponsor may occur following the preliminary design so that comments may be incorporated into the final design. (4 months)

2.2 Environmental assessment/environmental impact report (EA/EIR)—The EA/EIR would be based on the preliminary design and would confirm the potential impacts and required mitigation, if any, for the project. (1 year)

2.3 Final design—Final design would proceed following the EA/EIR work, focusing on the preferred alternative. This would involve producing engineering drawings, specifications, and other final contract documents suitable to bid and construct the project facilities. Possible review by resource agencies and local sponsor may occur following the final design. (1 year)

2.4 Permitting—The various permits would be obtained using the final design as the basis for permitting requirements. This process may be initiated before completion of final design. (9 months)

3.1 Construction and construction management (CM)—Construction oversight is required to enforce contract requirements and ensure a quality, functional end-product. Typical CM activities include (1) evaluating bids; (2) reviewing, approving, and testing proposed products and materials; (3) observing, photographing, and documenting all aspects of construction; (4) managing changes during construction; and (5) estimating contractor inventories, progress, and progress payments. Construction would potentially be phased over several years, given the size and complexity of the project. (2 years)

4.1 Operation and monitoring—Long-term operations and monitoring of the project would begin following completion of construction.

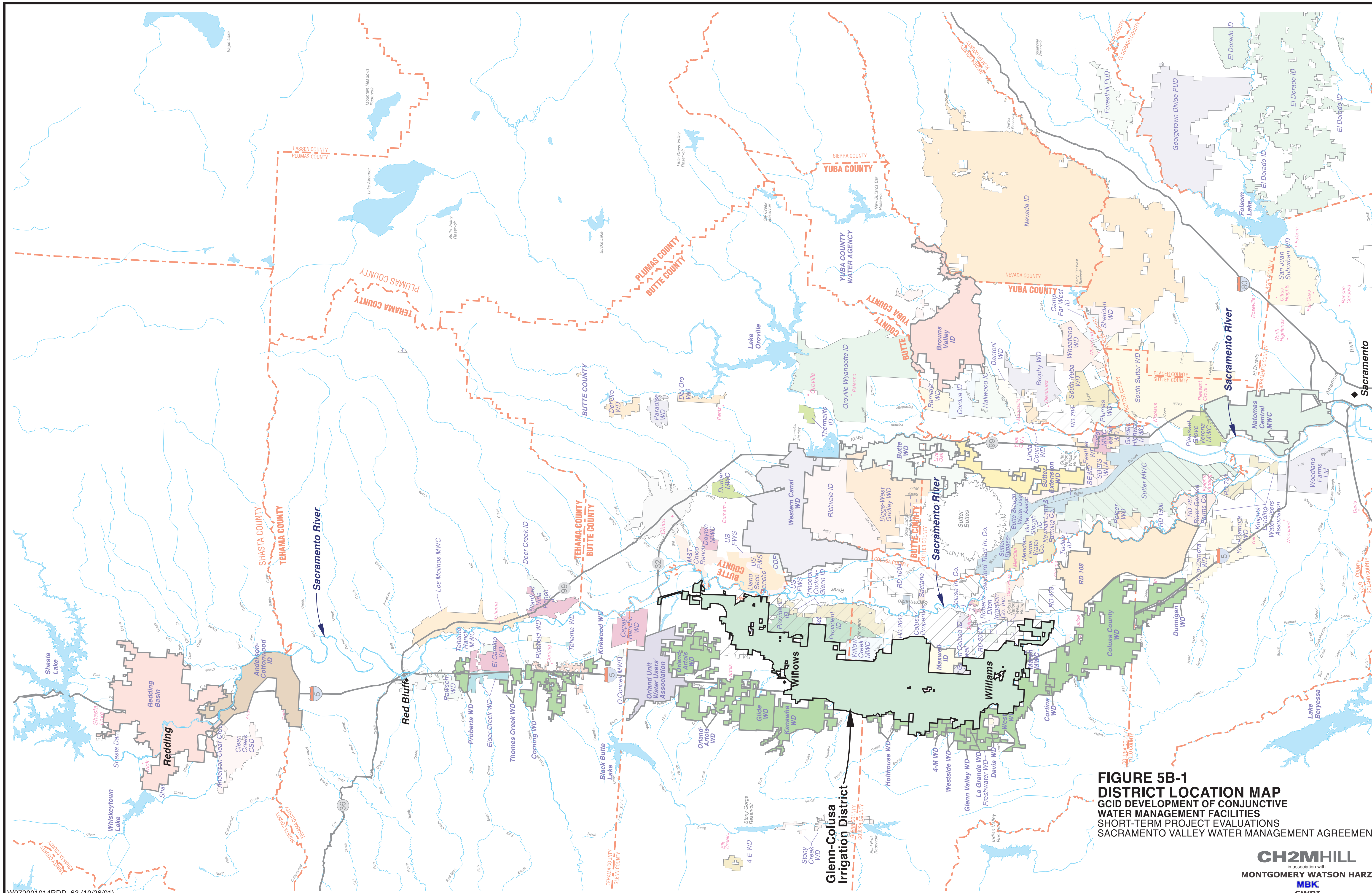


FIGURE 5B-1
DISTRICT LOCATION MAP
GCID DEVELOPMENT OF CONJUNCTIVE WATER MANAGEMENT FACILITIES
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

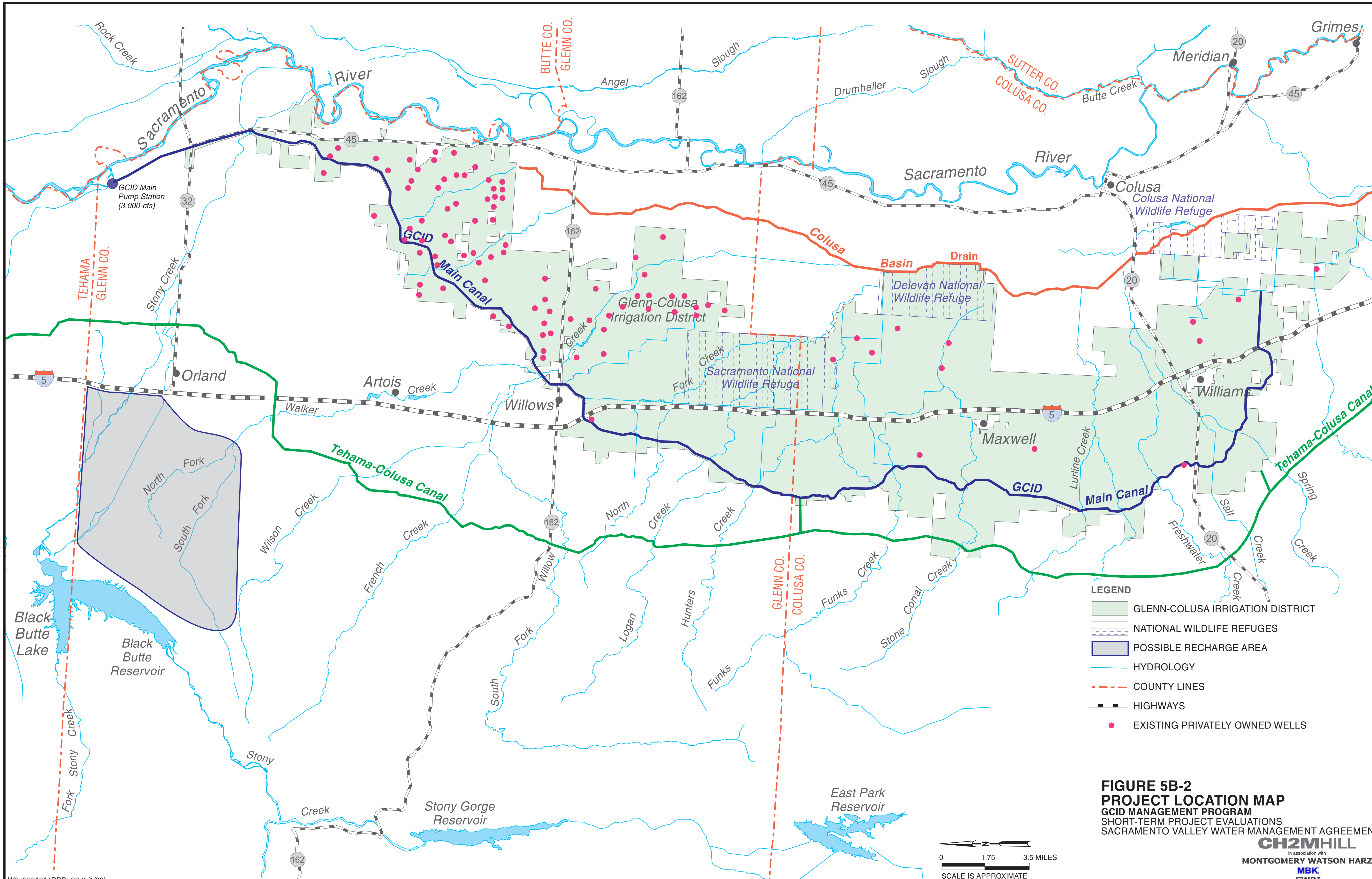


FIGURE 5B-2
PROJECT LOCATION MAP
GCID MANAGEMENT PROGRAM
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

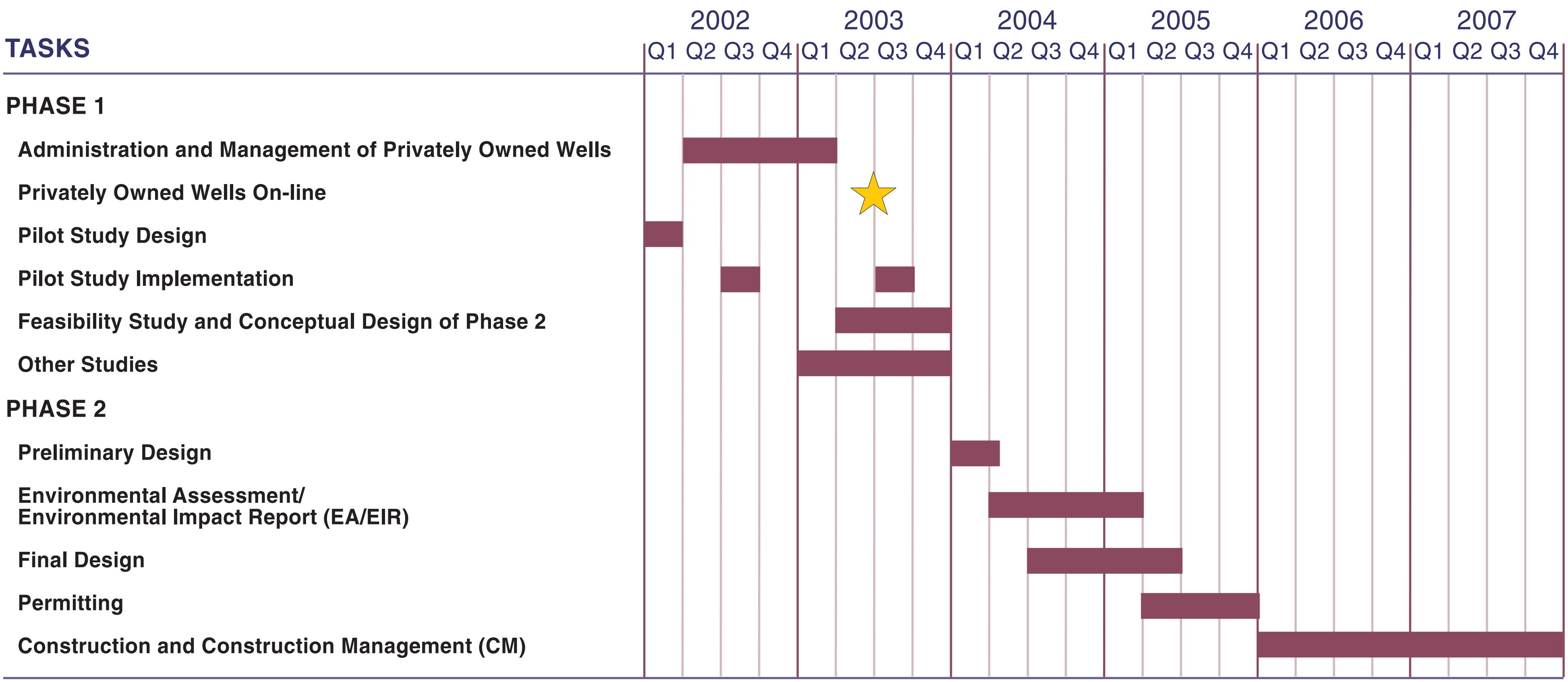


FIGURE 5B-3
PRELIMINARY IMPLEMENTATION SCHEDULE
GCID DEVELOPMENT OF CONJUNCTIVE WATER MANAGEMENT FACILITIES
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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MBK
SWRI

W072001014RDD_62 (10/26/01)

Project 5B—Draft CEQA Environmental Checklist

Project 5B—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature	Date
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☒	☐	☐	☐
Recharge basins may be used to accelerate the recharge of water into the groundwater basin, using available excess surface water supplies in wet or average water years. Approximately 200 acres of reclaimed existing gravel mining basins adjacent to Stony Creek, and 600 acres of new recharge basins would be constructed for use as recharge basins. The recharge basins may require a permanent conversion of potential Prime Farmland, Unique Farmland, or Farmland of Statewide Importance.				
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☒	☐	☐	☐
See response to II (a) above.				
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☒	☐	☐	☐
See response to II (a) above.				
III. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMP) during construction would reduce the amount of emissions and reduce the impact to a less than significant level.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☒	☐	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☒	☐	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☒	☐	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☒	☐	☐	☐
See response to IV (a) above.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace any vegetation removed during construction, which would reduce the impact to a less than significant level.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☒	☐	☐
See response to IV (e) above.				
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
See response to VII (a) above.				
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☒	☐
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Violate any water quality standards or waste discharge requirements? *Increases in turbidity would be likely to occur during any in-stream construction work. Additionally, there is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan and the implementation of BMPs to reduce any impacts to waterways in and around the project area.*	☒	☐	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted). *There are serious concerns about the long-term draw-down of the groundwater table and land subsidence, particularly in dry years. Model development would help determine the effects of increased groundwater pumping. The impact that groundwater withdrawal would have on existing groundwater supplies is as yet undetermined; however, it is potentially significant because of the complexity of the issue.*	☒	☐	☐	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site? *Locations of recharge basins and/or additional conveyance facilities may have some affect on drainage patterns of naturally existing waterways. These facilities would be located in such a way as to minimize any impact to existing drainage of the project area.*	☐	☒	☐	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site? *See response to VIII (c) above.*	☐	☒	☐	☐
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☒	☐	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to less than significant levels.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☒	☐	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☒	☐	☐

PROJECT 5C/D

Glenn-Colusa Irrigation District Flow Measurement Devices in Main Canal, Lateral System, and Drain Outflow Points/Existing Automation Program

1. Project Description

Project Type:	System improvement
Location:	Glenn and Colusa
Proponent:	Glenn-Colusa Irrigation District (GCID or District)
Project Beneficiaries:	GCID, in- and out-of-basin users, environment, Delta
Total Project Components:	Permitting, design, and construction of 30 flow measurement devices at previously identified system outflow points; design and construction of four check structure replacements on Main Canal
Potential Supply:	40,000 acre-feet per year (ac-ft/yr)
Cost:	10.2 million
Current Funding:	None
Short-term Component:	Permitting, design, and construction of 12 flow measurement devices at previously identified system outflow points; design and construction of four check structure replacements on Main Canal
Potential Supply (by 2003):	40,000 ac-ft/yr
Cost:	$8.7 million
Current Funding:	None
Implementation Challenges:	Possible environmental impacts of construction, acquisition of right-of-way/easements
Key Agencies:	U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG)

Summary

The purpose of this memorandum is to technically evaluate a project that would continue GCID's commitment to increase water use efficiency. The District proposes to construct 30 flow measurement devices with telemetry throughout the GCID conveyance system to continuously monitor system flows and outflows telemetrically, thereby improving water management within the District and conceivably throughout the sub-basin. Eighteen of the sites would be dedicated to the measurement of Main Canal, lateral, and drainage flows. The remaining 12 sites would be dedicated measurement sites for system outflows. Further, the District proposes to continue GCID's efforts to automate their Main Canal control structures to increase water use efficiency through reduction of operational spills.

Glenn-Colusa Irrigation District is located in the central portion of the Sacramento Valley on the west side of the Sacramento River, as illustrated on Figure 5C/D-1. The District's service area extends from northeastern Glenn County near Hamilton City to south of Williams in Colusa County. The east side of the District stretches toward the Coastal Range and Tehama-Colusa Canal Authority (TCCA). Its main facilities include a 3,000-cubic foot per second (cfs) pumping plant and fish screen structure, a 65-mile Main Canal, and approximately 400 miles of laterals and drains.

With 175,000 acres, GCID is the largest irrigation district not only in the Colusa Sub-basin, but also in the Sacramento Valley itself. The soils within this area generally consist of clay-like characteristics and are considered some of the most prime soils for agricultural in the world. The low infiltration rates of the tight soils are conducive to furrow and border irrigation. To that end, rice is the District's predominant crop. Other crops include but are not limited to tomatoes, vine crops, sunflowers, prunes, almonds, and walnuts. Typical years include more than 75 percent of its irrigated acreage in rice.

The Sacramento River serves as the principal water source for the District. Its diversion, the largest surface water diversion on the river, lies at the head of the District, just north of Hamilton City. The District also has the ability to supplement its supply with groundwater from local production wells through a voluntary conjunctive use program. The extensive canal system conveys water year-round as part of its commitment to is stakeholders and neighboring wildlife refuges.

Conservation Efforts

Recently, GCID's ability to divert their full entitlement was reduced because of the endangered species limitations associated with the District's previous fish screen operation. In addition, several years were classified as "critical years," and contract supplies were reduced to 75 percent of entitlements. The District managed several programs to supplement these reduced supplies, including the conjunctive use program mentioned above. Other programs included a water conservation program, which at one time required water use patrols around the District, and a water reuse program.

GCID has used its water management programs to significantly reduce its surface water diversions and irrigation demands. Within the last decade, GCID diversions have been reduced by an estimated 25 percent, large part because of conservation practices and such factors as precision farming techniques. Further, the District is continuously striving to increase the efficiency of their system through automation and water reuse.

An aggressive drainwater recapture program, which includes both groundwater seepage and tailwater runoff from cultivated fields from within GCID's service area, is a part of the District's overall water management program. GCID recaptures this water with both gravity and pump systems. Recaptured water is delivered to either laterals or the Main Canal for reuse. Currently, GCID recycles approximately 155,000 acre-feet (ac-ft) annually.

Much of GCID's drainwater is captured for use by downstream districts such as Provident Irrigation District (PID), Princeton-Codora-Glenn Irrigation District (PCGID), and Maxwell Irrigation District (MID). Glenn-Colusa Irrigation District is one of the irrigation districts that signed the Five Party Agreement of June 2, 1956. This agreement represents a cooperative effort by GCID, PID, PCGID, MID, and two entities that have since dissolved to share operation and maintenance of the drains within their respective service areas and to share the right to recirculate the water in those drains. In addition, Colusa Basin Drain Mutual Water Company members (57,000 acres, gross) rely on tailwater from GCID and other upstream water users.

GCID adopted a Water Transfer Policy in 1995. This policy identifies agricultural water users within the Sacramento Valley as the highest priority, and environmental purposes as the second highest priority for future water transfers. An In-basin Water Transfer Program was introduced in 1997 that provides for up to 20,000 ac-ft to be transferred to neighboring lands in full water supply years.

Short-term Component

GCID would come on-line with the first phase of its expanded flow measurement program within 2 years of project approval. Facility operations during the interim phasing of the project are expected to include 10 of the 30 proposed measurement sites. Construction of the first 10 structures would be expected to be completed by spring of 2003, with Phase 1 benefits realized during the 2003 irrigation season (approximately April through October). Design, permitting, and environmental documentation of the first set of structures are anticipated to require 1 year. One year is a conservative estimate given the recent activity of similar projects along the GCID Main Canal. Construction of the flow measurement facilities could be completed within 1 year. The benefits of the first phase of the project would be realized immediately upon operation. GCID would be able to record and monitor flows at the up-and-running sites immediately and adjust system operations accordingly.

GCID has proposed the replacement of four Main Canal check structures and the construction of a tainter gate at the Stony Creek Siphon (labeled Phase 1b). The existing Main Canal check structures control the canal head with flashboard structures that are decades old. This proposed project suggests replacing the four check structures on the Main Canal that have yet to be automated: Tuttle Check (Main Canal mile post 21.75), Able Check (Main Canal mile post 48.70), Lurline Creek Check (Main Canal mile post 53.71), and Spring Creek Check (Main Canal mile post 58.06), with radial gate check structures. Phase 1b would occur concurrently with Phase 1a.

The entire Phase 1b project is expected to be completed and fully utilized within 2 years of project approval. Design, permitting, and environmental documentation is anticipated to require 1 year. One year is a conservative estimate given the recent activity of similar projects along the GCID Main Canal. Demolition of the existing structures and construction of the new check structures could be completed within 1 year. The benefits of the project would be realized in December 2003.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The entire project is expected to be completed and fully utilized within 4 years of project approval. All construction is expected to be completed by spring of 2005, with project benefits realized during the 2005 irrigation season (approximately April through October.) Design and construction of all of the facilities would be completed on a rolling schedule, splitting up the 30 facilities into three packages of ten. Once the first package (Phase 1) is under construction, Phase 2 would follow with simultaneous design of the second package. Once the second package (Phase 2) is under construction, Phase 3 (the final phase) would follow with simultaneous design of the third package, the final ten measurement sites. Environmental permitting and documentation would be completed for all phases at the same time. See Figure 5C/D-2 for an illustration of project implementation. Each consecutive period of design ideally would be shorter in length because of the similarity of sites and structures.

Rather than send this project out to bid, the District could conceivably be responsible for the construction and/or installation of the measurement devices. The implementation schedule provided on Figure 5C/D-2 reflects this arrangement. The anticipation of the use of District forces in implementing this program would be based on the assumption that all measurement structures that require construction would accommodate flows less than 800 cfs. The facilities for this project are expected to include weirs, doppler, staging gages, and flumes.

2. Potential Project Benefits/Beneficiaries

The proposed construction of new facilities is expected to generate numerous benefits for both the local and regional water users. The beneficiaries of this program include GCID, downstream users, the environment, and the Sacramento-San Joaquin Delta. The following benefits are discussed in this section:

- Water Supply
- Water Management
- Environmental
- Water Quality

Water Supply Benefits

The viable water supply benefits under this program would be derived from the increased efficiency of the GCID delivery system. The District estimates that a reasonably monitored delivery and drainage system could be instrumental in avoiding up to 40,000 ac-ft of operational spills annually through improved management of existing supplies. GCID Main Canal spills, combined with Colusa Basin Drain flows, can range from 100 cfs to 2,000 cfs weekly. Managing and controlling flow fluctuation could yield flow benefits of hundreds of acre-feet daily. This could directly translate into reduced surface water diversions and subsequently into increased in-stream Sacramento River flows. This additional supply could assist in meeting in-basin and/or out-of-basin needs.

Water Management Benefits

Water management benefits include:

- **System Efficiency—**The most significant benefit and predominant goal of the project is increased system efficiency, or more specifically, water use efficiency. The measurement of GCID’s delivery and drainage system flows would substantially improve the District’s ability to more efficiently utilize their supply. The monitoring network would enable District staff to micromanage water delivery. The flow measurement structures and system would be used to analyze flow patterns to support operation decisions to manage flow. Measurement and tracking of system flows add a necessary dimension to the management of water supply by allowing the owner to more accurately define its water use. Further, the automation of GCID’s Main Canal would substantially contribute to the District’s efficient use of their supply. The automated check structures would enable District staff to micromanage water delivery and prevent the majority of the inevitable operational spills that are often associated with flashboard structures.

- **System Automation**—The new measurement devices could be incorporated with ongoing efforts by the District to automate the Main Canal. Flow measurement would allow GCID to maximize the use of automated structures, increasing its ability to manage system flows.

- **System Flow Measurement**—The new structures could be incorporated with ongoing District efforts to more accurately define their system flows and outflows. Measurement and tracking of system flows add a necessary dimension to the management of water supply by allowing the owner to more accurately define its water use.

- **GCID Operations**—The District would not sacrifice flexibility of delivery with additional structures or with construction. The District would be able to increase (and monitor) the dynamic head of the system, which could be used to provide temporary relief during an energy shortage. Less maintenance would be required because of automation and off-site controls. Also, the level of safety is increased for operational and maintenance staff. Flashboard structures can be extremely dangerous. Maintenance would be minimized through off-site controls and telemetry.

Environmental Benefits

As GCID's primary source of supply, the Sacramento River would be directly and most beneficially influenced by the District's efficient use of its water supply. The environmental benefits associated with this project would be quantified throughout the various stages of the project, from feasibility study through final design. Some environmental benefits that have been identified at this level of investigation include:

- **Sacramento-San Joaquin Delta/Downstream Water Purveyors**—The decrease in surface water diversions has the potential for increasing available seasonal in-stream flows to the Delta. The District's decreased diversions, an estimated 40,000 ac-ft, is a quantifiable number that directly reflects the potential increased available supply in the Sacramento River.
- **Aquatic/Riparian Habitat**—Improved in-stream flows would generate expected fisheries benefits, both in terms of water quality and sheer volume of water. Further, the reduced tailwater flows could potentially reduce straying of fish into the Colusa Basin Drain at Knights Landing by inadvertently reducing attraction flows for salmonids.

Water Quality Benefits

Water quality benefits of the project would generally stem from the increased in-stream flows. Improvements to both temperature and constituent properties of the river would be the most probable results of the increased flows. These benefits would need to be evaluated and modeled on a regional basis to determine impacts on water quality in the Sacramento River and the Delta.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Tables 5C/D-1, 5C/D-2, 5C/D-3 present order-of-magnitude project cost estimates for Phases 1a, 1b, and 2, respectively. Future stages of the project, from feasibility study to final design, would include progressively detailed cost estimates for the new facilities.

TABLE 5C/D-1
Phase 1a: Short-term Planning-level Project Costs
GCID Flow Measurement Devices in Main Canal, Lateral System, and Drain Outflow Points/Existing Automation Program

Facility	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)	Assumptions
GCID Measurement Sites	12	Each	50,000	600	Telemetry systems included
			Subtotal ->	**600**	
			Contingencies and Allowances (30%) ->	180	
			Total Construction Costs ->	780	
			Environmental Mitigation (5%) ->	40	
			Engineering, Environmental, Construction Management and Admin. (25%) ->	200	
			Total Short-term Project Cost for Phase 1a ->	**1,020**	

TABLE 5C/D-2
Phase 1b: Short-term Planning-level Project Costs
GCID Flow Measurement Devices in Main Canal, Lateral System, and Drain Outflow Points/Existing Automation Program

Item	Quantity	Units	Unit Price ($)	Total Cost (x 1,000)	Assumptions
Land Acquisition	4	Acres	6,000	24	
Easement/ROW Acquisition	12	Acres	1000	12	
Stony Creek Tainter Gate	1	Each	250,000	250	30 ft wide by 16 ft high
Tuttle Check Structure	1	Each	2,400,000	2,400	Each new check structure would have three radial gates; Cost includes demolition of existing structure
Able Check Structure	1	Each	670,000	670	
Luriline Creek Check Structure and Siphon	1	Each	765,000	765	
Spring Creek Check Structure and Siphon	1	Each	412,000	412	
			Subtotal ->	**4,530**	
			Contingencies and Allowances (30%) ->	1,360	
			Environmental Mitigation (5%) ->	300	
			Total Construction Costs ->	5,890	
			Engineering, Environmental, Construction Management and Admin. (25%) ->	1,470	
			Total Project Cost for Phase 1b ->	**7,660**	
			Total Short-term Project Cost (Phases 1a & 1b) ->	**8,680**	

ROW = right-of-way

TABLE 5C/D-3
Phase 2: Short-term Planning-level Project Costs
GCID Flow Measurement Devices in Main Canal, Lateral System, and Drain Outflow Points

Facility	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)	Assumptions
GCID Measurement Sites	18	Each	50,000	900	Telemetry systems included
			Subtotal ->	900	
			Contingencies and Allowances (30%) ->	270	
			Total Construction Costs ->	1,170	
			Environmental Mitigation (5%) ->	60	
			Engineering, Environmental, Construction Management and Admin. (25%) ->	290	
			Total Project Cost for Phase 2 ->	**1,520**	
			Total Project Costs (Phase 1a, 1b, and 2) ->	**10,200**	

Early phases of the project work would focus on refining the project scope and concepts through a feasibility study and preliminary design effort that should include modeling the system. It may be possible to utilize a model being developed for the District by the Irrigation Training and Research Center (ITRC) in San Luis Obispo. Some aspects of the project may be funded through existing programs. Currently, no other funding sources are in place for this project.

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment, notably through the reduction of spills and surplus flows that may provide environmental benefits. Often, when these “surplus” flows have been present for an extended amount of time, various entities may consider the water to be an entitlement, and may oppose changes to the flows. In such cases, it is common for projects to be subject to additional environmental scrutiny. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways; however, much of the work that is proposed to occur in the canal itself may be exempt from environmental review. It is likely that the appropriate level of environmental documentation necessary for this project would be an Initial Study/Finding of No Significant Impact (IS/FONSI), unless there is notable opposition to the changes in spill flow, in which case the project may require an environmental impact statement/environmental impact report (EIS/EIR).

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Large amounts of earthwork would be required for the recharge basins. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)**—The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Lands Commission—**Project would need to consult with State Lands Commission on the public agency lease/encroachment permitting for use of state lands.
- **State Reclamation Board—**The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)—**Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

The project implementation would occur in several incremental stages. Some political and environmental issues are related to long-term and consistent decrease in tailwater. The project would need to be developed in a manner that supports the objectives of the local and regional water management plans. The following lists some of the implementation challenges anticipated to be associated with this project:

Coordination among Public and Private Entities

Coordination would be required among local, state, and federal entities such as GCID, USFWS, USBR, and DWR. The governmental agencies would have interests associated directly with the project and indirectly as it may affect other interests in the area. Reliable communication and integrated coordination would be required to create a successful project.

Water Rights Implications

GCID participation would be predicated on the operation of such a program and would occur within the guise of the District's existing water rights. Decreases in surface water diversions would be anticipated in some years, and full contract quantities would be used in other years.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are located within the area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Downstream Water Users

Some downstream water users that do not belong to the District rely on releases and tailwater as part of their water supply (e.g., Colusa Basin Drain Mutual Water Company). Decrease of this supply could cause some discontent and political upheaval with such parties.

6. Implementation Plan

The following major steps would be required to implement the project. Each step depends on successful completion of the previous supporting steps and findings that support further actions. Figure 5C/D-2 shows an assumed implementation schedule based on typical time requirements for each step in a project of this scale.

1.1 Feasibility studies and conceptual design—This step can begin immediately and is intended to develop the specific project components, general features, operating concepts, and potential benefits. It would also determine the basic engineering and economic feasibility of the project. This step would also help determine the need for other studies such as system modeling.

2.1 Preliminary design—The preliminary design would involve engineering design of the major facilities to a 30-percent design level. This level of design would include such details as sizes, locations, and footprints of all major facilities. This information would support key implementation steps such as right-of-way acquisition (if required) and permitting and environmental studies.

2.2 Environmental documentation—Environmental documentation would be based on the preliminary design and would confirm the potential impacts and required mitigation, if any, for the project. The majority of the project would be within District boundaries and right-of-way. This project is expected to have minimal environmental impact.

2.3 Final design—Final design would proceed following the environmental documentation work. This would involve producing engineering drawings, specifications, and other final documents suitable to construct the project facilities. The type of documents and level of design would be based on District procedure, i.e., whether the project would go out to bid or construction would take place through the District.

2.4 Permitting—The various permits would be obtained using the final design as the basis for permitting requirements. The permitting process would begin during preliminary design.

2.5 Construction—Construction would potentially be phased over several years, given the number of facilities within the project.

3.1 Operation and monitoring—Long-term operations and monitoring of the project would begin following completion of construction.

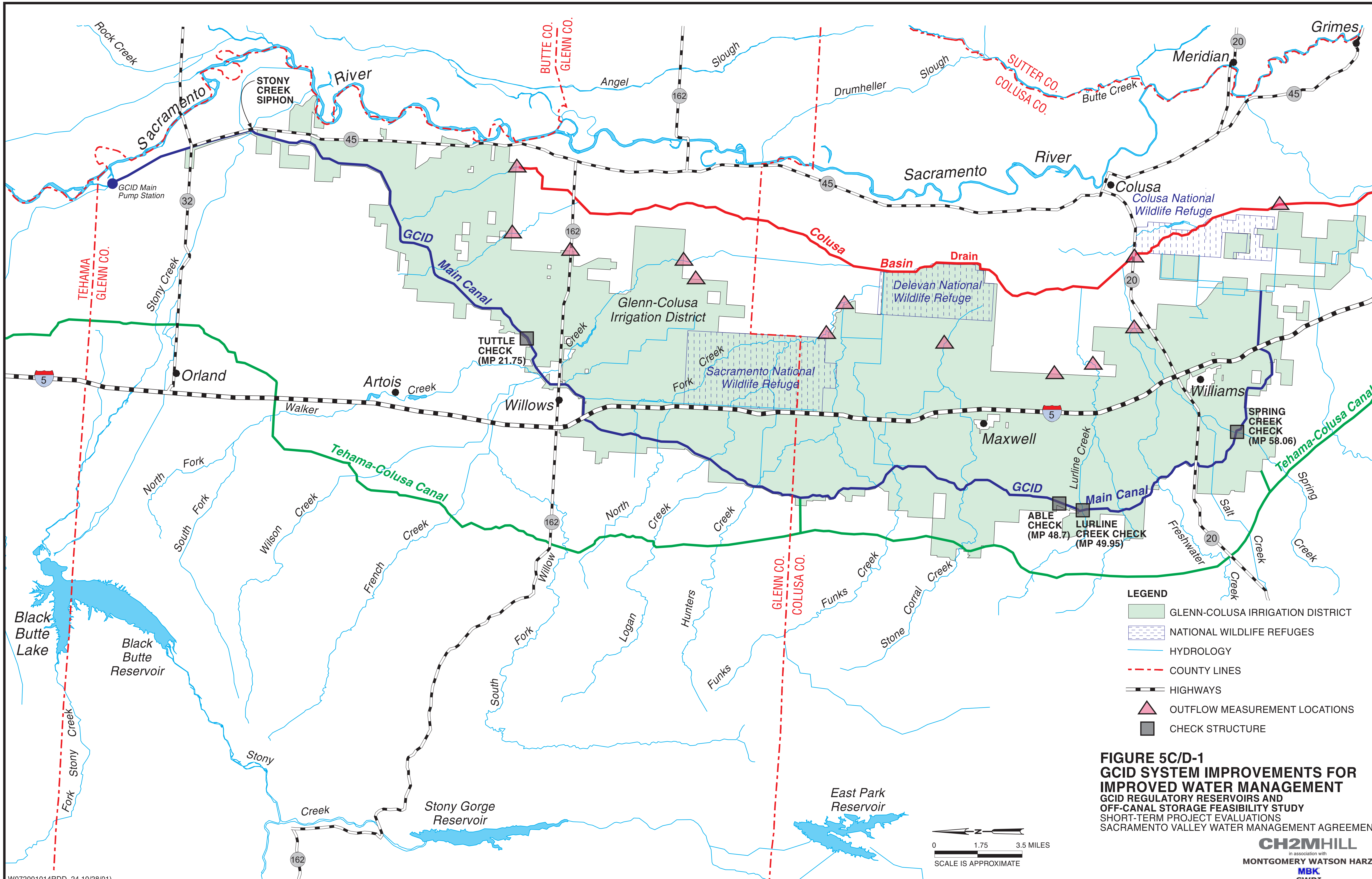

FIGURE 5C/D-1
GCID SYSTEM IMPROVEMENTS FOR IMPROVED WATER MANAGEMENT
GCID REGULATORY RESERVOIRS AND OFF-CANAL STORAGE FEASIBILITY STUDY
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

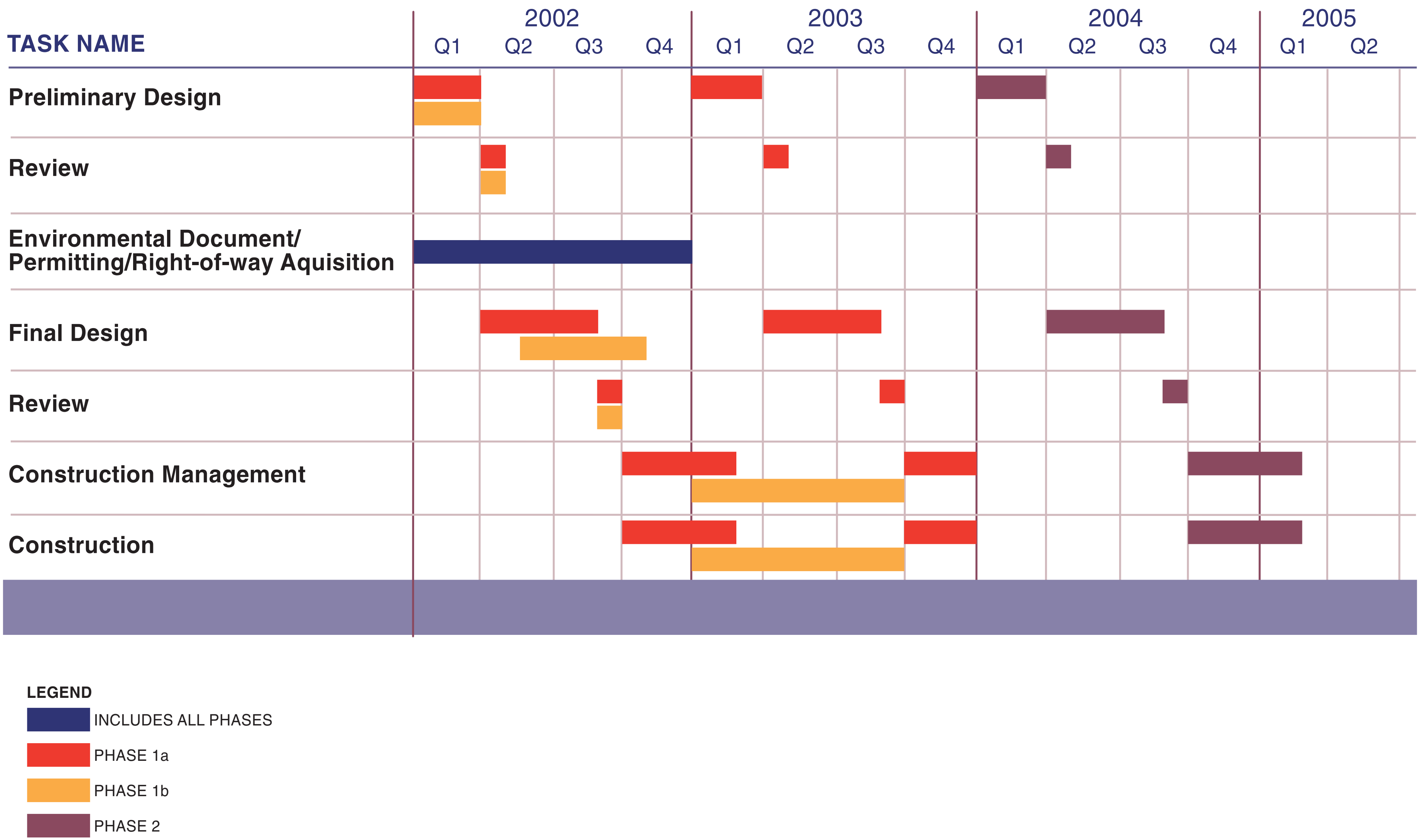

FIGURE 5C/D-2
PRELIMINARY IMPLEMENTATION SCHEDULE
GCID FLOW MEASUREMENT DEVICES IN MAIN CANAL, LATERAL SYSTEM, AND DRAIN OUTFLOW POINTS/EXISTING AUTOMATION PROGRAM
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_29(2/10/02)

Project 5C/D—Draft CEQA Environmental Checklist

Project 5C—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________ ____________________

Signature Date

______________________________ ____________________

Printed Name For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	☒
III. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to a less than significant level.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project construction scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☒	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☒	☐	☐
See response to IV (a) above.				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace vegetation removed during construction, which would reduce the impact to a less than significant level.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☒	☐	☐
See response to IV (a) above.				
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
Increases in turbidity would be likely to occur during any in-stream construction work. Additionally, there is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan and the implementation of BMPs to reduce any impacts to waterways in and around the project area.				
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
<u>XII. POPULATION AND HOUSING</u>—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
<u>XIII. PUBLIC SERVICES—Would the project:</u>				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
<u>XIV. RECREATION—Would the project:</u>				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>XV. TRANSPORTATION/TRAFFIC</u>—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
<u>XVI. UTILITIES AND SERVICE SYSTEMS</u>—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

Project 5D—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature ____________________ Date ____________________

Printed Name ____________________ For ____________________

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☒	☐
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☒	☐
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions and reduce the impact to a less than significant level.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project construction scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☒	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☒	☐	☐
See response to IV (a) above.				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace vegetation removed during construction, which would reduce the impact to a less than significant level.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☒	☐	☐
See response to IV (a) above.				
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
Increases in turbidity would be likely to occur during any in-stream construction work. Additionally, there would be a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan and the implementation of BMPs to reduce any impacts to waterways in and around the project area.				
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☐	☒
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
<u>IX. LAND USE AND PLANNING</u>—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
<u>X. MINERAL RESOURCES</u>—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
<u>XI. NOISE</u>—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
<u>XII. POPULATION AND HOUSING</u>—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
<u>XIII. PUBLIC SERVICES—Would the project:</u>				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
<u>XIV. RECREATION—Would the project:</u>				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>XV. TRANSPORTATION/TRAFFIC</u>—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
<u>XVI. UTILITIES AND SERVICE SYSTEMS</u>—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☐	☒

PROJECT 5E

Glenn-Colusa Irrigation District Glenn County Groundwater Monitoring Program and Model Development

1. Project Description

Project Type:	Groundwater/surface water planning
Location:	Glenn County and the Stony Creek Fan
Proponent:	Glenn-Colusa Irrigation District (GCID or District)
Project Beneficiaries:	Groundwater users in Glenn County, agricultural water users, GCID, Tehama-Colusa Canal Authority (TCCA), Orland Unit Water Users' Association (OUWUA), Orland–Artois Water District (OAWD), downstream water users
<u>Total Project Components:</u>	Short-term components, develop groundwater model, install additional monitoring wells, support future conjunctive use projects in the county and facilitate the proper planning and management of those projects
Potential Supply:	To be determined – this project would support subsequent studies to determine potential supply from the Stony Creek Fan
Cost:	$5.7 million
Current Funding:	$250,000 (AB 303 grant)
<u>Short-term Components:</u>	Develop groundwater data clearinghouse, analyze existing data, design monitoring program, install new monitoring wells
Potential Supply (by 2003):	None
Cost:	$2.7 million
Current Funding:	$250,000 (AB 303 grant)
Implementation Challenges:	Local concerns regarding overdraft, land subsidence, and export of groundwater
Key Agencies:	GCID, Glenn County, California Department of Water Resources (DWR)

Summary

The Stony Creek Fan within Glenn County has long been considered a groundwater resource with high potential for water supply benefits. The thick alluvial fan deposits combined with high rates of Stony Creek seepage indicate potential for groundwater storage and withdrawal. Implementation of a proposed conjunctive use project would require a thorough analysis of the groundwater system response. This proposed groundwater monitoring and modeling project is a necessary step to quantify the impacts and benefits of increased groundwater development in Glenn County. The geographic scope of the program is shown on Figure 5E-1.

The groundwater monitoring and model development project would support efforts in Glenn County to develop locally managed conjunctive use programs that may have the potential to supply up to 100,000 acre-feet (ac-ft) of groundwater for use during dry periods. The monitoring system would provide valuable data to develop accurate baseline information for modeling the groundwater basin and the impacts of potential conjunctive use operations. Glenn County does not have adequate funds to develop such a monitoring system in a timely manner.

The proposed project would support the Glenn County Groundwater Management Ordinance (Title 20, Chapter 3). The county does not intend to regulate the use of groundwater unless locally defined Basin Management Objectives (BMO) are violated. The BMOs are defined by local water users within hydrologic sub-areas of Glenn County. Maintaining and enforcing the BMOs are dependent on a well-designed monitoring program and groundwater model. GCID has recognized the need for funding and has taken a lead role in promoting this Glenn County monitoring and modeling project.

Funding assistance is needed to perform the following tasks: develop and maintain a clearinghouse for all existing groundwater monitoring efforts, determine additional monitoring requirements and design a monitoring program, install additional monitoring wells, and develop a groundwater model. The proposed groundwater program is expected to be completed by 2005, but has longer-term implications if groundwater development expands and conjunctive management of surface water and groundwater becomes more prevalent in Glenn County. The short-term and long-term components of the program are described below.

Short-term Component

Several tasks related to the countywide monitoring program would begin immediately after funding. The start of the project would only be delayed by the time required to hire staff or a consultant to support the proposed groundwater activities. The proposed short-term tasks described below would be completed by December 2003.

Clearinghouse for Groundwater Data

Hundreds of wells currently exist within Glenn County. Several wells are monitored for groundwater level by DWR on a seasonal basis. In addition, GCID monitors the levels in agricultural production wells that participate in the ongoing cooperative GCID groundwater program. Other entities such as municipalities, irrigation districts, U.S. Bureau of Reclamation, University of California, and U.S. Geological Survey monitor wells also. In addition to obtaining groundwater-level data, some water quality data is required to fully evaluate the feasibility of additional groundwater development in the Stony Creek Fan.

The proposed groundwater data clearinghouse would establish monitoring standards and place all groundwater data into a single database. The database would likely reside within the Glenn County Public Works Department. The clearinghouse would promote coordination among public and private entities involved with groundwater resources. Establishing an organized groundwater database and making it accessible to interested parties would facilitate proper groundwater development and conjunctive use management within Glenn County.

Monitoring Program

Prior to expanding the current level of groundwater monitoring activities, an inventory of all wells would need to be undertaken. Location of wells and capacity information would be noted. Also critically important would be the elevation of well screening and identification of the corresponding geologic formation. Pumping from different aquifers would have different effects on local groundwater levels and the overall system. The monitoring program would establish monitoring standards for all county wells and determine the frequency of data collection and what parameters other than groundwater levels need to be measured.

Installation of Monitoring Wells

After a thorough examination of existing groundwater data and the geographic distribution, a determination would be made on the location and number of new monitoring wells. These wells would be “multi-completion” wells where the perched aquifer and all deeper-confined aquifers would be penetrated and monitored. In addition, extensometers on some new groundwater monitoring wells would measure land subsidence, which is the consolidation of soils after groundwater withdrawal. Land subsidence issues must be considered with any proposed groundwater project requiring proper data collection. GCID proposes that approximately 50 new monitoring wells may be necessary to adequately monitor the Stony Creek Fan. For the short-term component (through 2003) half of the proposed number of wells and two extensometers will be completed.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost would occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The proposed monitoring and modeling project is expected to last through 2005. Included in the long-term component of the program is continued monitoring of existing and new wells and maintaining the newly established groundwater data clearinghouse. Additional tasks of the long-term component (beginning in January 2004) are described below.

Installation of Additional Monitoring Wells

The installation of monitoring wells is expected to continue in 2004. Depending on the design of the monitoring network, the remaining number of new wells recommended during the design of the monitoring program would be installed. Up to 25 new wells are expected to be installed to complete the monitoring network.

Development of the Stony Creek Fan Groundwater Model

A model of the groundwater resources within the Stony Creek Fan and throughout Glenn County would be required to understand the impacts of an expanded groundwater withdrawal and possible recharge program within Glenn County. Another objective of the model would be to establish the hydraulic connection between the groundwater aquifers and the Sacramento River. This is critical for establishing optimal locations for pumping and recharge for a managed conjunctive use program and to determine safe levels of groundwater development. A calibrated model would also be a management tool upon implementation of a conjunctive use project. The model would use existing groundwater data collected in the clearinghouse process and data from new monitoring wells.

Prior to model development, coordination with the DWR Integrated Storage Investigations (ISI) would be necessary to avoid the duplication of engineering efforts. A detailed set of model objectives would be required prior to development with input from various water interests.

The calibrated model would allow the county to examine the potential impacts on the local water resources as a result of additional groundwater use. This would include impacts if the groundwater was used locally or exported to water-short areas, including south-of-Delta. The model would also predict long-term groundwater levels under varying levels of pumping and artificial recharge. The model would identify locations and quantities for the development of recharge basins.

Long-term Implications

The ultimate goal of the Glenn County groundwater program is to fully support future conjunctive use projects in the county and facilitate the proper planning and management of these projects. Several projects in the Stony Creek Fan within Glenn County are being proposed. This includes the DWR ISI and several projects proposed as part of the Sacramento Valley Water Management Agreement. These projects and their proposed timeframe are listed in Table 5E-1.

TABLE 5E-1
Proposed Groundwater Development and Conjunctive Use Projects in the Stony Creek Fan
Glenn-Colusa Irrigation District Glenn County Groundwater Monitoring and Modeling Project

Sacramento Valley Water Management Agreement Project	Proponents	Time Frame
Stony Creek Fan Conjunctive Water Management Program (Project 8A)	OAWD, OUWUA, GCID	Pilot studies completed 2003 to 2005. Long-term implementation could begin in 2005.
GCID Development of Conjunctive Water Management Facilities (Project 5B)	GCID	Pilot studies and partial groundwater well network completed by December 2003. Completion of plan and development of new wells by 2005.
OUWUA and TCCA Regional Water Use Efficiency (Project 9A)	OUWUA	Implementation in 2007 to 2010.

2. Potential Project Benefits/Beneficiaries

An objective of the proposed monitoring and subsequent modeling efforts is to address the proper management of the local groundwater resources that could in turn provide numerous benefits to Glenn County water users, downstream water users, and Delta water needs. This effort could quantify sustainable pumping quantities and the required recharge to maintain acceptable groundwater-level seasonal fluctuations and prevent long-term drawdown of the groundwater table.

Water Supply Benefits

The proposed project would evaluate the current level of monitoring, organize existing data into one database, determine the location of new monitoring wells, and continue to collect data. This process would be incorporated into a groundwater model that would assist any proposed conjunctive use project in the county. Ultimately, this monitoring and modeling project would lead to a managed conjunctive use project with real water supply benefits. This project would also be an opportunity for the general public to understand how the groundwater is impacted, both positively and negatively, with a managed conjunctive use program.

Primary beneficiaries of an implemented conjunctive use program would be agricultural water users in Glenn County. The new supply would supplement surface water supplies and firm up water needs in dry years for users such as GCID and TCCA. Downstream water users could also benefit if surface water normally diverted was made available after a conjunctive management program was implemented.

Water Management Benefits

Developing the tools for proper conjunctive management of surface water and groundwater supplies within Glenn County is the focus of this project. Proper management and an understanding of the impacts of increased groundwater development will be critical if any proposed conjunctive use projects are to be implemented. This monitoring and modeling project would be a necessary step for development. Another management aspect of the proposed project would be to combine all current monitoring efforts into one database, which would promote cooperation within the groundwater basin. The proposed model would assist in determining how much operational flexibility a managed conjunctive use program would achieve.

Environmental Benefits

The proposed monitoring and modeling program would not directly provide environmental benefits, but would provide valuable information that could be used to evaluate future conjunctive use projects. Future conjunctive use projects would use the data and model to determine environmental benefits in terms of water quantity. Reduced surface water diversions by GCID, TCCA, or others results in more water in the Sacramento River and/or the Delta for potential environmental purposes such as in-stream flows or meeting water quality standards.

Water Quality Benefits

Water quality parameters would likely be measured and included in the groundwater data clearinghouse. Monitoring would help establish a baseline for groundwater quality and possibly identify sources of contamination. This program would identify how much influence a conjunctive use project would have on flows in the Sacramento River as well as inflows to the Delta.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Table 5E-2 shows the anticipated short-term implementation costs of the Glenn County groundwater monitoring and modeling program. The costs of program elements that extend beyond December 2003 are shown in Table 5E-3. These costs represent the likely maximum number of monitoring wells required for an extensive program. The design of the monitoring program would include the basis for the number of wells and location throughout Glenn County. The number and location of monitoring wells with extensometers would also be determined in this project task. This cost estimate assumes that 50 monitoring wells would be installed and two of those would include extensometers.

TABLE 5E-2
Estimated Costs for Short-term Component
Glenn-Colusa Irrigation District Glenn County Groundwater Monitoring and Modeling Project

Task	Quantity	Units	Unit Price ($)	Total Cost ($ x1000)	Assumptions
Develop and Maintain Data Clearinghouse	2	Years	25,000	**50**	
Review and Design Monitoring Program	1	Each	25,000	**25**	
Install Monitoring Wells	25	Each	80,000	**2,000**	Multi-completion wells, includes geologist, mapping, recorder
Install Extensometers	2	Each	10,000	**20**	Additional cost on two multi-completion wells
		Short-term Program Cost Subtotal ->		2,100	
		Contingency (30%) ->		630	
		Total Short-term Cost ->		**2,730**	

TABLE 5E-3
Estimated Costs for Long-term Component
Glenn-Colusa Irrigation District Glenn County Groundwater Monitoring and Modeling Project

Task	Quantity	Units	Unit Price ($)	Total Cost ($ x1000)	Assumptions
Install Additional Monitoring Wells	25	Each	80,000	**2,000**	Multi-completion wells, includes geologist, mapping, recorder
Develop Groundwater Model	1	Lump Sum	300,000	**300**	
		Long-term Program Cost Subtotal ->		2,300	
		Contingency (30%) ->		690	
		Total Long-term Cost ->		**2,990**	

Other Sources of Funding

Partial funding has been secured for the proposed monitoring program. The AB 303 grant program is committed to providing $250,000. The grant would be used for the installation of four new monitoring wells. Currently, Glenn County does not have the financial resources to support the entire proposed program in a timely manner. Therefore, requested additional funding totals $5.25 million.

4. Environmental Issues

This project is primarily an exercise in data collection and analysis. No physical impacts are anticipated to occur as a result of the project, although the results of the project may lead to the development of future projects. It is anticipated that the appropriate level of environmental documentation for the project would be a Categorical Exclusion/Categorical Exemption, requiring a very minimal degree of effort.

A draft California Environmental Quality Act (CEQA) environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

There are serious concerns about the long-term drawdown of the groundwater table and land subsidence as a result of any conjunctive use program. The proposed model development would help determine the effects of increased groundwater pumping. Local involvement would be required to get any conjunctive use project implemented, and the proposed monitoring and modeling program may be the vehicle for public involvement. If the general public is familiar with model development through outreach at irrigation district landowner meetings or other meetings, then the model results may have more local credibility and support when prospective conjunctive use programs are evaluated.

Long-term exporting of in-basin water supplies is a sensitive political issue. Estimates of local benefits and exported water would have to be a part of any future conjunctive use program. The local opposition would likely increase if the water produced is mostly for export. A public outreach program incorporated with the monitoring and modeling program may be required to address public perception.

Key Stakeholders

Table 5E-4 describes many key stakeholders that would be involved with the implementation process. Many of the listed stakeholders would be providing historical groundwater data and ongoing monitoring for the clearinghouse. All of the listed stakeholders should be involved with establishing the objectives of the Stony Creek groundwater model. The future implications of the Glenn County monitoring and modeling program would likely involve all of these stakeholders with regard to the impacts and benefits of a conjunctive use project.

TABLE 5E-4
Stakeholder Roles and Issues
Glenn-Colusa Irrigation District Glenn County Groundwater Monitoring and Modeling Program

Stakeholder	Role	Issues
GCID	Project lead and potential groundwater developer	Quantify potential for development and safe yield; protect existing surface water rights, overdraft, and land subsidence; provide groundwater data
Glenn County	Eventual project lead; maintain data clearinghouse	Determine impacts on the county; maintain county economic base; enforce groundwater ordinance and BMOs
OUWUA	Potential groundwater developer	Same as GCID
OAWD	Potential groundwater developer	Same as GCID
TCCA	Potential groundwater developer	Same as GCID
City of Orland	Protect municipal water supply	Groundwater levels

TABLE 5E-4
Stakeholder Roles and Issues
Glenn-Colusa Irrigation District Glenn County Groundwater Monitoring and Modeling Program

Stakeholder	Role	Issues
Hamilton City	Protect municipal water supply	Groundwater levels
City of Willows	Protect municipal water supply	Groundwater levels
City of Artois	Protect municipal water supply	Groundwater levels
South-of-Delta exporters	Potential benefactor of new supply	Non-utilized surface water available for export?
Various local interest groups	Protect local economy	Would the new water be exported?
Environmental Interests	Habitat protection for Sacramento River and Delta	What is effect on Sacramento River and Delta inflow? Timing, temperature, quantity?
DWR	ISI lead; groundwater monitoring	Coordination with ISI program; support data clearinghouse
USBR, University of California, USGS	Groundwater monitoring	Support data clearinghouse

6. Implementation Plan

This project is ready to proceed upon complete funding. Assuming that the project would begin in January 2002, the estimated completion date is December 2005. The time schedule includes 1 year to develop the clearinghouse, 6 months to analyze data, 1 year to install the monitoring system, and 1 year to develop the model. The schedule includes 3 years of maintaining the established data clearinghouse.

Implementation must include coordination with the DWR ISI program, which is initiating groundwater model development in the Stony Creek Fan. Coordination should prevent duplication of cost-intensive modeling efforts.

This project has strong ties to other proposed Sacramento Valley Water Management Agreement projects in the Colusa Basin. The proposed Glenn County monitoring and modeling project is directly tied to any proposed conjunctive use programs in the Stony Creek Fan area including the Stony Creek Fan Conjunctive Water Management Program, OUWUA and TCCA Regional Water Use Efficiency, and the GCID Development of Conjunctive Water Management Facilities. Coordination with these projects would be essential.

Funding provided by the Sacramento Valley Water Management Agreement could be phased similar to the proposed schedule. The most costly task would be the installation of approximately 50 new monitoring wells to begin in June 2003, which would last approximately 1 year. Figure 5E-2 shows the general project cost and preliminary timeline for the monitoring and modeling project.

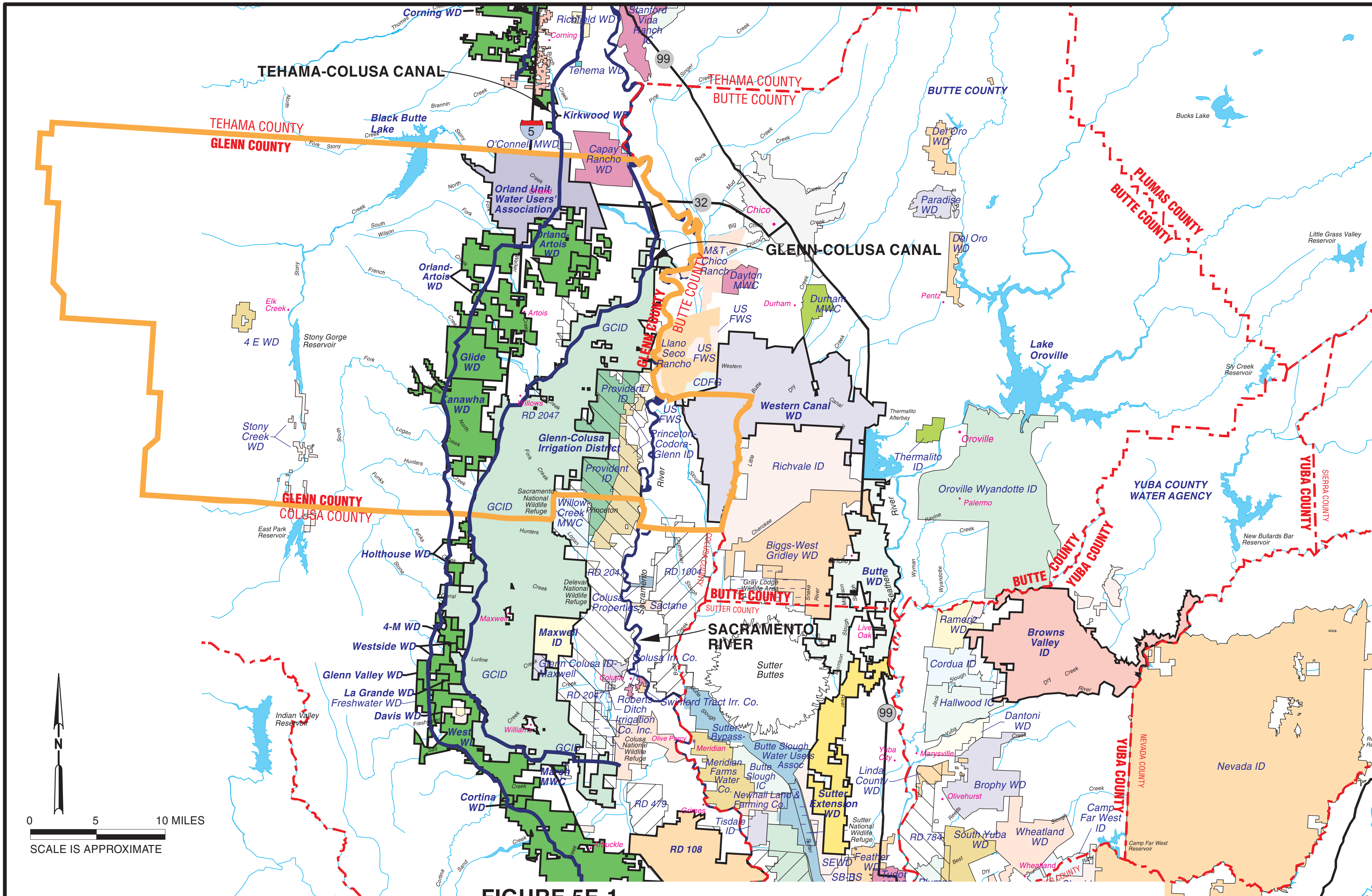

FIGURE 5E-1
PROJECT LOCATION MAP

GCID GLENN COUNTY GROUNDWATER MONITORING PROGRAM AND MODEL DEVELOPMENT

SHORT-TERM PROJECT EVALUATIONS

SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL

in association with

MONTGOMERY WATSON HARZA

MBK

SWRI

W072001014RDD_21 (10/26/01)

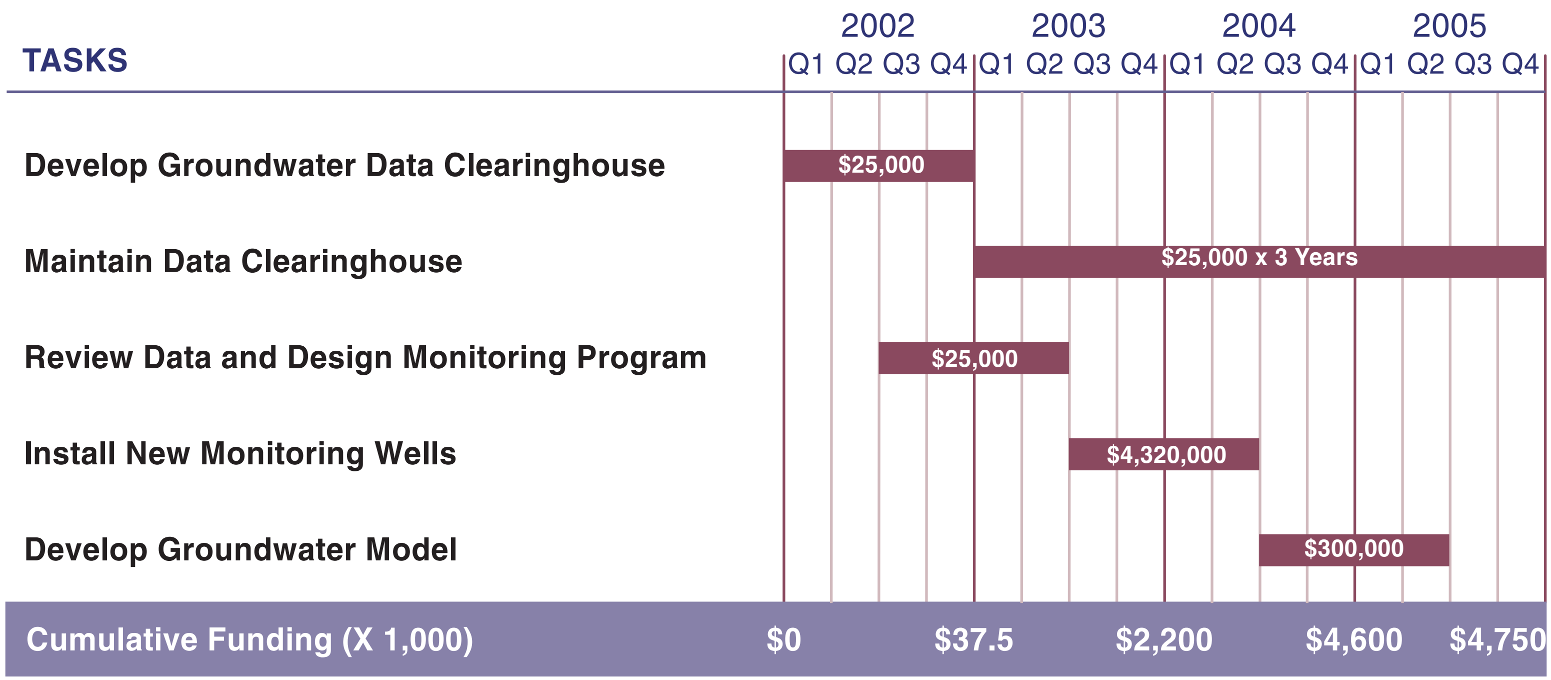

FIGURE 5E-2
PRELIMINARY IMPLEMENTATION SCHEDULE
GCID GLENN COUNTY GROUNDWATER MONITORING PROGRAM AND MODEL DEVELOPMENT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_09 (10/26/01)

Project 5E—Draft CEQA Environmental Checklist

Project 5E—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature	Date
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☒	☐
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☒	☐
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☒	☐
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☒	☐
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☐	☒
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☐	☒
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐

Up to 50 new monitoring wells may be necessary to adequately monitor the Stony Creek Fan. These wells may be required to be placed in environmentally sensitive areas. The wells would be sited to minimize any disruption of local habitat areas.

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☒	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☐	☒	☐
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
See response to IV (a) above.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☐	☒	☐
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill is unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless best management practices were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
See response to VII (a) above.				
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☒	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☒	☐
There are serious concerns about the long-term draw-down of the groundwater table and land subsidence. Model development would help in determining the effects of increased groundwater pumping. Minimal pumping of groundwater would occur as a result of the monitoring program and model development; however the impact is considered less than significant to groundwater supplies.				
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☐	☒
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
<u>IX. LAND USE AND PLANNING</u>—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☒	☐
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
<u>X. MINERAL RESOURCES</u>—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
<u>XI. NOISE</u>—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction of each monitoring well. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☒	☐	☐
See response to XI (a) above.				
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
<u>XII. POPULATION AND HOUSING</u>—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

PROJECT 6A

Maxwell Irrigation District Conjunctive Use Project

1. Project Description

Project Type:	Conjunctive water management
Location:	Colusa County
Proponent(s):	Maxwell Irrigation District (MID or District)
Project Beneficiaries:	MID, in- and out-of-basin users, environment, Delta
Total Project Components:	Short-term components, development of District-owned groundwater well facilities
Potential Supply:	8,000 to 13,000 acre-feet per year (ac-ft/yr)
Cost:	$2 million
Current Funding:	$75,000 (authorized District cost-share)
Short-term Components:	Test-hole drilling, evaluation and production well construction and testing, groundwater monitoring
Potential Supply (by 2003):	8,000 to 13,000 ac-ft/yr
Cost:	$2 million
Current Funding:	$75,000 (authorized District cost-share)
Implementation Challenges:	Public perception, coordination among public and private entities, coordination between concurrent and similar regional projects, lack of sufficient groundwater data, water rights implications, environmental regulatory compliance, land acquisition, recharge basins
Key Agencies:	MID, Colusa Basin counties, local landowners, U.S. Bureau of Reclamation (USBR), California Department of Water Resources (DWR), environmental interest groups, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), Sacramento-San Joaquin Delta

Summary

Maxwell Irrigation District is proposing a conjunctive water management project. The project would involve construction and operation of up to three new deep water wells for (1) reduction in surface water diversions, (2) improved reliability and availability of good-quality water to the District; (3) supplemental water for agriculturally induced wetlands; and (4) supply for Colusa Sub-basin lands during times of critical need. Each well would be located adjacent to or in close proximity of the District's existing conveyance canals. Short lengths (less than 100 feet) of 16-inch smooth-wall pipe would be used, as needed, to convey water from the wells to the existing canals. The water could then flow by gravity into the District's distribution system. This evaluation describes a short-term project that would yield approximately 8,000 acre-feet (ac-ft) of groundwater from the new wells during the irrigation season. It is assumed that an additional yield of approximately 5,000 ac-ft could be developed to meet the wetland needs within the District and/or the adjacent Delevan National Wildlife Refuge (NWR) in the fall of drier years. The project location and well sites are illustrated on Figure 6A-1.

The District is located approximately 10 miles north of the City of Williams and approximately 15 miles south of the City of Willows. The District boundaries are the Colusa Drain on the east, Maxwell Road on the north, and Two Mile Road on the west (Figure 6A-1). The southern boundary is irregular and locally extends to Lurline Road. Glenn-Colusa ID surrounds the District on the north, west, and south. A portion of the District's northern boundary is shared with Delevan NWR. Sharing property boundaries with Delevan NWR gives the District opportunities to assist in providing environmental benefits. For instance, within the District, approximately 4,600 acres are planted with rice each year, and 1,500 acres are permanent wetlands. This represents almost 90 percent of the entire District, which provides obvious and direct environmental benefit to the waterfowl migration in the Pacific Flyway.

The majority of the District overlies the Stony Creek aquifer, which has excellent recharge characteristics. The District has already undertaken reconnaissance-level subsurface exploration to better understand and evaluate its ability to make use of this aquifer. Such investigations should be coordinated with other similar projects within the sub-basin so as to ascertain a comprehensive understanding of system dynamics and determine possible associated impacts to the basin with regard to future groundwater development. Groundwater development of the Stony Creek aquifer is being considered by several districts within the Colusa Sub-basin, including but not limited to Glenn-Colusa ID, Orland-Artois Water District, and Orland Unit.

Short-term Component

The proposed conjunctive use project would include the development of up to three deep wells (approximately 900 feet below ground surface (ft-bgs) that would pump approximately 5,000 to 6,000 gallons per minute (gpm) each and would be located in close proximity to the District's existing conveyance canals. Each well would be constructed of 20-inch and 16-inch blank and 16-inch perforated casing. The perforated casing would consist of louvered well screen. Use of louvered well screens would minimize the risk of being damaged during construction and well development. It would also allow for future re-development of the well using aggressive surging and bailing techniques. Each well would be grouted and sealed to a depth of 270 ft-bgs to minimize the risk from infiltration of surface water into the subsurface.

Initially, the wells would be used primarily as a supplemental or back-up supply to the District's existing surface water supplies from the Sacramento River and its tributaries when surface water supplies are curtailed. The project would improve the availability of a reliable supply of good-quality water for the District's 6,100 acres of permanent and agriculturally induced wetlands, reducing dependence on surface water diversions for this use. In addition, having groundwater wells available would provide the opportunity to supply 8,000 to 13,000 ac-ft of groundwater to lands within the Colusa Sub-basin during times of critical need.

The District has an agreement with a landowner to develop up to two wells located along the District's main east/west canal leading from the Sacramento River to the Colusa Drain (potential Tuttle well sites) in Section 9, Township 16 North and Range 2 West (Figure 6A-1).

Two additional potential well sites have been identified along the northern boundary of the District's main service area adjacent to Maxwell Road (potential Gunnersfield well sites). The Gunnersfield sites are adjacent to the District's main delivery canal in Section 5, Township 16 North and Range 2 East. Test Holes 6312 and 6313 were drilled and logged at these locations in 1993 to depths of 750 and 770 ft-bgs, respectively. Luhdorff & Scalmanini, Consulting Engineers conducted an evaluation of the sites and prepared a report for the District (dated March 1995). The report indicates that adequate, reliable supply is available to the District from the Stony Creek Aquifer. Use of these sites would be dependent upon their acquisition from the landowner.

The District is in an ideal location to take advantage of available groundwater supplies to enhance conjunctive use and provide water for environmental benefits. These benefits could come as reduced diversions from the Sacramento River and/or increased supplies to Delevan NWR and improved water quality in the Colusa Drain. This project would provide the opportunity to realize these environmental benefits.

Monitoring

Questions that need to be addressed with regard to the impacts of implementing conjunctive use operations in close proximity to the Sacramento River and tributary streams include, but are not limited to:

1. Would pumping intercept surface water from the river by directly inducing infiltration in response to nearby groundwater pumping?
2. Would induced recharge occur, and if so, how, where, and when (e.g., purposeful artificial recharge vs. in-lieu recharge)?
3. How would the basin be managed within its perennial yield?
4. Would third-party impacts (e.g., groundwater-level impacts) result from operations during pumping cycles?

Once construction is complete, the District would implement a program to collect, evaluate, and report data regarding water use, water quality, and the groundwater/surface water interaction of the project. The District intends to develop its monitoring program in conjunction with its groundwater management plan. Detailed parameters of the monitoring program would be developed during program design and initial program administration. This is likely to occur concurrent with well design and construction.

The District plans to include the Colusa High School Environmental Science Academy (Academy) as an integral component of the program. The District would provide technical assistance, training, and funding to the Academy to assure the continuation of a quality program. The reason for involving the Academy is to provide the participants with a valuable hands-on educational program relating to both local and statewide conservation and environmental issues, while at the same time collecting the necessary data for evaluation by the District or its engineer of project impacts on groundwater levels, quality, and river/aquifer interaction.

The monitoring and reporting program could include the following data collection:

- Collecting static groundwater-level data each spring and fall (initially this could be more frequently obtained).
- Collecting monthly electrical conductivity (EC) and temperature data from each well.
- Collecting monthly EC and temperature data in the canal upstream and downstream of each well when the wells are in use.
- Groundwater sampling at least once each year when the wells are in use (possibly more frequently during initial stages of the project).
- Performing annual reconnaissance surveys to identify and evaluate any potential impacts, either positive or negative, resulting from the project. Should negative impacts be discovered, the District would take steps to evaluate the extent of the impacts and determine how best to remedy or mitigate them. Preparing quarterly reports that summarize data collected and comparing them with historical data. The reports might include maps, photographs, charts, or other reasonable means to clearly depict the data.

Long-term Component

There is no direct long-term component associated with this project. The results of this project could lead to further development of regional groundwater resources.

Hydrogeologic Evaluation

Hydrogeologic Setting

The easterly portion of Colusa County, in which the District is located, is part of the Sacramento Basin, an extensive groundwater body. The principal geologic formations in the project area consist of continental Tehama Formation sediments at depth overlain by Quaternary alluvium and flood basin deposits. Flood basin deposits consist chiefly of silt and clay deposited in low-lying areas adjacent to major streams during periods of high runoff. Coarser-grained alluvial fan deposits, exposed to the west of the project, might interfinger with these flood basin deposits in the project area. The Tehama Formation continental deposit, which outcrops in the hills west of the project, is chiefly a heterogeneous mix of gravel, sand, silt, and clay, some cobbles and boulders, sandstone, breccia, and conglomerate. These deposits extend to the base of freshwater at a depth of about 2,000 feet. The Quaternary flood basin deposits probably do not extend to more than 200 or 250 feet below the surface within the District.

Groundwater within the upper 200 to 250 feet is generally unconfined. The flood basin deposits are saturated most of the year because they absorb water from rainfall and the overflow of small creeks. Recharge to the underlying continental deposits occurs as direct infiltration of rainfall and surface water flows in their outcrop area west of the project and possibly via discharge from adjacent alluvial fan deposits and other deep sources.

Available groundwater-level data in the general vicinity of the District (Figures 6A-2, 6A-3, and 6A-4) suggest that local pumping has caused minimal seasonal impacts and essentially no long-term impacts on groundwater levels and associated groundwater storage. Hydrographs of groundwater levels, plotted from the DWR online database, indicates that seasonal fluctuations are generally on the order of less than 10 feet, and that there has been no historical trend toward lowering groundwater levels that are not reflective of periodic regional drought conditions. Depth to groundwater in wells has generally been less than 20 ft-bgs since about 1960. The locations of wells depicted on Figures 6A-2, 6A-3, and 6A-4 hydrographs are shown on Figure 6A-1.

The sources of recharge identified above are of excellent quality for the purposes of irrigation and wetland water supply. As indicated by historical observations from wells in the surrounding area, the groundwater that would be pumped from these wells is also of excellent quality for the intended uses.

Hydrogeologic Suitability

Varying amounts of groundwater were pumped for different purposes in the Town of Maxwell area, mostly within the boundaries of the surrounding GCID during the years 1992, 1994, 1995, 1996, and 1997. Throughout this time period, notably including the 1992 and 1994 dry years when totals of 77,776 ac-ft and 52,152 ac-ft, respectively, were pumped, groundwater levels remained consistent with historical conditions (that is, minor seasonal fluctuations, but essentially no increasing or decreasing trend over time). Although the majority of this intermittent groundwater pumping occurred more to the north in GCID, some pumping at very high capacities also occurred in the Maxwell area. A review of the historical records indicates the pumping in this area has not caused a significant change in groundwater levels or quality. Thus, even without purposeful artificial recharge, there is widespread historical evidence that in-lieu recharge, particularly during periods of low to no pumping, has maintained an essentially constant or ”full” groundwater basin. This is a bold statement…this is based on information from a couple of dry years separated by a wet year and not a long-term drought condition. From these historical observations, it is assumed that MID’s proposed conjunctive use program of pumping and in-lieu recharge is both technically feasible and unlikely to result in any substantial change in groundwater conditions over those that have been experienced historically.

Preliminary Evaluations

The majority of wells in the vicinity of the planned District wells are constructed about 300 to 400 ft-bgs; two wells are constructed to approximately 700 ft-bgs – a municipal well in Maxwell to the west of the District and an irrigation well about 2 ½ miles northwest of the District. The District's Gunnersfield test holes TH 6312 and TH 6313 were drilled and logged to depths of 750 770 ft-bgs, respectively.

Thick aquifer materials exist between about 100 and 400 ft-bgs throughout the area east and northeast of the District. These aquifer materials are highly transmissive and capable of yielding significant volumes of groundwater to wells that develop from them. These same materials thin significantly from east to west, and occur as relatively thin lenses at the locations of the District's test holes. For purposes of this summary, the aquifer materials between 100 and 400 ft-bgs are called the shallow aquifer.

At both of the District's Gunnersfield test hole sites, highly permeable aquifer materials were encountered at depth of approximately 600 ft-bgs. Few wells are completed in the deep aquifer near the planned District wells. The only deep wells with logs on file at DWR are the one municipal well at Maxwell, located about 5 miles west of the District's test hole sites, and one irrigation well, located about 2 ½ miles northwest of the District's test hole sites. For purposes of this summary, aquifer materials below a depth of about 400 ft-bgs are called the deep aquifer.

The distribution of the deep aquifer materials to the east and northeast is not known . There has been no groundwater exploration below about 400 ft-bgs. This is likely because wells completed to that depth have provided sufficient yields, and there has been no need to incur the expense to explore for deeper aquifer materials.

Using the results of the Gunnersfield test hole evaluations for TH 6312 and TH 6313, preliminary well designs have been prepared. Final well designs would be prepared upon the completion and evaluation of three new test holes that would be drilled to about 1,000 ft-bgs. The preliminary design would include wells constructed to depths of about 900 ft-bgs with multiple sections of well screen beginning at a depth of about 240 ft-bgs. Plans call for a 75-foot sanitary seal, 230 feet of annular seal, and 20-inch-diameter casing transitioning to 16-inch-diameter casing with a slip joint at about 290 feet in. This preliminary well design was used to obtain well construction costs. (*The District is currently working with a well driller to refine the well construction and equipping costs).*

Preliminary Aquifer Response Analysis

Estimates of aquifer characteristics, derived from lithologic descriptions and shallow well yields, indicate the transmissivity of the shallow aquifer is on the order of 150,000 gallons per day per foot (gpd/ft) of aquifer width. The only available data on deep well yield from the Maxwell municipal well suggests that the transmissivity of the deep aquifer could be as low as 12,000 to 15,000 gpd/ft. However, the nature of the deep aquifer materials at the District's test hole sites suggests that well yields should be closer to those of the shallow aquifer to the east-northeast, and not as low as to the west at Maxwell. Consequently, for purposes of this summary, the transmissivity of the deep aquifer materials at the District's well sites is estimated to be about 150,000 gpd/ft.

There are no data with which to estimate the storativity of the shallow or deep aquifer materials in the Maxwell area. The lithology of the area suggests that the shallow materials are likely to be semi-confined, and the deep materials are more likely confined. For purposes of this evaluation, aquifer storativity is assumed to be in the range of those conditions: 0.005 (semi-confined) to 0.0005 (confined).

As introduced above, the District's planned wells would each be designed for pumping capacities up to 6,000 gpm; depending on aquifer characteristics and associated well yields in the area, it is desired that a minimum pumping capacity be 5,000 gpm per well. Since the District plans to use the wells as a supplemental, or partial replacement, supply for a portion of its surface water deliveries from USBR, there are no defined water requirements for the wells in a conventional sense (i.e., the wells would discharge a planned annual volume of water to irrigate a certain area). Rather, the wells would initially be used to supplement or "replace," as necessary, some of the District's early season surface water diversions. The wells could be operated, during the irrigation season, as long as 60 days during April and May, or as long as 120 days from April through mid-August in any given year. In addition, the wells could be used to provide water in the fall of drier years for rice straw decomposition and for wetland habitat both within the District and, if necessary, within Delevan NWR.

Distance drawdown and well interference computations were made using the theoretical aquifer characteristics described above and a well field consisting of two wells spaced approximately 1,500 feet apart. If each of the proposed wells located at the sites for TH 6312 and TH 6313 were pumped at their design capacity of 6,000 gpm, the pumping water level in each well would be about 134 ft-bgs after 120 days of pumping. Distance drawdown calculations indicate that similarly constructed wells can be expected to experience about 45 feet of interference drawdown at a radial distance of 1,000 feet, and about 20 feet of interference drawdown 10,000 feet from the wells. However, once the future wells come online, an evaluation of the potential for groundwater/surface water interaction would be conducted. Furthermore, coordination with adjacent groundwater users would be needed to forecast the additional interference drawdown that would occur as a result of implementing combined conjunctive use programs valleywide.

2. Potential Project Benefits/Beneficiaries

This project would assure that a reliable supply of good-quality water would be available to support a diverse wetland community within the project area. Initially, this supply would be used as a supplemental or back-up supply for the District's surface water supplies. Therefore, the wells would be used, as needed, to assure a continuous supply to the District's 6,100 acres of permanent and agriculturally induced wetlands. In addition, this project would provide the opportunity to help meet the increasing water supply and water quality demands of the District, Colusa Drain, Delevan NWR, Sacramento River, and Bay-Delta Estuary.

Local Benefits

Local benefits of this project include a reliable supply of good-quality water to meet both the agricultural and wetland needs within the District, especially in times of shortages. In addition, the conjunctive use of water developed under this project would provide more reliable supplies for water users who rely on the water supply available in the Colusa Drain. This also could result in improved water quality in the Colusa Drain. The project could be expanded in the future to provide water to the Delevan NWR while maintaining the supply to meet the District's needs.

Added Delta Supply

In times of shortages in the Delta, the District could rely on the groundwater supply developed under this project and forego some of its surface water supply. This remaining surface water supply could then be made available to help meet Delta outflow and water quality requirements as well as other Delta demands.

Water Quality Improvement

This project would provide a supplemental supply of good-quality water, which could be used to maintain and improve water quality within the District as well as the Colusa Drain. This alone would benefit over 50,000 acres. In addition, this water supply could be used, if necessary, to improve water quality conditions within Delevan NWR. Water not diverted by the District from the Sacramento River could be made available to meet water quality requirements downstream of the District's point of a diversion and in the Delta.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

The capital costs for developing this program are estimated to be approximately $1,287,000 as shown in Table 6A-1. The District's Board of Directors has authorized the cost share at a level of up to $75,000. The District's share of the capital costs would be paid from its existing reserves. Future costs for operation of the project, maintenance of project facilities, and monitoring and reporting would be paid by the District through its standby water availability charges and water tolls. These future costs include the administration and monitoring of the conjunctive use plan that is estimated to cost approximately $5,000 per year. In addition to the $75,000 cost share and annual O&M and monitoring costs, the District has paid $20,000 towards securing the proposed Tuttle well site locations as well as approximately $25,000 for the two Gunnersfield test wells and 1995 report. In addition, the District expended approximately $650,000 to construct an inverted siphon under the Colusa Basin Drain to convey water from its Sacramento River pumping plant to the District's main canal. Prior to completion of this project, water diverted from the Sacramento River was delivered into the Colusa Basin Drain at the Maxwell Dam near the northeast boundary of Delevan NWR. This water was then re-diverted from the Colusa Drain, into the District's main canal, and on to the District's service area. The siphon project allows the District to deliver high-quality Sacramento River water directly to its place of use without mixing it with water from the Colusa Basin Drain. Groundwater pumped at the Tuttle sites would also be conveyed through the siphon to the remainder of the District's service area. While not constructed expressly for the purpose of conveying groundwater, the siphon project is an important element in the District's planned conjunctive use program.

TABLE 6A-1
Planning-level Project Costs
Maxwell Irrigation District Conjunctive Use Project

Item	Quantity	Units	Unit Price	Total Cost	Assumptions
Environmental Documentation (NEPA/CEQA)	1	Lump Sum	$50,000	$50,000	
Test-hole Drilling	3	Each	$21,000	$63,000	New exploration at the two Tuttle sites and one Gunnersfield site
Site Acquisition	2	Well Site	$50,000	$100,000	Two well sites at Gunnersfield
Well Construction and Equipping	3	Each Well	$252,000	$756,000	900-ft deep; 5,000 gpm, and 8,000 to 13,000 ac-ft/yr
Power Supply	3	Each Well Site	$6,000	$18,000	PG&E transformers and power drop to each well
Site Improvements	1	Lump Sum	$50,000	$50,000	Site grading, well pads, retaining walls as needed at each well site
Conveyance Construction	3	Each Well Site	$6,000	$18,000	250 ft of 16-inch pipe, valves, other materials and welding to convey well water to canals
Engineering-Test Holes	2	Each Site	$5,000	$10,000	Geologic logging, e-log evaluation, final well design
Engineering-Well Construction	3	Each Well	$14,000	$42,000	Well construction oversight and inspection
Engineering-Other	1	Lump Sum	$5,000	$5,000	
Legal	1	Lump Sum	$5,000	$5,000	
Groundwater Management Plan	1	Lump Sum	$50,000	$50,000	Development of groundwater management plan

TABLE 6A-1
Planning-level Project Costs
Maxwell Irrigation District Conjunctive Use Project

Item	Quantity	Units	Unit Price	Total Cost	Assumptions
Administration	1	Lump Sum	$20,000	$20,000	Administer conjunctive use program development
Subtotal				$1,187,000	
			Contingencies and Allowances (30%)	$356,100	
			Total Construction Costs	$1,543,100	
			Environmental Mitigation (5%)	$77,200	
			Engineering, Construction Management and Admin. (25%)	$385,800	
Total Initial Project Cost				**$2,006,100**	

NEPA/CEQA = National Environmental Policy Act/California Environmental Quality Act
PG&E = Pacific Gas and Electric

4. Environmental Issues

The project area is located in Colusa County between the Town of Maxwell on the west and the Sacramento River on the east. As identified in a biological survey report prepared for the District in 1997, the topography of the project area is typical of the Great Central Valley of California, consisting primarily of flat and slightly undulating terrain with a 0 to 2 percent slope.

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment, notably through the artificial manipulation of groundwater levels. In some areas of the state, these types of projects have resulted in public concern and controversy, which tends to heighten scrutiny of the environmental effects of such projects. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. It is likely that the appropriate level of environmental documentation necessary for this project would be an environmental impact statement/environmental impact report (EIS/EIR).

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Large amounts of earthwork would be required for the recharge basins. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.

- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers—**The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Lands Commission—**The project would need to consult with State Lands Commission on the public agency lease/encroachment permitting for use of state lands.
- **State Reclamation Board—**The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)**—Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

The project implementation would occur in several incremental stages, each of which would have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. The following lists some of the implementation challenges anticipated to be associated with this project.

Public Perception

Landowners have significant concern regarding possible groundwater overdraft. While the aquifer recharge aspects of this project may go a long way to alleviate these concerns, overdraft likely would remain a concern throughout the various stages of this project from feasibility analysis through construction and very likely continue thereafter. Monitoring and modeling of groundwater levels would not only be an essential part of this project technically, but also politically. Further, public concern accompanies any water delivery project during these water-tight times with regard to whom any project may or, just as importantly, may not benefit. As a result, many counties have passed ordinances and set numerous groundwater management objectives. To that end, the county has set strict guidelines for such water management programs as water transfers that dictate the priority of transfers taking into consideration primarily the intended recipient of the water.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities such as USFWS, USBR, and DWR. The governmental agencies would have strong interests associated directly with the project and indirectly as it may affect other interests in the area. It is highly probable that because of the complexity and far-reaching implications of the project that competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Projects

Numerous parties are examining similar projects throughout the valley. To optimize the effectiveness of these projects, coordination between the endeavors would be required from the onset. The strongest motivation for such an effort is three-fold: (1) to avoid duplication of effort and as a result efficiently utilize available funds, (2) to avoid the nullification of project benefits through competing projects, and perhaps most importantly, (3) to optimize the benefits of these projects to the watershed.

Lack of Sufficient Groundwater Data

In many areas, there is limited groundwater information available, or the information that is available is unreliable.

Water Rights Implications

Maxwell ID's water rights would have to be guaranteed and preserved. There is concern that a "use it or lose it" mentality may become prevalent during the implementation of the conjunctive use program. Although the District would be expecting to decrease their annual surface water diversions, it should not be assumed that they would be relinquishing a comparable amount to their water rights.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Habitat for known Endangered Species Act-listed species such as the valley elderberry longhorn beetle and the giant garter snake is present within the project area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Land Acquisition

It is probable that land would have to be acquired for the production wells, recharge basins, and conveyance systems. Some landowners may be resistant to the land purchases.

Recharge Basins

Siting of the recharge basins could be politically and environmentally challenging. The basin siting would have to rely heavily on groundwater modeling results, public outreach, and close coordination with environmental interest groups and government agencies (e.g., USFWS).

6. Implementation Plan

As shown graphically on Figure 6A-5, upon approval of the project and subsequent funding agreements, the District would begin the preparation of the required environmental documentation for the project. This process is expected to take up to 2 months to complete. Once the environmental documentation is complete, the District would drill two new test holes for evaluation of the Tuttle well sites. The District would review the data from these test holes and compare them with the results of the two Gunnersfield test holes to determine which three of the four potential well sites would provide the greatest benefit for the project. Coincident with the drilling of the Tuttle test wells, the District would begin negotiations regarding the acquisition of the Gunnersfield site or sites. It is estimated that the selection of the well sites would be completed within approximately 1 month of the completion of the environmental documentation.

After the three well sites have been selected, contracts would be let for the required site improvements including drilling and completion of the wells and conveyances, and PG&E would be contacted for the installation of the necessary equipment for the power supply at each site. It is estimated the wells would be constructed, and all necessary tests would be completed within 7 ½ months after the funding agreements have been signed.

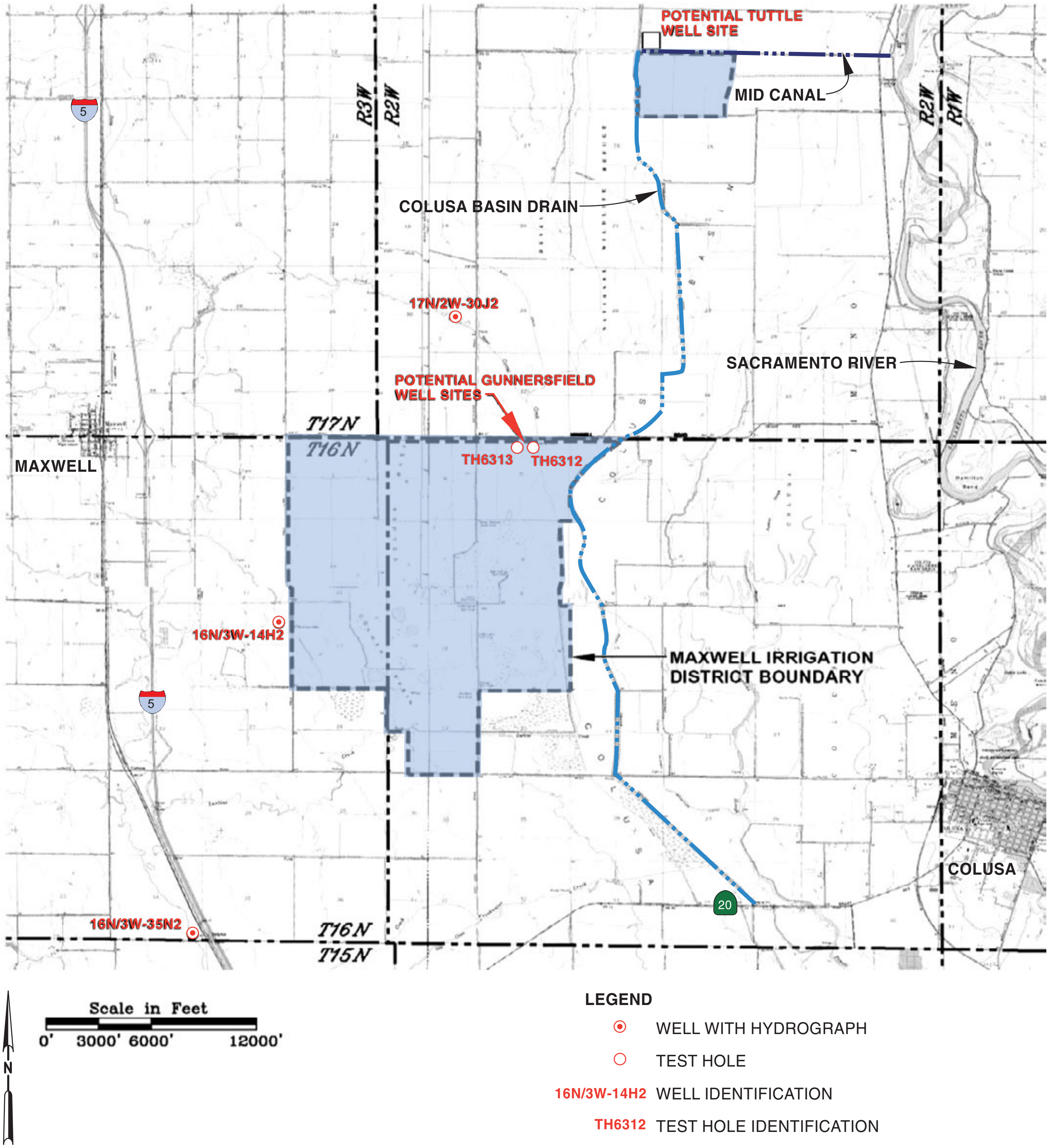

FIGURE 6A-1
PROJECT LOCATION MAP
MID CONJUNCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_50 (10/24/01)

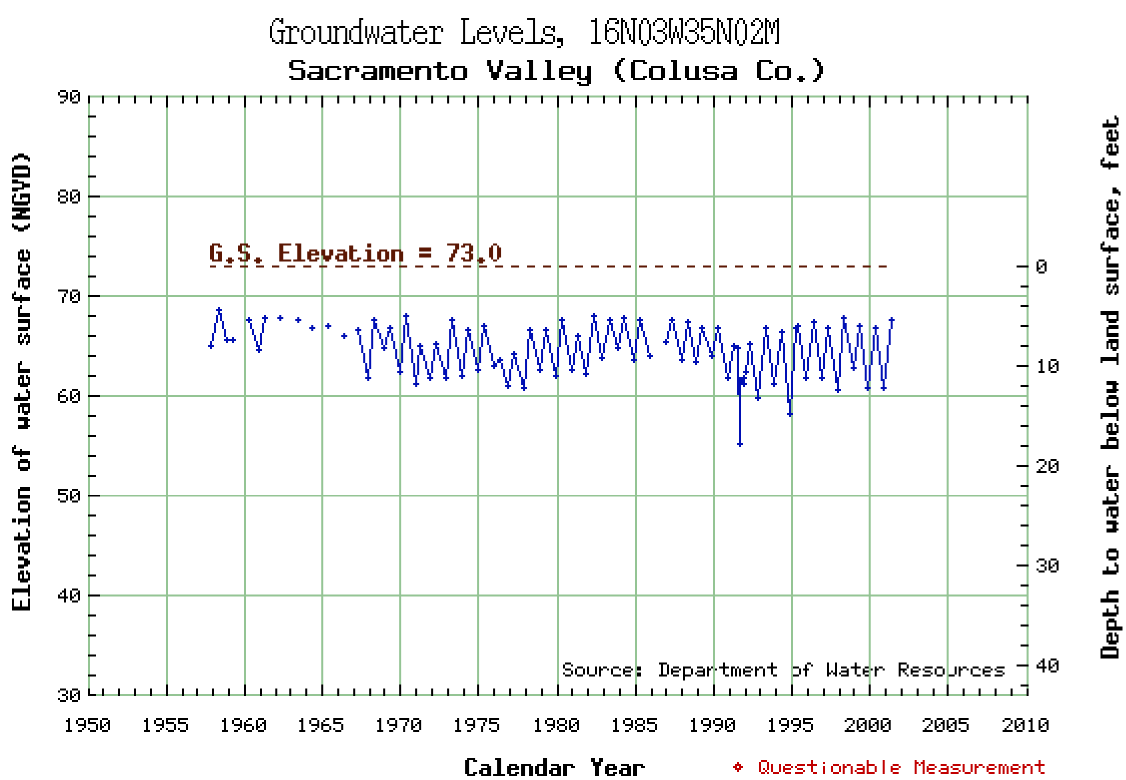

FIGURE 6A-2
HYDROGRAPH FOR WELL 16N/3W-35N2
MID CONJUNCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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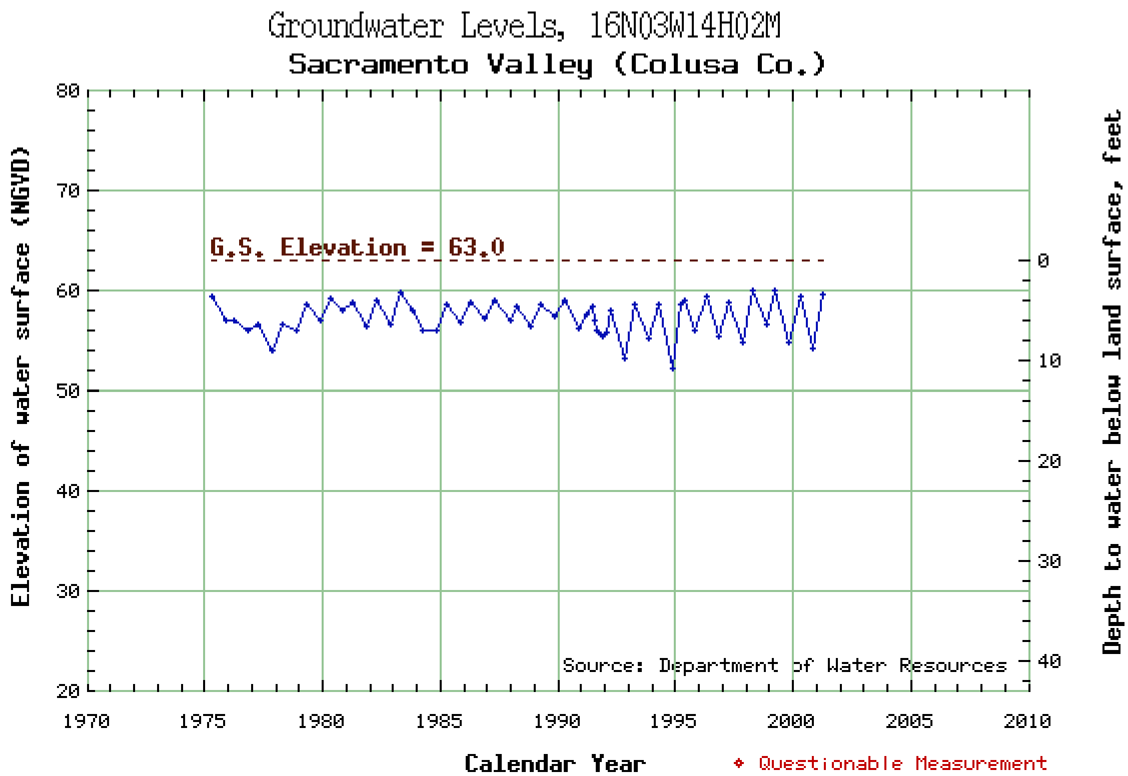

FIGURE 6A-3
HYDROGRAPH FOR WELL 16N/3W-14H2
MID CONJUNCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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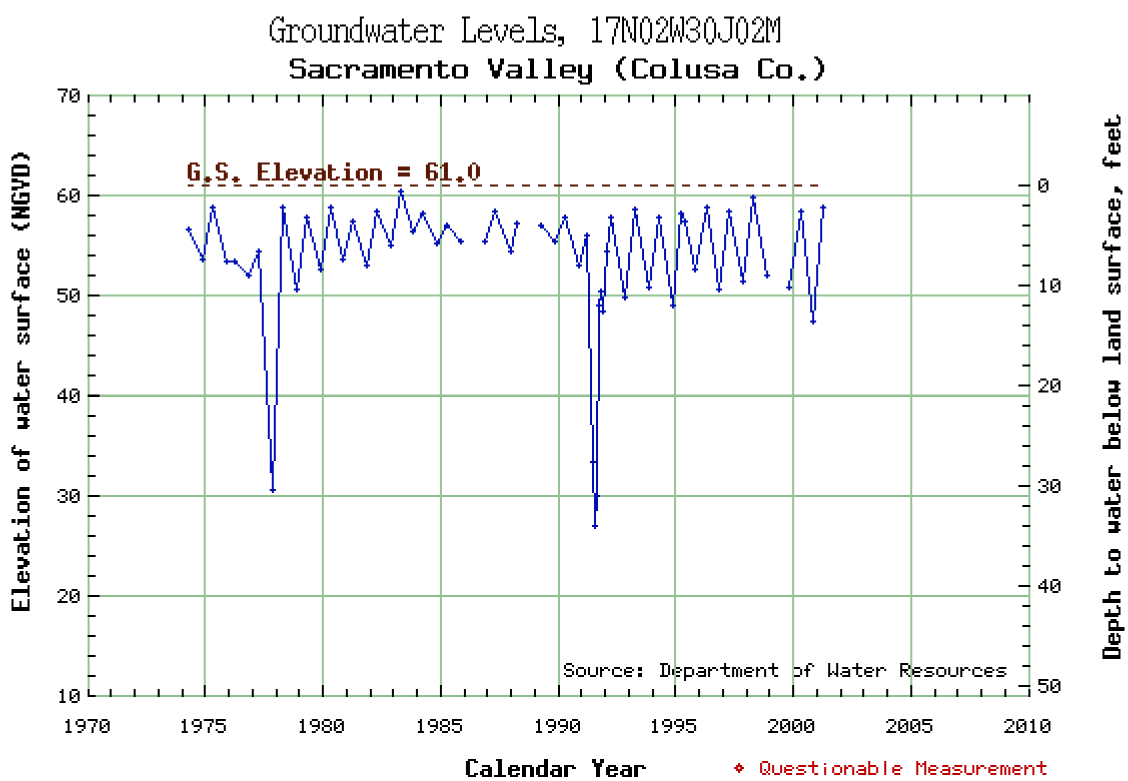

FIGURE 6A-4
HYDROGRAPH FOR WELL 17N/2W-30J2
MID CONJUNCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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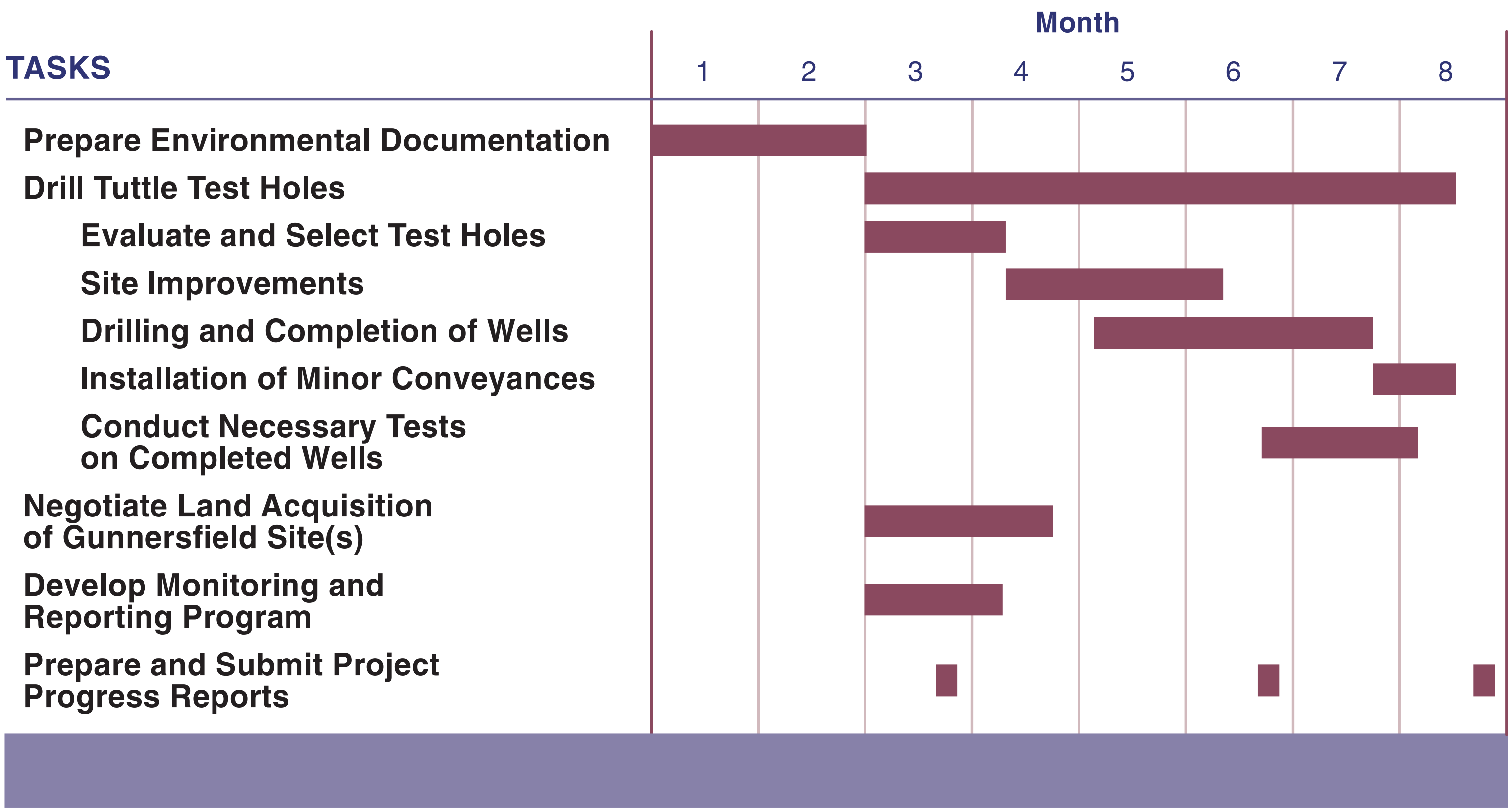

FIGURE 6A-5
PRELIMINARY IMPLEMENTATION SCHEDULE
MID CONJUNCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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Project 6A—Draft CEQA Environmental Checklist

Project 6A—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☒ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature	Date
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☒	☐
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☒	☐
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to a less than significant level.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☐	☒	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☐	☐	☒
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☒	☐
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☐	☒	☐
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements? *There is a potential for an increase of erosion and sedimentation from construction activity that would require the implementation of BMPs to reduce any impacts to waterways in and around the project area.*	☐	☒	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted). *There are serious concerns about the long-term draw-down of the groundwater table and land subsidence, particularly in dry years. Model development would help in determining the effects of increased groundwater pumping. The impact that groundwater withdrawal would have on existing groundwater supplies is as yet undetermined; however, it is potentially significant because of the complexity of the issue.*	☒	☐	☐	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
<u>IX. LAND USE AND PLANNING</u>—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
<u>X. MINERAL RESOURCES</u>—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
<u>XI. NOISE</u>—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☒	☐	☐
See response to XI (a) above.				
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>XV. TRANSPORTATION/TRAFFIC</u>—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
<u>XVI. UTILITIES AND SERVICE SYSTEMS</u>—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>XVII. MANDATORY FINDINGS OF SIGNIFICANCE</u>				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? (“Cumulatively considerable” means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

PROJECT 8A

Stony Creek Fan Conjunctive Water Management Program

1. Project Description

Project Type:	Conjunctive water management
Location:	Colusa Basin, northern Glenn County
Proponent:	Orland-Artois Water District (OAWD), Orland Unit Water Users' Association (OUWUA), and Glenn-Colusa Irrigation District (GCID)
Project Beneficiaries:	OAWD, OUWUA, GCID, in- and out-of-basin users, environment, Delta
<u>Long-term Components:</u>	Short-term components, development of regional conjunctive water management program consisting of a direct and in-lieu recharge component, a groundwater production component, a dedicated monitoring well network component, and supporting elements including development of an integrated groundwater-surface water model and outreach program
Potential Supply:	Currently being evaluated as part of ongoing Phase 1 feasibility study (possibly range from 50,000 acre-feet per year [ac-ft/yr] to 100,000 ac-ft/yr)
Cost:	$245 million (Preliminary; refine during ongoing Phase 1 work)
Current Funding:	$530,000
<u>Short-term Components:</u>	Development of a pilot scale project consisting of direct and in lieu recharge components, a groundwater production component (through agreements with private well owners), a groundwater monitoring program, integrated groundwater-surface water modeling, and an outreach program
Potential Supply (by 2003)	Potential minimal supply as part of pilot scale project; this supply might be available during the 2002/2003 water year
Cost:	$2.1 to $2.5 million
Current Funding:	$530,000 (California Department of Water Resources [DWR] Integrated Storage Investigation [ISI])

Implementation Challenges:	Environmental issues; strong coordination among local, state, and federal agencies and specific regional-scale projects; water rights issues
Key Agencies:	OAWD, OUWUA, GCID, Glenn County, local landowners, DWR, U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), environmental interest groups, California Department of Fish and Game (CDFG), State Water Resources Control Board

Summary

The basic premise of the proposed Program is to conjunctively manage surface water and groundwater to change the timing of available supplies. This is accomplished by supplying the Program with surface water for storage or replenishment, typically in above normal and wet year-type conditions, and then recovering a portion of this water during periods of water supply shortage. This type of integrated resources management has the potential to improve operational flexibility on a regional basis resulting in measurable benefits locally in the form of predictable, sustainable supplies, and improved reliability for water users' elsewhere in the state.

A program such as this has many facets. The core elements are the physical opportunities that exist to develop a storage and recovery program, the operational criteria governing how and when storage and recovery occurs, and the economic feasibility of the program.

Physical Characteristics

The physical characteristics of the study area (see Figure 8A-1) are well suited for the proposed conjunctive water management program. The northern Glenn County aquifer has adequate groundwater storage and production capacity. The Stony Creek Fan is a highly permeable and transmissive formation capable of accepting natural and artificial recharge at relatively rapid rates. Existing surface water distribution and extraction facilities are well positioned to support in lieu recharge operations. A strategic alliance has been formed by the Program sponsors bringing these key elements together to help make the Program possible.

Direct recharge could take place primarily over permeable portions of the Stony Creek Fan that exists in portions of OUWUA, OAWD, and to a lesser extent in GCID. In lieu recharge could occur in a majority of the OAWD area, where agricultural lands can be irrigated with a combination of surface water and groundwater pumped by privately owned wells. In lieu opportunities are not readily available to OUWUA lands because of the existing dominant use of surface water and lack of agricultural production wells. Expanded in lieu recharge in OAWD and OUWUA could be accomplished with the development of new extraction facilities in areas currently served only by surface water. The proposed investigation would consider the cost of developing a range of direct recharge as well as in lieu recharge opportunities.

Initial Program concepts have considered a variety of surface water sources that could be supplied for storage, primarily by Program sponsors. These sources include: 3F Central

Valley Project (CVP) water; unappropriated waters of the Sacramento River Basin; GCID Base Supply; Stony Creek water; unused Tehama-Colusa CVP contract water; and new supplies generated by potential new surface storage facilities. Surface water could be conveyed via OUWUA facilities or the Tehama-Colusa Canal and delivered either to irrigators or to recharge facilities through existing distribution facilities. Characterization of each of these potential sources is a key requirement for project refinement. The point of diversion and timing, rate and duration of availability of each source would determine how it could be conveyed and whether direct or in lieu recharge would be required.

The prevailing direction of existing regional groundwater flow through the study area is generally from northwest to southeast, meaning that any water recharged by the Program would probably migrate over time. Consequently, recovery would be located down-gradient of recharge locations. One option would be for recovery of stored water to be performed by down-gradient pumpers located in GCID. In that case a cooperative pumping program agreement would be required between GCID and these private landowners to coordinate pumping operations. Stored water could also be recovered by landowners located in OAWD, also requiring agreements between OAWD and the relevant landowners.

The geology of the Stony Creek Fan is not well known, and a major objective is to characterize the factors that influence groundwater flow through the study area. Opportunities to influence groundwater flow by strategic pumping, thereby slowing or eliminating groundwater migration, would also be examined. The outcome of these investigations would guide formulation of recharge and recovery strategies.

Operational Considerations

Water placed into storage is commonly referred to as "Put" water. Water retrieved from storage is commonly referred to as "Take" water. Regardless of the supply source, Put and Take cycles would govern the operation of the conjunctive water management project. The relationship between these Put and Take cycles would be based on the agreed upon terms and conditions. Terms and conditions would be based on a combination of factors including indexes describing anticipated water supply availability, formulas describing the fraction of stored water that can be recovered, Glenn County BMOs (for groundwater levels, groundwater quality, and land subsidence), and other technical, economic, and institutional considerations.

Economic Feasibility

The yield of the Program has not yet been analyzed, but initial indications are that the Program could augment existing local water supplies as well as improve water supply reliability regionally. The key factors that could limit the Program are likely to be recharge and extraction capacity. The proposed investigation would evaluate a range of possible recharge and extraction scenarios to determine the most cost-effective means of providing yield under water-short conditions. This analysis would require an understanding of the overall water balance of the study area, water needs of the Program sponsors, an assessment of direct and in lieu recharge opportunities and associated costs, an assessment of extraction facilities and costs, proposed operational criteria, and an assessment of potential environmental and third-party impacts. These analyses would be conducted as part of initial feasibility studies described further below.

Short-term Component

The short term components of this project consist of feasibility studies, followed by one or more small-scale pilot projects based on the study findings. Environmental study work would then follow or begin in parallel with the pilot projects. The feasibility study to investigate the conjunctive water management program would cost approximately $730,000, and is underway. Funding has been made available as part of a cost-share arrangement between DWR ISI and OAWD (lead agency) in partnership with OUWUA and GCID. There are several efforts that are underway in conjunction with the feasibility study including the development of the groundwater production element, a groundwater monitoring program improvement element, an integrated groundwater-surface water model, and an outreach plan. Technical and policy oversight groups representing the program proponents are providing overall direction of these efforts. Coordination and integration of these elements is critical to the success of this overall program. The combined costs of these efforts in conjunction with the overall feasibility study is estimated to be between $2,100,000 and $2,500,000.

Small-scale pilot test projects would be conducted as part of the feasibility studies. Depending on location and local conditions, these pilot test projects could potentially generate a small quantity of water supply by 2003. Larger-scale pilot projects, or demonstration projects, are planned for subsequent phases of the work following completion of the feasibility studies. The costs for the larger-scale demonstration projects depends on the findings of the feasibility studies.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The project area is located in northern Colusa Sub-basin within Glenn County and overlies the Stony Creek Fan alluvium as well as other areas served by the project proponents. The combination of groundwater resources, favorable recharge conditions, and the surface water supply and distribution facilities provides a strong potential for a conjunctive water management program to utilize the surface and groundwater resources for maximum local and regional water supply benefits. The conjunctive management concepts presented here should be considered in the context of other conjunctive management proposals such as Projects 5B, 5E, and 9A, each of which are considering development of a common ground-water resource within the Stony Creek Fan aquifer. Ideally, these various projects would be evaluated and developed in a coordinated manner under this CALFED ISI-sponsored investigation

The conceptual outline for conjunctive water management under this project is as follows. Local groundwater pumping would be done on a seasonal basis for two basic beneficial purposes. First, local groundwater pumping in the project proponents service areas could allow reduced diversions of their respective surface water supply, allowing an equivalent quantity of water to be held in storage in upper reservoirs and released for other targeted beneficial uses. These beneficial uses could include a mix of other local irrigation needs, in-stream flow or other environmental uses, or transfer to third parties under appropriate arrangements. Secondly, local groundwater pumping by users within the project area could help cover the supply deficit caused by Central Valley Project Improvement Act (CVPIA)-instituted supply cutbacks as well as seasonal restrictions on the operation of Red Bluff Diversion Dam (RBDD).

Recharge of the groundwater basin would occur from a mix of in lieu recharge (natural recharge with reduced groundwater pumping in wet years) and direct recharge from infiltration basins supplied with surface water using a combination of the regional surface water distribution facilities.

The potential yield from the conjunctive water management program, in terms of dry-year yield only or average annual yield, is unknown. However, previous investigations of the Stony Creek Fan groundwater basin provide a range of potential development levels for further evaluation. The ongoing feasibility investigation would firm up the groundwater development potential for this area over the next year.

The following primary types of facilities may be required for the conjunctive water management portion of this project:

- **Recharge basins—**Recharge basins may be used to accelerate the recharge of water into the groundwater basin using available excess surface water supplies in wet or normal years. The recharge basins would be located to provide "inflow" to the basin near its upgradient area, indicated by the groundwater flow and hydrogeology of the basin. The total acreage of basins required would depend on the targeted annual recharge quantity and the rate of infiltration from the basins to the underlying aquifer. Existing gravel mining sites along Stony Creek may provide suitable areas for such basins. An assumed conceptual-level sizing of the basins was done using the following parameters (general soils characteristics of the area with an assumed average infiltration rate of 0.5-foot per day): 120 days of recharge operation during wet years, approximately 50,000 ac-ft of targeted recharge, use of approximately 200 acres of reclaimed existing gravel mining basins adjacent to Stony Creek, and 600 acres of new recharge basins. The recharge basins could potentially serve a second purpose as off-canal storage facilities or drainage recapture/storage facilities.
- **Extraction wells—**The number, size, capacity, and location of the extraction wells would be determined by feasibility-level investigations, groundwater modeling, monitoring, and other critical factors. Operating agreements between project parties and private landowners would be developed to enable management of groundwater production, both in terms of when and where extractions occur or do not occur. Using an assumed average well capacity of approximately 3,000 gallons per minute (gpm) and a seasonal pumping window of approximately 3 months, the required number of new wells for pumping up to 50,000 ac-ft/yr is between 40 and 50 wells. It is assumed that a number

of existing suitable wells could be utilized under operating agreements with private well owners potentially distributed throughout the project proponent service areas.

- **Monitoring wells—**A network of monitoring wells would be required to track ground-water levels and provide critical information to ensure groundwater management objectives are being met. The monitoring well data would help track key objectives such as total recharge and extraction volumes, hydraulic gradients and flow directions for the groundwater, and impacts to other parties.
- **Distribution pipelines—**The extraction wells may discharge directly into canals or open-channel laterals in some cases, but in others it may be necessary to convey the groundwater from the wells to distribution facilities. The size and length of these pipe-lines would depend on the actual flow rates from wells and the well location relative to existing or future distribution systems.

2. Project Benefits/Beneficiaries

Water Supply Benefits

The place and type of use for the project yield would depend on the following factors: the actual hydrologic conditions for each year (wet, normal, dry), the final configuration of the project facilities, project participants, operating agreements, and targeted benefits. The types of targeted water supply beneficiaries are assumed to include the following:

- **The project proponents: OAWD, OUWUA, and GCID, and other local water users—** The proposed project would assist in meeting local irrigation supply requirements. In normal and wet years this supply may come primarily from surface water sources, with some groundwater use as required in drier years.
- **Stony Creek and Sacramento River—**In-stream flows and other environmental benefits in support of long-term Stony Creek and Sacramento River management objectives could potentially be met with this regional project. This increased supply to in-stream flows would come from a combination of flexibility on the use of RBDD to reduce early spring diversions, seasonal use of groundwater to minimize the need for surface water supplies, and increased efficiency within the irrigation districts.
- **Sacramento-San Joaquin Delta and other Sacramento Basin users**—Other Sacramento Basin water supply needs, including increased net seasonal inflows to the Sacramento-San Joaquin Delta, could be met with the proposed project. This supply would likely come primarily from dry-year use of groundwater in the project area, with reduced sur-face water diversions providing net increases in in-stream flows to the Delta.

Water Management Benefits

This project may potentially provide water management benefits primarily by increasing conveyance and on-farm efficiency, providing flexibility in the timing of surface water diversions on both the Sacramento River and Stony Creek, increasing the ability to store and target releases of surface water supplies, and providing increased flexibility and reliability through management of both surface- and groundwater supplies. The operational basis for these potential management benefits is described under Section 1. The conjunctive water management of the groundwater and surface water supplies may also help to minimize impacts from increased groundwater pumping such as subsidence and long-term changes in groundwater levels.

Water Quality Benefits

The water quality benefits of the project are anticipated to derive largely from the increased seasonal in-stream flows, which generally would be expected to improve both temperature and constituent quality parameters. These benefits would need to be evaluated and modeled on a regional basis to determine both the qualitative and quantitative impacts on water quality in Stony Creek, the Sacramento River, and the Delta.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to –30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Conceptual-level Capital Costs

Future phases of the feasibility study would include detailed cost estimates for new facilities. At this time, an extremely rough cost opinion for the long-term project can be made for general comparative purposes only. Each major project component can be considered somewhat independently from a cost perspective, so that the actual cost of the implemented project could vary widely depending on the scope and layout of the facilities actually constructed. Tables 8A-1 and 8A-2 present general cost information for each component.

TABLE 8A-1
Planning-level Capital Costs for Distribution System Improvements/Expansions
Stony Creek Fan Conjunctive Water Management Program

Item	Quantity	Units	Unit Price ($)	Total Capital Cost ($ million)	Assumptions
OUWUA Distribution System	6,500	Acres	3,600	23.4	Piped distribution system for approximately one-third of the 20,000 acre service area.
OAWD Distribution System	15,000	Acres	3,600	54.0	Piped distribution system for expanded service area increasing service area 50 percent to include lands not in district.
GCID Distribution System	15,000	Acres	3,600	54.0	Piped distribution system for expanded service area to potentially include lands not in district (assumed same expansion amount as OAWD)
			Subtotal	**131.4**	
			Contingencies and Allowances (30%)	39.4	
			Total Construction Costs	170.8	
			Engineering, Environmental, Construction Management and Admin. (25%)	42.7	
			Total Cost	**$213.5**	

TABLE 8A-2
Planning-level Capital Costs for Conjunctive Management Facilities
Stony Creek Fan Conjunctive Water Management Program

Item	Quantity	Units	Unit Price ($)	Total Capital Cost ($ million)	Assumptions
Extraction Wells (possible in all three districts)	35	Each	200,000	7.0	35 wells, 500 ft deep, 16-inch dia., 2,500 gpm. 50,000 ac-ft/yr dry-year pumping, mix of new and existing wells, 50 wells total.
Monitoring Wells (single-completion)	25	Each	19,500	0.5	Estimated Well Construction Cost (Single Completion Monitoring Well 200' deep)
Monitoring Wells (multi-completion)	25	Each	96,000	2.4	Estimated Well Construction Cost Multi-completion Monitoring Well 1000' deep)
Recharge Basins (in a three districts)	1,940,000	Cubic yards	5	9.7	600 acres of new basins
			Subtotal	**19.6**	
			Contingencies and Allowances (30%)	5.9	
			Total Construction Costs	25.5	
			Engineering, Environmental, Construction Management and Admin. (25%)	6.4	
			Total Cost	**$31.8**	

Initial Funding Requirements and Sources

Early phases of the project work consist of completing a feasibility study, conceptual design, in preparation for potential implementation of pilot project(s). This work is being supported by a cost-sharing agreement between the project proponents and the ISI Conjunctive Water Management Branch. OAWD, in partnership with OUWUA and GCID, has received funds of $530,000 from the ISI to complete the feasibility investigations. In addition, additional funding is being provided for the groundwater production element, the monitoring improvement program element, the integrated groundwater-surface water modeling, and the outreach plan.

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment, notably through the artificial manipulation of groundwater levels. In some areas of the state, these types of projects have resulted in public concern and controversy, which tends to heighten scrutiny of the environmental effects of such projects. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. It is likely that the appropriate level of environmental documentation necessary for this project would be an environmental impact statement/environmental impact report (EIS/EIR).

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board**—Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board**—Large amounts of earthwork would be required for the recharge basins. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act**—Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)**—The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Lands Commission**—Project would need to consult with State Lands Commission on the public agency lease/encroachment permitting for use of state lands.

- **State Reclamation Board—**The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)—**Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft California Environmental Quality Act (CEQA) environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

The project implementation would occur in several incremental stages, each of which would have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. The following lists some of the implementation challenges anticipated to be associated with this project.

Public Perception

Landowners have significant concern regarding possible groundwater overdraft. While the aquifer recharge aspects of this project may go a long way to alleviate these concerns, overdraft likely would remain a concern throughout the various stages of this project from feasibility analysis through construction and very likely continue thereafter. Monitoring and modeling of groundwater levels would not only be an essential part of this project technically, but also politically. Further, public concern accompanies any water delivery project during these water-tight times with regard to whom any project may or, just as importantly, may not benefit. As a result, many counties have passed ordinances and set numerous groundwater management objectives. To that end, the county has set strict guidelines for such water management programs as water transfers that dictate the priority of transfers taking into consideration primarily the intended recipient of the water.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities such as USFWS, USBR, and DWR. The governmental agencies would have strong interests associated directly with the project and indirectly as it may affect other interests in the area.

It is highly probable that because of the complexity and far-reaching implications of the project that competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Projects

Numerous parties are examining similar projects throughout the valley. To optimize the effectiveness of these projects, coordination between the projects would be required from the onset. The strongest motivation for such an effort is three-fold: (1) to avoid duplication of effort and as a result efficiently utilize available funds, (2) to avoid the nullification of project benefits through competing projects, and perhaps most importantly, (3) to optimize the benefits of these projects to the watershed.

Lack of Sufficient Groundwater Data

In many areas, there is limited groundwater information available, or the information that is available is unreliable.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Habitat for known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake is present within the project area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Land Acquisition

It is probable that land would have to be acquired for the production wells, recharge basins, and conveyance systems. Some landowners may be resistant to the land purchases.

Recharge Basins

Siting of the recharge basins could be politically and environmentally challenging. The basin siting would have to rely heavily on groundwater modeling results, public outreach, and close coordination with environmental interest groups and government agencies (e.g., USFWS).

Key Stakeholders

The conceptual scale of the project necessarily involves a wide range of stakeholders whose interests may be impacted by the project. Table 8A-3 summarizes the key stakeholders and the range of issues that each would be expected to have interests and concerns regarding.

TABLE 8A-3
Stakeholder Roles and Issues
Stony Creek Fan Conjunctive Water Management Program

Stakeholder	Role/Concerns/Issues
OAWD, OUWUA, and GCID	• Project proponent and direct beneficiary
Glenn County	• Groundwater management objectives, compliance with County's Groundwater Management Ordinance (#1115)
Tehama County Water Interests	• Neighboring county to north; concerns with impacts to groundwater
Local Landowners	• Groundwater level changes • Project facility construction and long-term impacts
USBR, DWR	• Orland Unit and TCCA facility operations, water rights • Integration with other regional management concepts such as off-stream storage
Environmental Interest Groups	• In-stream flow impacts, fishery impacts, land use

6. Implementation Plan

The following major steps would be required to implement the project. Each step depends on successful completion of the previous supporting steps, and findings that support further actions. Figure 8A-2 shows an assumed implementation schedule based on typical time requirements for each step in a project of this scale.

1.1 Feasibility studies and conceptual design—This step has already begun, and is intended to develop the specific project components, general features, operating concepts, and potential benefits. This step would determine the basic engineering and economic feasibility of the project, and would also help determine the need for other studies.

2.1 Other studies (groundwater modeling)—These supporting studies would provide more detailed evaluation of specific aspects of the project, and would include a groundwater production element, a groundwater monitoring improvement program element, an integrated groundwater-surface water model, and development of an outreach plan.

2.2 Pilot projects—The studies may support the implementation of pilot projects such as local groundwater pumping or diverting winter flows for recharge to existing basins. The pilot projects would provide critical information to support final design and confirm the viability of specific project operating objectives.

3.1 Preliminary design—The preliminary design would involve engineering design of the major facilities to a fairly detailed level including sizes, locations, footprints, and other. This information would support key implementation steps such as right-of-way acquisition, soils testing, mapping, and permitting and environmental studies.

4.1 Environmental assessment/environmental impact report (EA/EIR)—The EA/EIR would derive from the preliminary design and would confirm the potential impacts and required mitigation, if any, for the project.

5.1 Final design—Final design would proceed following the EA/EIR work, focusing on the preferred alternative. This would involve producing engineering drawings, specifications, and other final contract documents suitable to bid and construct the project facilities.

6.1 Permitting—The various permits would be obtained using the final design as the basis for permitting requirements.

7.1 Construction—Construction would potentially be phased over several years, given the size and complexity of the project.

7.2 Operation and monitoring—Long-term operations and monitoring of the project would begin following completion of construction.

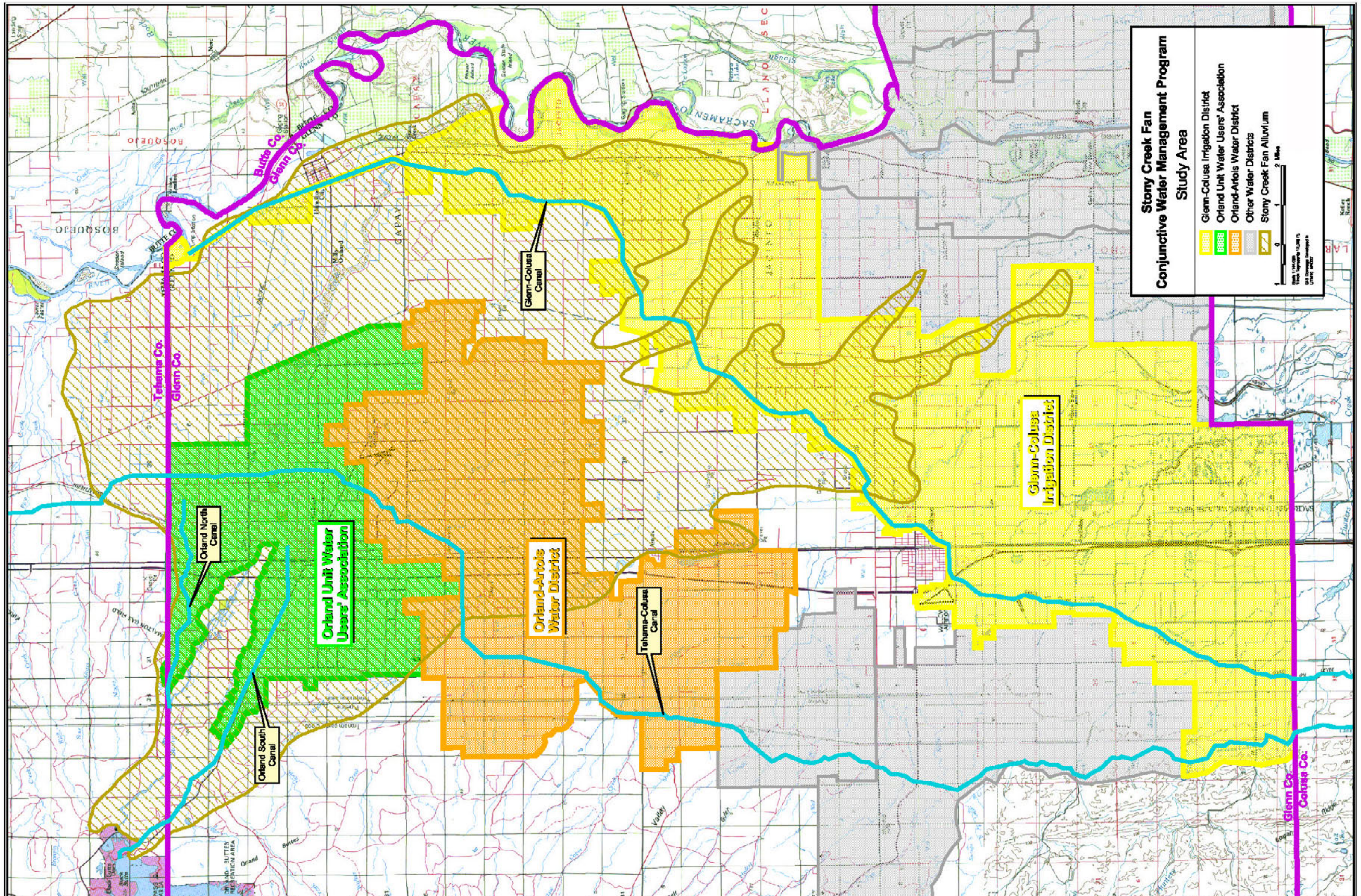

FIGURE 8A-1
PROJECT LOCATION MAP
STONY CREEK FAN CONJUNCTIVE WATER MANAGEMENT PROGRAM
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_81 (10/26/01)

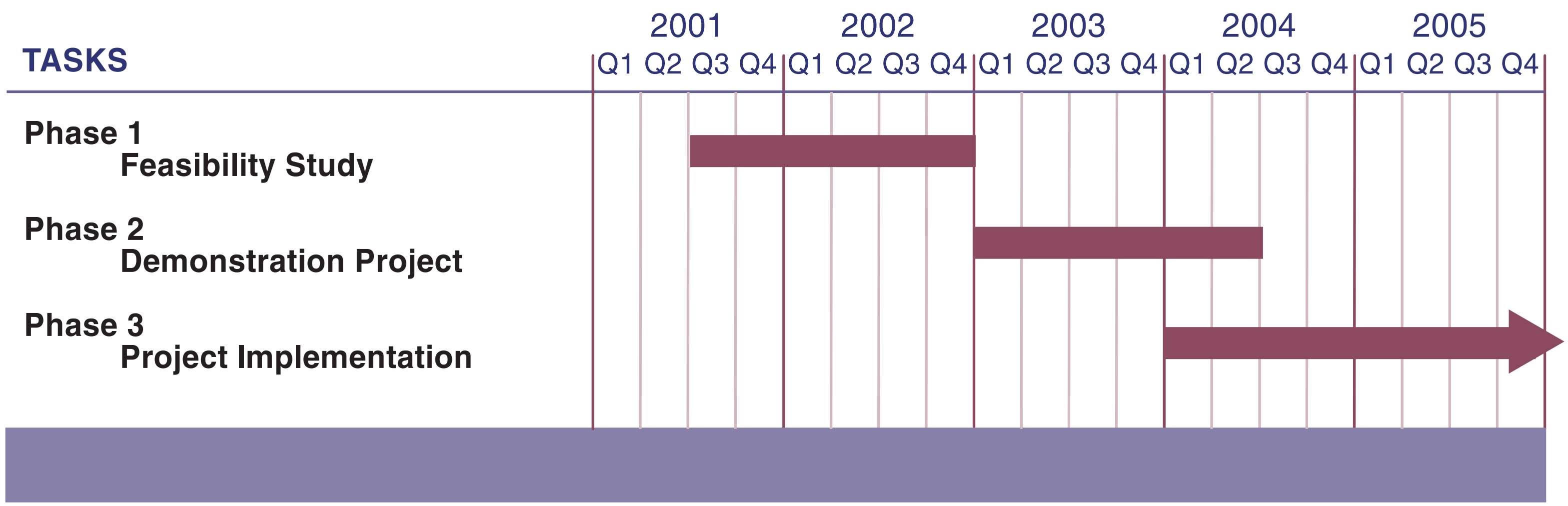

FIGURE 8A-2
PRELIMINARY IMPLEMENTATION SCHEDULE
STONY CREEK FAN CONJUNCTIVE WATER MANAGEMENT PROGRAM
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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Project 8A—Draft CEQA Environmental Checklist

Project 8A—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________	______________
Signature	Date
______________________	______________
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☒	☐	☐	☐
Recharge basins may be used to accelerate the recharge of water into the groundwater basin, using available excess surface water supplies in wet or average water years. Approximately 200 acres of reclaimed existing gravel mining basins are adjacent to Stony Creek. The recharge basins may require a permanent conversion of potential Prime Farmland, Unique Farmland, or Farmland of Statewide Importance..				
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☒	☐	☐	☐
See response to II (a) above.				
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☒	☐	☐	☐
See response to II (a) above.				
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to a less than significant level.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
IV. BIOLOGICAL RESOURCES—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☒	☐	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☒	☐	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☒	☐	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☒	☐	☐	☐
See response to IV (a) above.				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace any vegetation removed during construction, which would reduce the impact to a less than significant level.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☒	☐	☐
See response to IV (e) above.				
V. CULTURAL RESOURCES—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
See response to VII (a) above.				
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☒	☐
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Violate any water quality standards or waste discharge requirements?	☒	☐	☐	☐
Increases in turbidity would be likely to occur during any in-stream construction work. Additionally, there is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan, and the implementation of BMPs to reduce any impacts to waterways in and around the project area.				
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☒	☐	☐	☐
There are serious concerns about the long-term draw-down of the groundwater table and land subsidence, particularly in dry years. Model development would help in determining the effects of increased groundwater pumping. The impact that groundwater withdrawal would have on existing groundwater supplies is as yet undetermined; however, it is potentially significant because of the complexity of the issue.				
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☒	☐	☐
Locations of recharge basins and/or additional conveyance facilities may have some affect on drainage patterns of naturally existing waterways. These facilities would be located in such a way as to minimize any impact to existing drainage of the project area.				
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☒	☐	☐
See response to VIII (c) above.				
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☒	☐	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☒	☐	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☒	☐	☐

PROJECT 10A

Reclamation District No. 108 Pilot Well Development/Conjunctive Management Project

1. Project Description

Project Type:	Conjunctive water management
Location:	Northern Yolo County and Southern Colusa County
Proponent(s):	Reclamation District No. 108 (RD 108 or District) in collaboration with California Department of Water Resources (DWR)
Project Beneficiaries:	RD 108, Yolo-Zamora Water District (Y-ZWD), Colusa County Water District (CCWD), Dunnigan Water District (DWD), RD 787, Colusa Drain Mutual Water Company, the Delta and its environment
<u>Total Project Components:</u>	Short-term components, development of the conjunctive management in lieu groundwater recharge area and construction of an additional 5 to 10 wells within the groundwater pumping area
Potential Supply:	25,000 to 35,000 acre-feet per year (ac-ft/yr)
Cost:	$26.3 million
Current Funding:	None
<u>Short-term Components:</u>	Pilot well/development
Potential Supply (by 2003):	15,000 to 20,000 ac-ft/yr
Cost:	$1.31 million
Current Funding:	None
Implementation Challenges:	Coordination among water districts and state and local agencies, public education, water rights implications, environmental compliance
Key Agencies:	RD 108, DWR, Yolo and Colusa counties, Y-ZWD, DWD, CCWD, Reclamation District No. 787 (RD 787), U.S. Bureau of Reclamation (USBR), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), environmental interest groups

Summary

In July 1997, DWR completed a pre-feasibility investigation of the potential to develop a conjunctive management project within the Lower Colusa Basin of Yolo and Colusa counties. The investigation was conducted in cooperation with RD 108, CCWD, and Y-ZWD and included analysis of two alternatives for conveyance and distribution of water to areas where in lieu groundwater recharge could be accomplished. Groundwater would be pumped during dry years from wells within RD 108, and the basin would recover during wet years through in lieu recharge. The study area encompasses approximately 300 square miles and is generally coextensive with the service areas of the districts within the southern portion of the Colusa Basin (see Figure 10A-1).

The eastern boundary of the study area is the Sacramento River, and the western boundary is along the eastern foothills of the Coast Range, which effectively marks the western edge of the groundwater basin. As part of the investigation, DWR installed 12 multiple-completion groundwater monitoring wells at selected locations throughout RD 108 (see Figure 10A-2). DWR is continuing to monitor the water levels and water quality of these wells, as well as three existing wells owned and operated by RD 108, and is evaluating the collected data from these and other existing wells in the area. DWR is also considering modification and expansion of the alternative groundwater recharge areas described in the pre-feasibility investigation.

RD 108 proposes to move forward with a conjunctive management program in cooperation with DWR. The initial phase, (short-term component), is the construction of five pilot wells within RD 108 to be completed within 18 months. The long-term component of the project is the development of the conjunctive management in lieu groundwater recharge area and construction of an additional 5 to 10 wells within the groundwater pumping area.

Reclamation District No. 108 Water Supply

RD 108 was formed in 1870 under the Reclamation District Act for the purpose of providing flood protection for farmland along the west side of the Sacramento River by constructing levees. In the early 1900s, the District began constructing and operating pumping plants for diversion of water from the Sacramento River and irrigation canals to provide delivery of water to farmland within southern Colusa and northern Yolo counties.

In 1964, the District entered into a water rights settlement contract with USBR that provided for delivery of supplemental water during the summer months from the Central Valley Project. Except during critical dry years, the District's surface water supply from the river has been able to meet the irrigation requirements of the 48,000-acre service area, and, in certain years, the District has been able to help its neighbors with authorized water transfers. Because of the District's established rights to surface water and its contract with USBR, Sacramento River water has supplied nearly all of the water needs of District lands.

Over the years, there has been only limited development of the groundwater supply for irrigation of lands, mostly to irrigate lands adjacent to the river corridor.

In the late 1950s and early 1960s, the District installed three irrigation wells within its northern area as a backup water supply during dry years. These wells have been used periodically as an emergency water source and, during the early 1990s, as a contributing supply for the California drought water bank. The wells are being operated this year under a Forbearance Agreement with USBR and the Westlands Water District. However, since there has been very limited need and use of the groundwater aquifer underlying the District, the groundwater production capabilities are virtually untested and, therefore, virtually unknown.

Drainage and Reuse

The District is surrounded on three sides by flood control levees, e.g., Sacramento River on the east, Colusa Basin Drain on the west, and the 2047 Canal (Lateral 14A) on the south. There is no gravity drainage outlet; therefore, all water within the system that is in excess of irrigation needs must be pumped out or recycled within the District's irrigation distribution system. Drainage water is pumped at the Rough and Ready Pumping Plant into the Sacramento River for reuse and at the Riggs Ranch Pumping Plant into the Colusa Basin Drain for irrigation use by downstream farms.

Under the District's water management program, drainage water is also recycled within the irrigation service area and blended with water diverted from the river. Both drainage water and blended irrigation water quality are regularly monitored to maintain control of salinity levels within the range of acceptability for irrigation.

Existing Studies and Modeling

A comprehensive groundwater model of the lower Colusa Basin is being developed by DWR. In the next stage of the conjunctive management program (feasibility level investigation), DWR would evaluate the groundwater characteristics and survey water/aquifer interactions and the operational parameters of surface- and groundwater levels within the basin.

The pre-feasibility-level investigation by DWR evaluated several preliminary alternatives that would involve groundwater pumped within RD 108 in an effort to provide for in lieu recharge within either Y-ZWD or CCWD. The practicability of conveying surface water from the Sacramento River to the in lieu groundwater recharge areas is being reconsidered by the DWR. A more practical and economical approach is being considered that involves moving water by exchange through the Tehama-Colusa Canal (TC Canal) and possible extension thereof. Ongoing monitoring and analysis by DWR of the groundwater conditions within the lower Colusa Basin will improve the existing database. Figures 10A-3 and 10A-4 compare groundwater elevation contours for 1976 and 1996. The contours show water levels under dry-year conditions, prior to completion of the TC Canal, with conditions following the flood event of 1995. Figures 10A-1, 10A-2, 10A-3, and 10A-4 were excerpted from the DWR pre-feasibility investigation report.

Short-term Component

Development of the groundwater production capability within RD 108 is an important element of an in lieu conjunctive management program within the lower Colusa Basin. The initial phase of development would be the installation of five production wells. These pilot wells, installed to depths of 800 feet, would be completed and operating within 18 months and would have capacities ranging from 3,500 gallons per minute (gpm) to 6,000 gpm. Pumping lift is estimated to be on the order of 100 feet. The production wells would be situated in strategic areas throughout the District, designed to minimize interference, and would be located adjacent to the main laterals to facilitate conveyance of groundwater into and through the District's irrigation distribution system. The groundwater investigation by DWR over the past several years, in monitoring groundwater levels and water quality within the several aquifers underlying the District, has resulted in preliminary data indicating that there is potential for production of significant quantities of good-quality groundwater. The pilot production well would prove this capability.

Quantified information on production capabilities of the aquifer and quality of the groundwater is critical to verifying the groundwater model being developed by DWR for the lower Colusa Basin. The model will provide the basis for evaluating the groundwater impacts of various conjunctive management scenarios in the District and the potential for regional projects. Successfully producing pilot wells would lead to the design of an expanded well field and construction of additional wells at sites selected by DWR under the long-term component of this proposed program.

Monitoring Wells

DWR has installed 12 multi-completion monitoring wells within RD 108 (see Figure 10A-2) that will be used to evaluate changes in groundwater levels and water quality. Studies to date have shown that water quality in most areas of the District is very good.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The long-term project would consist of a network of 10 to 15 District-owned and -operated groundwater wells capable of supplying from 25,000 to 35,000 ac-ft/yr to in lieu groundwater recharge areas. Five of these wells would be installed under the initial phase (short-term component). The groundwater recharge areas identified by DWR for the conjunctive management program are Y-ZWD and CCWD. Initially, DWR investigated delivery from the Sacramento River at the Knights Landing outfall gates. The project included up to six pumping facilities having significant capital costs. It appears that a more desirable option would utilize the TC Canal to convey water to the point or points where gravity delivery to the recharge area can take place. This approach would require less initial capital costs than the earlier alternatives proposed by DWR and would allow for incremental expansion of in lieu recharge as the project develops. There are also opportunities with other TC Canal water users, such as DWD.

2. Potential Project Benefits/Beneficiaries

The proposed conjunctive management project would produce potential local and regional benefits to water users and to the environment. The expected local beneficiaries are RD 108, Y-ZWD, CCWD, and DWD. Other local water user entities that may benefit through their participation are RD 787 and Colusa Drain Mutual Water Company. Potential beneficiaries would also include the Delta and its environment.

Water Supply

Full implementation of the groundwater production facilities is anticipated to develop a capability to extract up to 34,000 ac-ft/yr during dry and critical years. During wet years, water would be available for surface water delivery where groundwater pumping has resulted in declining and/or highly fluctuating water tables and, in certain areas, land subsidence. The decrease in groundwater pumping in the areas receiving the wet-year water would allow for in lieu recharge of the underlying aquifers.

Water Management

In addition to in lieu recharge of the underground, the groundwater production capacity could be utilized to reduce surface water diversions during dry years to allow additional flows in the river for requirements of downstream users, including aquatic species and increased flows in the Delta.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Short-term Component

Estimated costs for the initial five wells are shown in Table 10A-1.

TABLE 10A-1
Estimated Costs
Reclamation District No. 108 Pilot Well Development/Conjunctive Management Project

Item	Total Cost x $1,000
Production Wells — 5 each @ $160,000	800
Land Acquisition — 2 acres @ $5,000	10
Subtotal	810
Contingencies (30 percent)	240
Subtotal	1050
Design, Environmental Documentation, and Administration (25 percent)	260
Total	**1,310**

Long-term Component

The long-term project component involves installation of an additional 5 to 10 production wells and the conveyance of water to in lieu groundwater recharge areas. Preliminary design of surface water conveyance systems was prepared by DWR for delivery of water from the Sacramento River to lands within Y-ZWD and CCWD. Since Y-ZWD does not have a surface water distribution system, a new canal system would have to be constructed.

An alternative plan for Y-ZWD would be to convey surface water from an extension of the Tehama-Colusa Canal to a distribution system within the District. This plan is being investigated by DWR. According to preliminary design and cost analyses prepared by DWR, it is estimated that the capital costs for an extension of the TC Canal and distribution system to convey surface water to the groundwater recharge area of Y-ZWD would be on the order of $25 million.

CCWD and DWD have existing pipeline distribution systems connected to the TC Canal from which they presently receive delivery of Central Valley Project water from USBR. Supplemental surface water can be conveyed through these existing distribution systems. If surface water can be delivered through the Tehama Colusa Canal under a conjunctive management exchange arrangement, there would be no capital cost component for this recharge alternative serving either or both of these districts.

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem. Additionally, the project could provide environmental benefits at the reservoir site by providing waterfowl habitat.

Project implementation would also result in impacts to the environment, notably through the conversion of open space to recharge basins. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. It is likely that the appropriate level of environmental documentation necessary for this project would be an environmental impact statement/environmental impact report (EIS/EIR).

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Large amounts of earthwork would be required for the recharge basins. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)—**The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Lands Commission—**Project would need to consult with State Lands Commission on the public agency lease/encroachment permitting for use of state lands.
- **State Reclamation Board—**The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)—**Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **Division of Safety of Dams (DSOD)—**Design and configuration of the storage basins may require permitting and compliance with Dam Safety because of the height of the retention walls. DSOD is structured within DWR.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft California Environmental Quality Act (CEQA) environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

Project implementation would occur in two phased periods of time, the final phase having the more significant challenges because of its potential size and complexity. Some of these challenges are discussed below.

Coordination among Public and Private Entities

Close coordination would be required among local, state, and federal entities. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Project

Numerous parties are investigating similar conjunctive management projects throughout the Sacramento Valley. Coordination between those involved with these investigations is very important. Such coordination can avoid duplication of effort, avoid the nullification of project benefits through competing projects, and optimize the benefits of these projects to the watershed.

Lack of Sufficient Groundwater Data

The lower Colusa Basin has limited groundwater information available, particularly within RD 108. DWR has been compiling data from its monitoring wells within RD 108 and elsewhere in the lower Colusa Basin and is working on a groundwater model for the basin.

Water Rights Implications

RD 108's participation would involve the District's existing water rights. Surface water diversions would be expected to decrease in some years, while full contract quantities would be utilized in other years.

Public Perception

Landowners may have concerns about possible groundwater overdraft. Aquifer recharge aspects of this project may tend to alleviate these concerns. Monitoring and modeling of groundwater levels would be an essential part of this project both technically and politically.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Land Acquisition

It is probable that land or easements would have to be acquired for the production wells and for new conveyance and delivery systems. Some landowners may object to acquisition of their lands.

Key Stakeholders

The key stakeholders expected to be associated with or impacted by this conjunctive management and recharge project and their anticipated roles, concerns, and/or issues are identified in Table 10A-2.

TABLE 10A-2
Stakeholder Roles and Issues
Reclamation District No. 108 Pilot Well Development/Conjunctive Management Project

Stakeholder	Role/Concerns/Issues
RD 108	• Project proponents and direct beneficiary
Yolo and Colusa counties: CCWD, DWD. Y-ZWD	• Groundwater management objective, compliance with AB-3030 plans
DWR	• Planning for conjunctive management within lower Colusa Basin water rights
Local landowners	• Impacts on both short-term and long-term groundwater levels • Acquisition of possible land easement and/or purchase
USBR	• Water rights • Integration with other regional management concepts and programs
Environmental interest groups	• In-stream flow impacts, fishery impacts, habitat and Endangered Species Act issues, land use water quality impacts

6. Implementation Plan

The following major steps are proposed to implement the project.

Short-term Component

Task 1.1 Site selection—Coordinate with DWR in selecting the most appropriate sites to construct the pilot wells, considering the following criteria: water quality, long-term yield, environmental adaptability, and proximity to distribution system. Obtain land rights where necessary. Prepare required environmental documentation. (3 months)

Task 1.2 Prepare design—Prepare plans and specifications for well construction and contract documents, and obtain appropriate environmental clearance and permits. (3 months)

Task 1.3 Bid process—Conduct bidding, select contractor, and award bid. (2 months)

Task 1.4 Construction—Complete pilot well drilling and testing to determine production capability. Size the pump and pump driver as indicated by pump test, and order equipment. Install equipment and connect well to distribution system. (8 months)

Task 1.5 Short-term program implementation—Operate wells to establish production capabilities and data for DWR analysis. (ongoing)

Long-term Component (To be better defined upon further evaluation of the long-term component)

Task 2.1 Analysis of data—Data collected during the RD 108 pilot study would be analyzed by DWR to establish the parameters of the Conjunctive Management Program. (1 year—beginning 1 year after successful completion of Task 1.4. This allows 1 year to gather data from the newly installed wells.)

Task 2.2 Preliminary design— The preliminary design would involve engineering design of the major facilities to a 30-percent design level. This level of design would include such details as sizes, locations, and footprints of all major facilities. This information would support key implementation steps such as right-of-way acquisition, soils testing, mapping, and permitting and environmental studies. Possible review by resource agencies and local sponsor may occur following the preliminary design so that comments may be incorporated into the final design. (4 months)

Task 2.3 Environmental assessment/environmental impact report (EA/EIR)—The EA/EIR would be based on the preliminary design and would confirm the potential impacts and required mitigation, if any, for the project. (1 year)

Task 2.4 Final design—Final design would proceed following the EA/EIR work. This would involve producing engineering drawings, specifications, and other final contract documents suitable to bid and construct the project facilities. Possible review by resource agencies and local sponsor may occur following the final design. (1 year)

Task 2.5 Permitting—The various permits would be obtained using the final design as the basis for permitting requirements. This process may be initiated before completion of final design. (9 months)

Task 3.1 Construction and construction management (CM)—Construction oversight is required to enforce contract requirements and ensure a quality, functional end-product. Typical CM activities include (1) evaluating bids; (2) reviewing, approving, and testing proposed products and materials; (3) observing, photographing, and documenting all aspects of construction; (4) managing changes during construction; and (5) estimating contractor inventories, progress, and progress payments. Construction would potentially be phased over several years, given the size and complexity of the project. (1.5 years)

Task 4.1 Operation and monitoring—Long-term operations and monitoring of the project would begin following completion of construction.

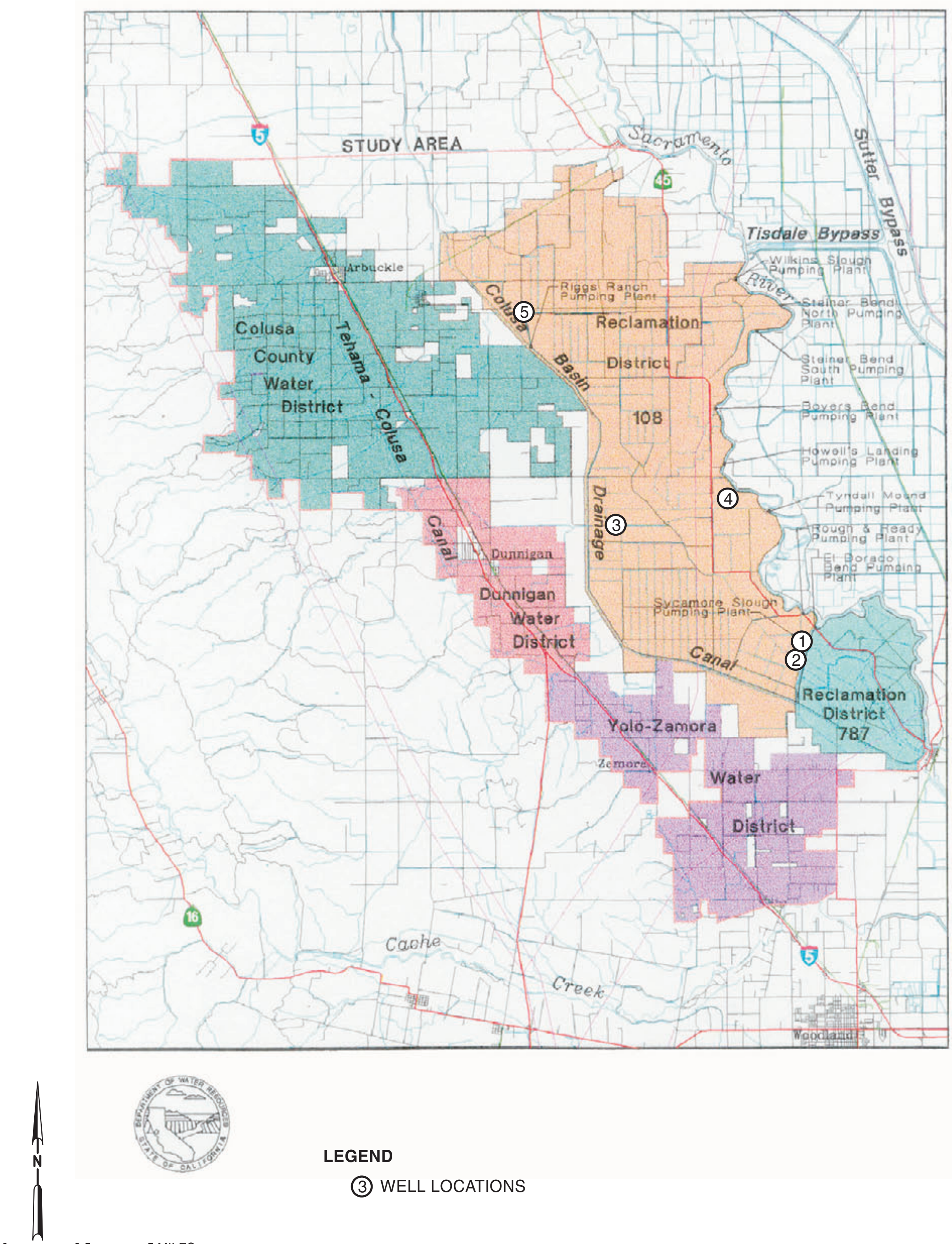

FIGURE 10A-1
PROJECT LOCATION MAP

RD 108 PILOT WELL DEVELOPMENT/
CONJUNCTIVE MANAGEMENT PROJECT

SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_53 (6/4/02)

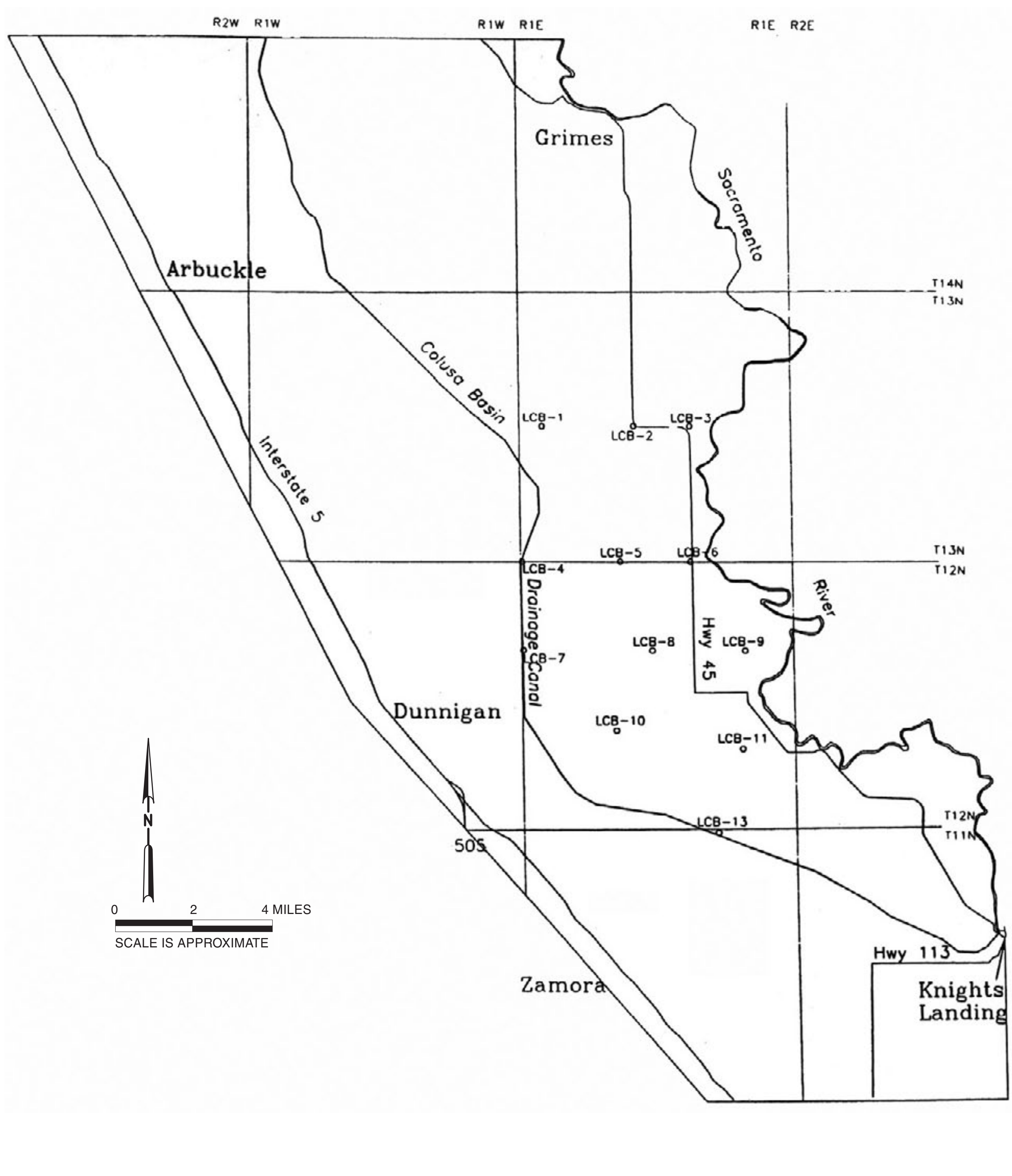

FIGURE 10A-2
LOCATIONS OF EXISTING MULTI-COMPLETION MONITORING WELLS IN THE LOWER COLUSA BASIN STUDY AREA

RD 108 PILOT WELL DEVELOPMENT/ CONJUNCTIVE MANAGEMENT PROJECT

SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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in association with
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MBK
SWRI

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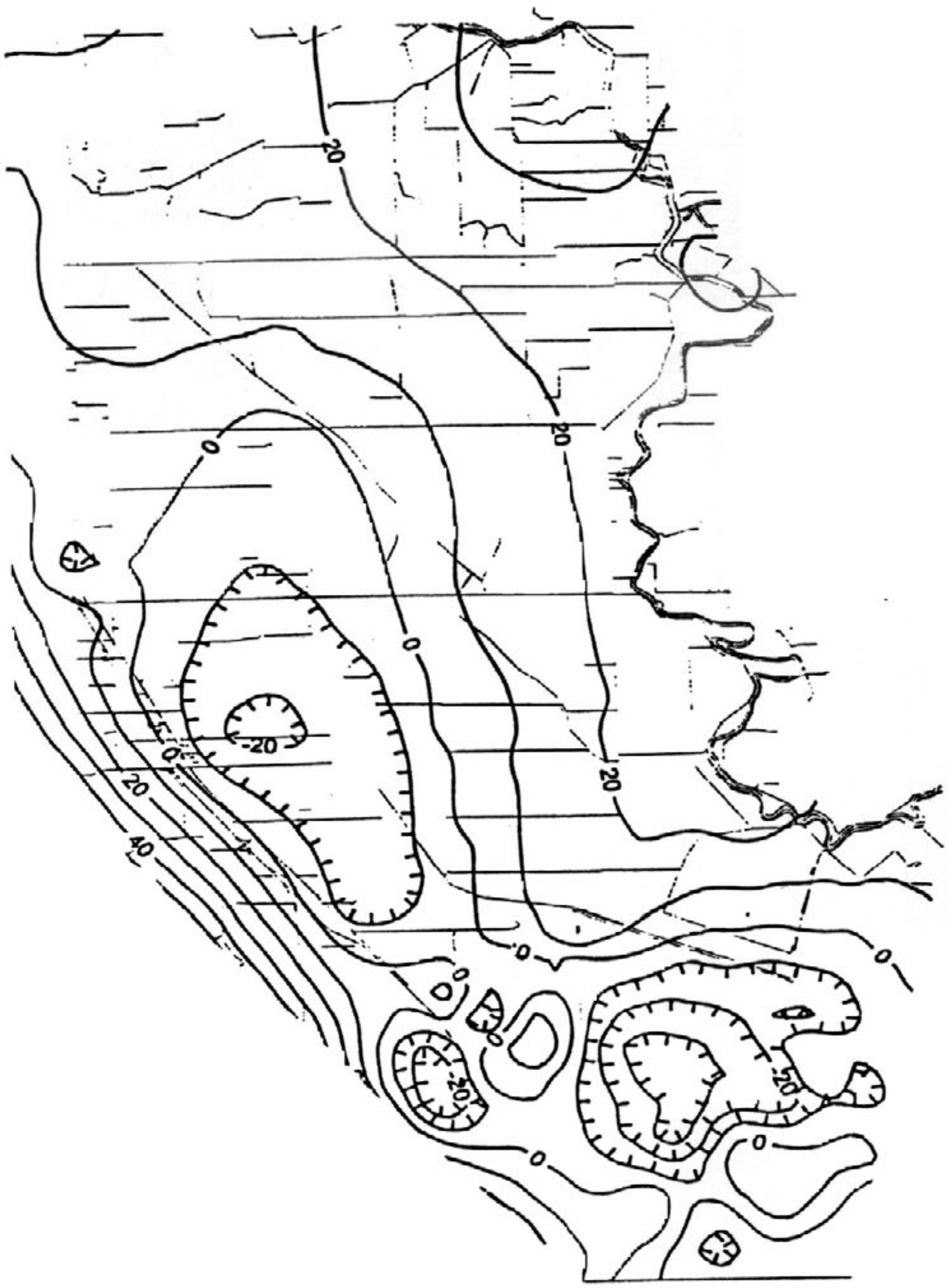

FIGURE 10A-3
SPRING 1976 GROUNDWATER ELEVATION CONTOUR MAP
RD 108 PILOT WELL DEVELOPMENT/ CONJUNCTIVE MANAGEMENT PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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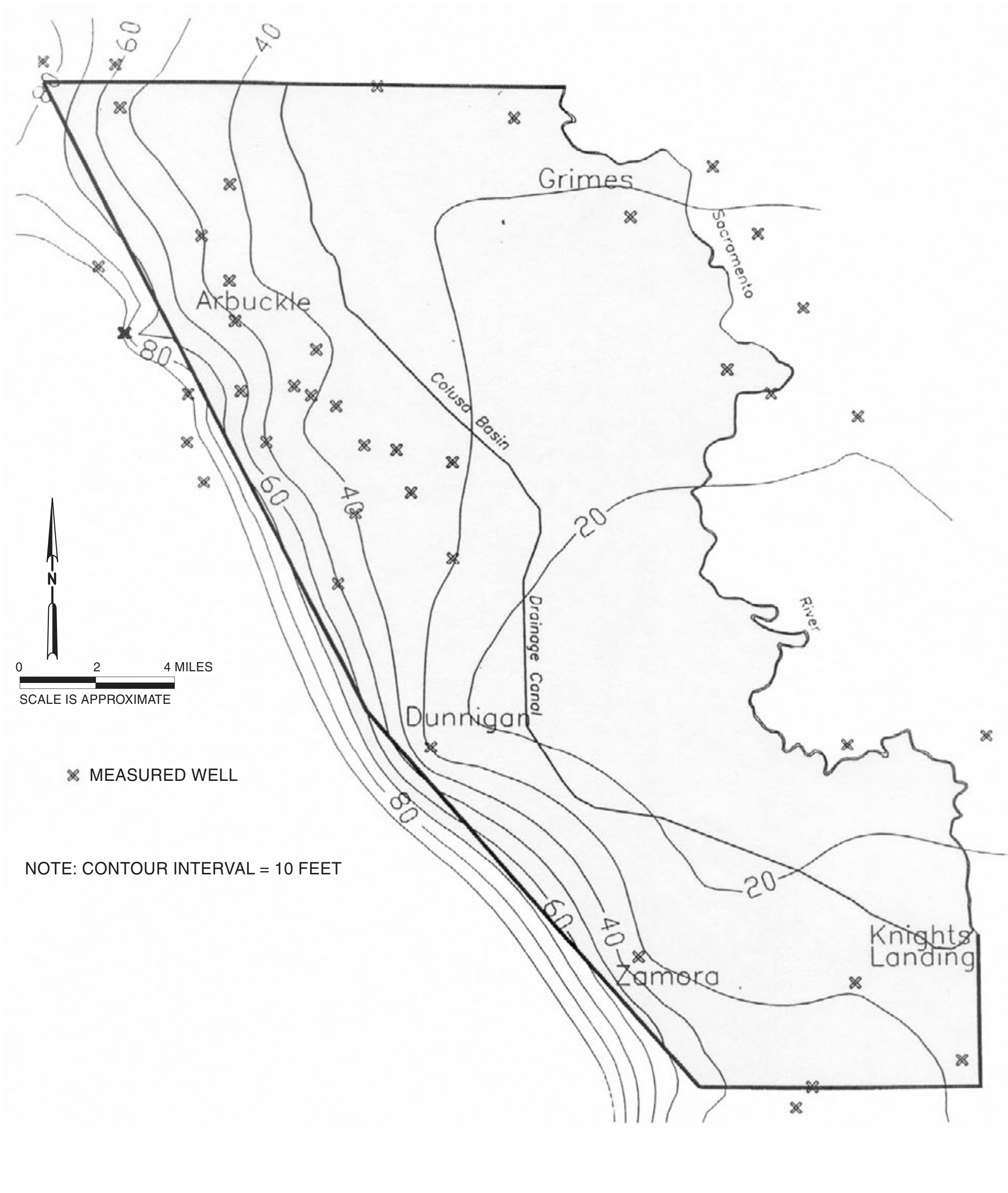

FIGURE 10A-4
SPRING 1996 GROUNDWATER ELEVATION CONTOUR MAP
RD 108 PILOT WELL DEVELOPMENT/ CONJUNCTIVE MANAGEMENT PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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Project 10A—Draft CEQA Environmental Checklist

Project 10A—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☒ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature	Date
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☒	☐	☐	☐
This project would include conveyance facilities and recharge basins. The exact location of the basins are yet to be determined. The majority of land around these locations is used for agricultural purposes. The conveyance facility and recharge basins may require a permanent conversion of potential Prime Farmland, Unique Farmland, or Farmland of Statewide Importance.				
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☒	☐	☐	☐
See response to II (a) above.				
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☒	☐	☐	☐
See response to II (a) above.				
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to a less than significant level.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☐	☒	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☐	☐	☒
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☒	☐
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☐	☒	☐
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☒	☐	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY—Would the project:				
a) Violate any water quality standards or waste discharge requirements? *There is a potential for an increase of erosion and sedimentation from construction activity that would require the implementation of BMPs to reduce any impacts to waterways in and around the project area.*	☐	☒	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted). *There are serious concerns about the long-term draw-down of the groundwater table and land subsidence, particularly in dry years. Model development would help in determining the effects of increased groundwater pumping. The impact that groundwater withdrawal would have on existing groundwater supplies is as yet undetermined; however, it is potentially significant because of the complexity of the issue.*	☒	☐	☐	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☒	☐	☐
See response to XI (a) above.				
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
<u>XII. POPULATION AND HOUSING</u>—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
<u>XIII. PUBLIC SERVICES—Would the project:</u>				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
<u>XIV. RECREATION—Would the project:</u>				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☐	☒
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☒	☐	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

Sutter Sub-basin

PROJECT 22B

Sutter Mutual Water Company Irrigation Recycle Project

1. Project Description

Project Type:	Irrigation water reuse
Location:	Sutter Basin, Sutter County
Proponent(s):	Sutter Mutual Water Company (SMWC or Company), Reclamation District No. 1500 (RD 1500 or District)
Project Beneficiaries:	SMWC water users, RD 1500, U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG)
Total Project Components:	Short-term components, design and preparation of construction documents, construction of recapture/recycle project
Potential Supply (by 2005):	25,000 acre-feet per year (ac-ft/yr)
Cost (Phases 3 and 4):	$10.8 million
Current Funding:	None
Short-term Components:	Feasibility study, surveys and mapping, National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) compliance, preliminary design of recapture/recycle project
Potential Supply (by 2003):	None
Cost (Phases 1 and 2)	Phase 1: $250,000 Phase 2: $250,000 $500,000
Current Funding:	None
Implementation Challenges:	Environmental coordination and landowner acceptance
Key Agencies:	CDFG, USFWS, National Marine Fisheries Service (NMFS), and State Water Resources Control Board (SWRCB)

Summary

The proposed project would enhance and maximize the use of applied surface water for irrigation purposes and minimize summer drainage that must be pumped out of the Sutter Basin. The objective to increase the recapture/recycle effort entails construction of check structures and lift pumps in the RD 1500 Main Drainage Channel and return drainage to the Main Irrigation Canal for redistribution throughout the service area.

SMWC is a private company that provides irrigation water to approximately 50,000 acres within the Sutter Basin east of the Sacramento River approximately 45 miles northwest of Sacramento.

The SMWC service area is within the boundaries of RD 1500 and, therefore, all summer and winter drainage is collected in the District's Main Drain and conveyed to the pumping plant in the southerly end of the District where it is pumped out of the District into the Sacramento Slough, which is tributary to the Sacramento River (See Figure 22B-1).

A reconnaissance investigation of the potential to recycle irrigation runoff throughout the Company service area was completed in 1997 with the finding that a formal feasibility report would be justified. The investigation found that 80 percent of the drainage water in the SMWC service area is generated upstream of the Bohanon Control Structure located in the RD 1500 Main Drain, meaning that the facility and similar structures placed upstream with lift pumps could effectively return even greater quantities of drainwater for recycle use than are currently available for recycle purposes.

The SMWC owns and operates the Bohannon Control Structure in the RD 1500 Main Drain. It currently provides storage in the drain, thereby raising levels in the drainage laterals where lift pumps return drainage to the irrigation distribution system. The existing effort has successfully captured 10,000 to 15,000 ac-ft of drainwater for reuse in an average year. Since the drought years in the late 1980s and early 1990s, the U.S. Bureau of Reclamation (USBR) and water users, through an aggressive effort to enhance water conservation, have minimized the total volume of drainwater from field runoff to a point where reduced quantities exist to operate recycle systems to the fullest design potential.

Because of water quality concerns, SMWC has an ongoing program of monitoring water quality of its delivery supply and reuse water. This program will continue with promotion of additional recycle use to ensure that salt build-up in the soil is not occurring to the point where crop production and soil fertility are affected.

Because minimal recapture could be accomplished from drain laterals with the previously constructed facilities, attention was focused on relift pumping plant installations on the Main Drain to return flow to the Main Canal at the north end of the service area.

The project features include excavation of the main drainage channel; installation of relift pumping structures; and installation of automated control, monitoring, and alarm systems for distribution system control and operation. Figure 22B-2 illustrates the system features and the primary existing infrastructure.

The objective of the proposed project is to supplement existing surface water supply and recapture efforts to provide adequate supply during critical periods of rice flooding and to fulfill irrigation requirements when surface flows are insufficient. The project is proposed as a supplemental supply under short-term reduced-allocation situations.

Periods of water shortage in the past have enhanced the awareness of water needs and demands by agricultural, urban, and environmental interests. Useful water planning must be implemented thoughtfully, realistically, and practically through coordinated efforts by all interests, giving due consideration to specific environmental settings and project economic feasibility.

Short-term Component

The initial Phase 1 work would entail preparation of a project-level feasibility report to include mapping and surveying along the Main Drain to determine control structure and lift pump locations. An analysis and quantification of drainage water availability for reuse would also be updated from the 1997 reconnaissance study to confirm the reliability of supply. Preliminary design of project features would be included to provide sufficient detail for preparation of cost estimates.

A site biological survey would be conducted to determine the potential environmental effects of the project. An environmental assessment would also be prepared to focus on site-specific issues.

It is anticipated that Phase 1 work would be accomplished in late summer 2002.

Phase 2 would include an analysis of operational procedures outlining anticipated operation and maintenance tasks and costs, development of a schedule for design, and preparation of the required environmental documents.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

Following approval of environmental documentation meeting NEPA and CEQA requirements, Phase 3 would commence with final design. This activity would include system design and preparation of construction documents. Phase 4 would begin in year 2004 with construction of facilities, implementation of the project, preparation of operations and maintenance materials, and continuation of water quality monitoring. Construction would be completed in early winter 2004, with the project fully implementable by the 2005 irrigation season.

2. Potential Project Benefits/Beneficiaries

The proposed recapture and recycle program envisioned would enhance the efficiency of the Company's agricultural diversions during those critical periods when competition for water delivery is highest, as well as those periods when SWRCB invokes water diversion curtailment for riparian and appropriative water rights.

The project benefits RD 1500 in that it reduces the quantity of surface runoff to Company drains and pumping plants, thus reducing power consumption of less efficient facilities.

Additional beneficiaries include the State Water Project and the Central Valley Project whose supplies would be less impacted during critically dry years when surface water curtailment activities are in place.

Water Supply Benefits

SMWC would benefit from the project through potential reduction in surface water diversions from its three Sacramento River pumping plants. It would also provide greater reliability in meeting irrigation delivery requirements during periods of drought when diversion restrictions prevent full use of surface water, and when imbalances occur in the conveyance system, requiring greater peak-field delivery than is currently possible.

Environmental Benefits

Environmental benefits would be provided by maintaining a greater water supply in the river for fish, ensuring supply to the refuges within the Sacramento Valley, and allowing additional flow through the Delta.

Water Quality Benefits

No change in water quality is expected with construction and implementation of the project, although short-term irrigation service area water quality conditions would deteriorate during below-average rainfall periods when salts would not be entirely flushed from the drainage basin.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to –30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Project costs are shown in Table 22B-1 and are based on the 1997 reconnaissance study of the recycle/reuse proposal. The estimated total project cost is $10.5 million, which includes contingencies, engineering, construction management, environmental documentation, and administration.

TABLE 22B-1
Feasibility and Capital Cost Estimate
Sutter Mutual Water Company Irrigation Recycle Project

Item	Quantity	Units	Unit Cost	Total Cost
Phase 1				
Feasibility Report, Biological Survey, Environmental Assessment, and Preliminary Design				$250,000
Phase 2				
Operational Procedures and Environmental Compliance				$250,000
Phases 3 and 4				
RD 1500 Main Drain:				
Channel Excavation and Material Disposal	500,000	Cubic yards	$10	$5,000,000
Pumping Plant Structure:				
Pump Sump, Piling , Trash Rack, Platform, and Walkway	2	Each	$250,000	$500,000
125-hp Motor and Pump (including pipe, fittings, and flap gates)	4	Each	$73,000	$292,000
100-hp Motor and Pump (including pipe, fittings, and flap gates)	1	Each	$68,000	$68,000
150-hp Motor and Pump (including pipe, fittings, and flap gates)	4	Each	$79,000	$316,000
200-hp Motor and Pump (including pipe, fittings, and flap gates)	1	Each	$95,000	$95,000
Electrical Equipment (including panels, switch gear, starters, and controls)	2	Each	$100,000	$200,000
			Subtotal ->	$6,471,000
Contingencies and Allowances (30%) ->				$1,941,300
Environmental Mitigation (5%)->				$323,550
Engineering, Environmental Compliance, Construction Management and Admin. (25%) ->				$1,617,750
Phase 1 through 4 Total Preliminary Project Cost ->				**$10,853,600**

hp = horsepower

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible and efficient water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment. Key issues that are anticipated relate primarily to the proposed excavation of the Main Drainage Channel, and could require elimination of habitat adjacent to and within the canal prism. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways. Depending upon the controversial nature of the Endangered Species Act (ESA) issues, it is likely that the appropriate level of environmental documentation necessary for this project would be a Mitigated Negative Declaration.

Implementation of the project would also require issuance of permits from various regulatory agencies. A summary of the likely permitting requirements follows. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Large amounts of earthwork would be required for the construction activities. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction. In addition, National Pollutant Discharge Elimination System (NPDES) stormwater-related approvals may be required.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)—**The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights of way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

The project implementation would occur in several incremental stages, each of which would have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. The following lists some of the implementation challenges anticipated to be associated with this project.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Habitat for known ESA-listed species such as the valley elderberry longhorn beetle and the giant garter snake is present within the project area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities such as USFWS, USBR, and DWR. The governmental agencies would have strong interests associated directly with the project and indirectly as it may affect other interests in the area. It is highly probable that because of the complexity and far-reaching implications of the project that competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Projects

Numerous parties are examining similar projects throughout the valley. To optimize the effectiveness of these projects, coordination between the projects would be required from the onset. The strongest motivation for such an effort is three-fold: (1) to avoid duplication of effort and as a result efficiently use available funds, (2) to avoid the nullification of project benefits through competing projects, and perhaps most importantly, (3) to optimize the benefits of these projects to the watershed.

6. Implementation Plan

The proposed project would be conducted as a four-phase project. Phases 1 and 2 are the subject of the short-term component (this proposal), and if the project meets feasibility requirements, Phases 3 and 4 will be implemented as long-term components. The four phases are briefly described below.

Phase 1

The initial phase consists of preparation of the feasibility report, a site biological survey, an environmental assessment, a cost estimate, and the preliminary project design.

Phase 2

Phase 2 includes an analysis of operational procedures and reliability of proposed facilities by quantification of the capital, operation, and maintenance costs, development of a specific schedule for design and construction, and completion of all environmental documentation and permitting requirements.

Phase 3

The third phase would include complete engineering design, plan preparation, and specifications for construction of the project.

Phase 4

The final phase would include construction of all proposed facilities for integration of the enhanced recapture/recycle facilities with the existing SMWC distribution system.

Figure 22B-3 illustrates the approximate schedule for completion of the four-phase project.

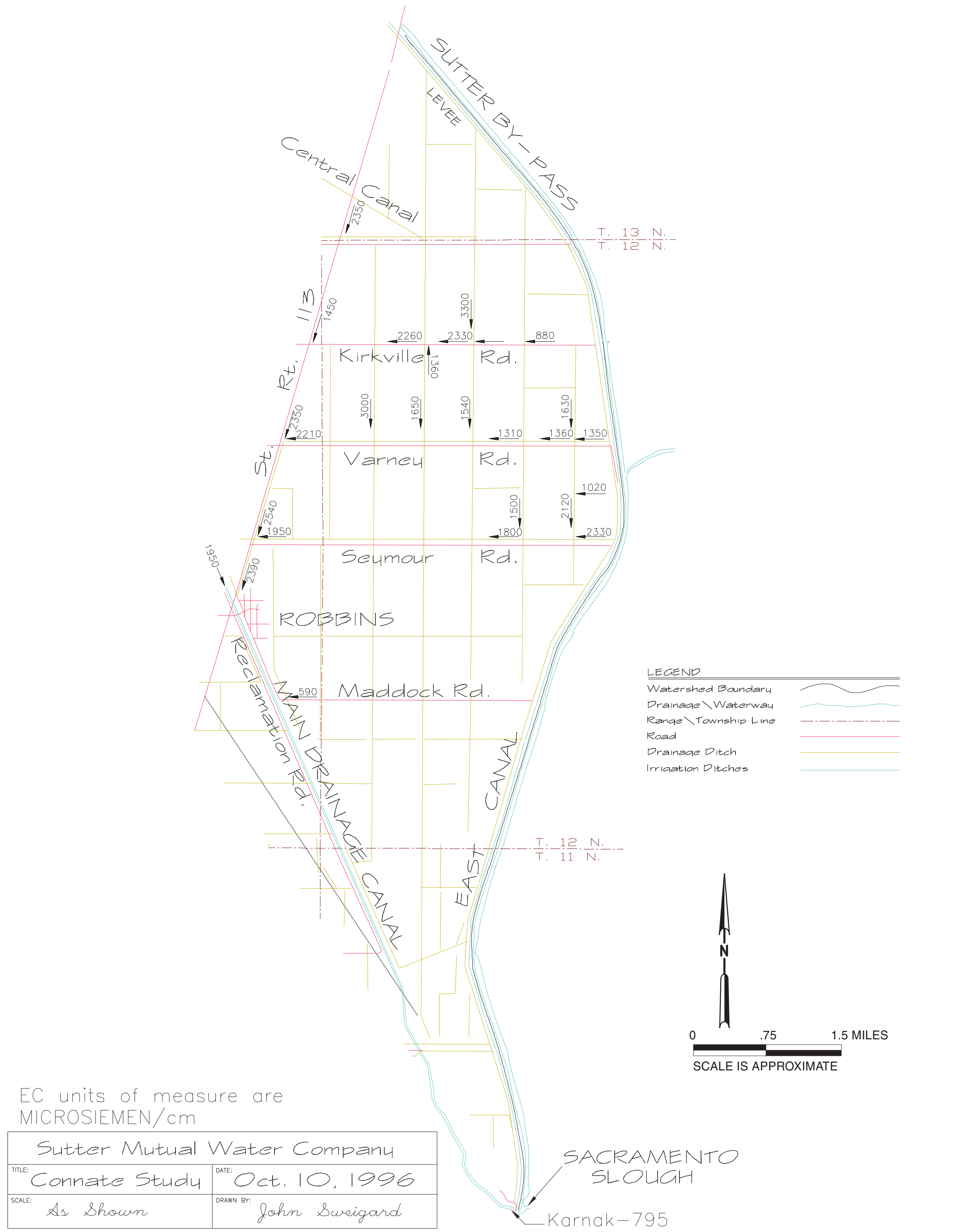

FIGURE 22B-1
PROJECT LOCATION MAP
SMWC IRRIGATION RECYCLE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_55 (10/26/01)

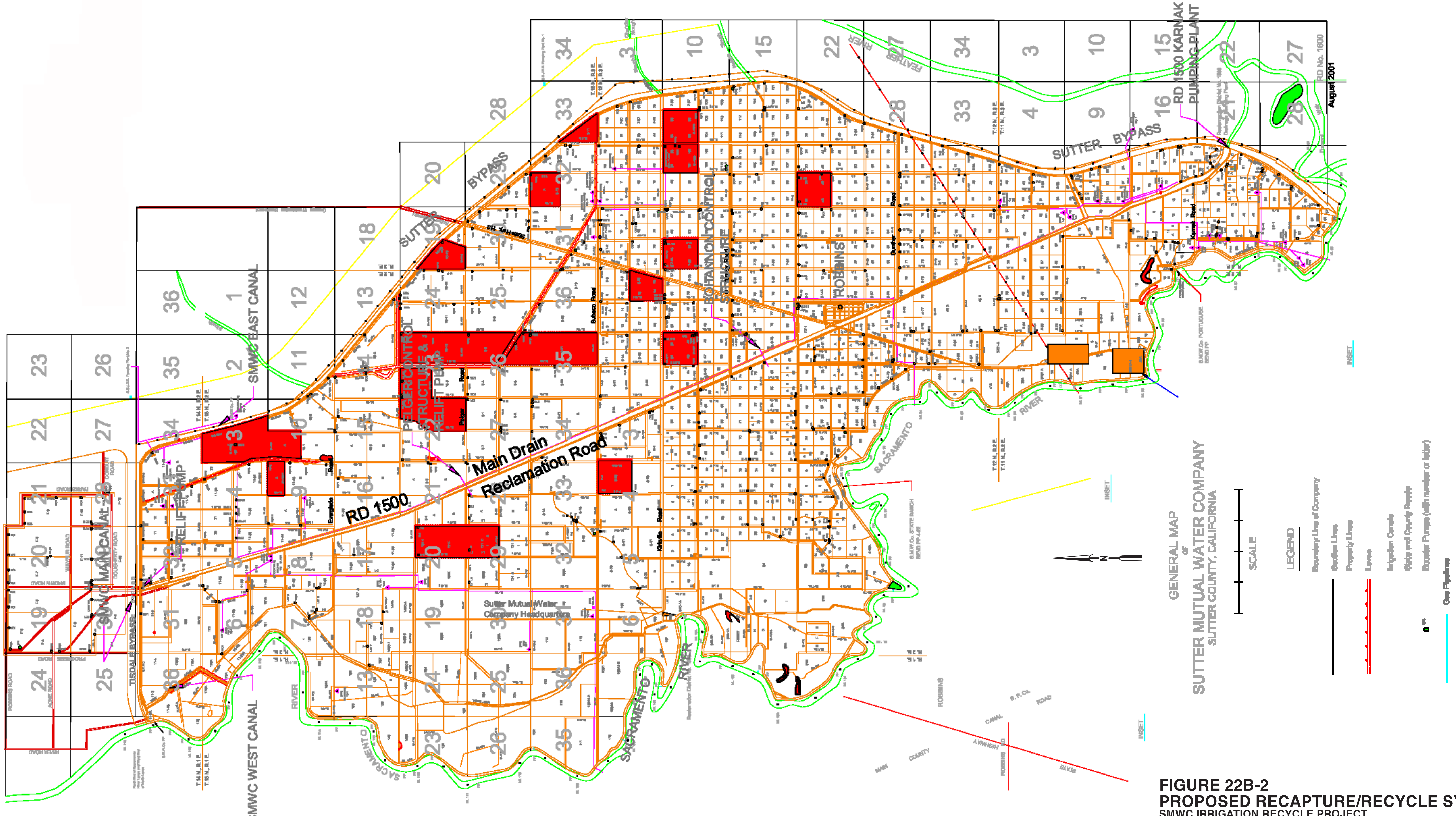

FIGURE 22B-2
PROPOSED RECAPTURE/RECYCLE SYSTEM
SMWC IRRIGATION RECYCLE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_56 (10/23/01)

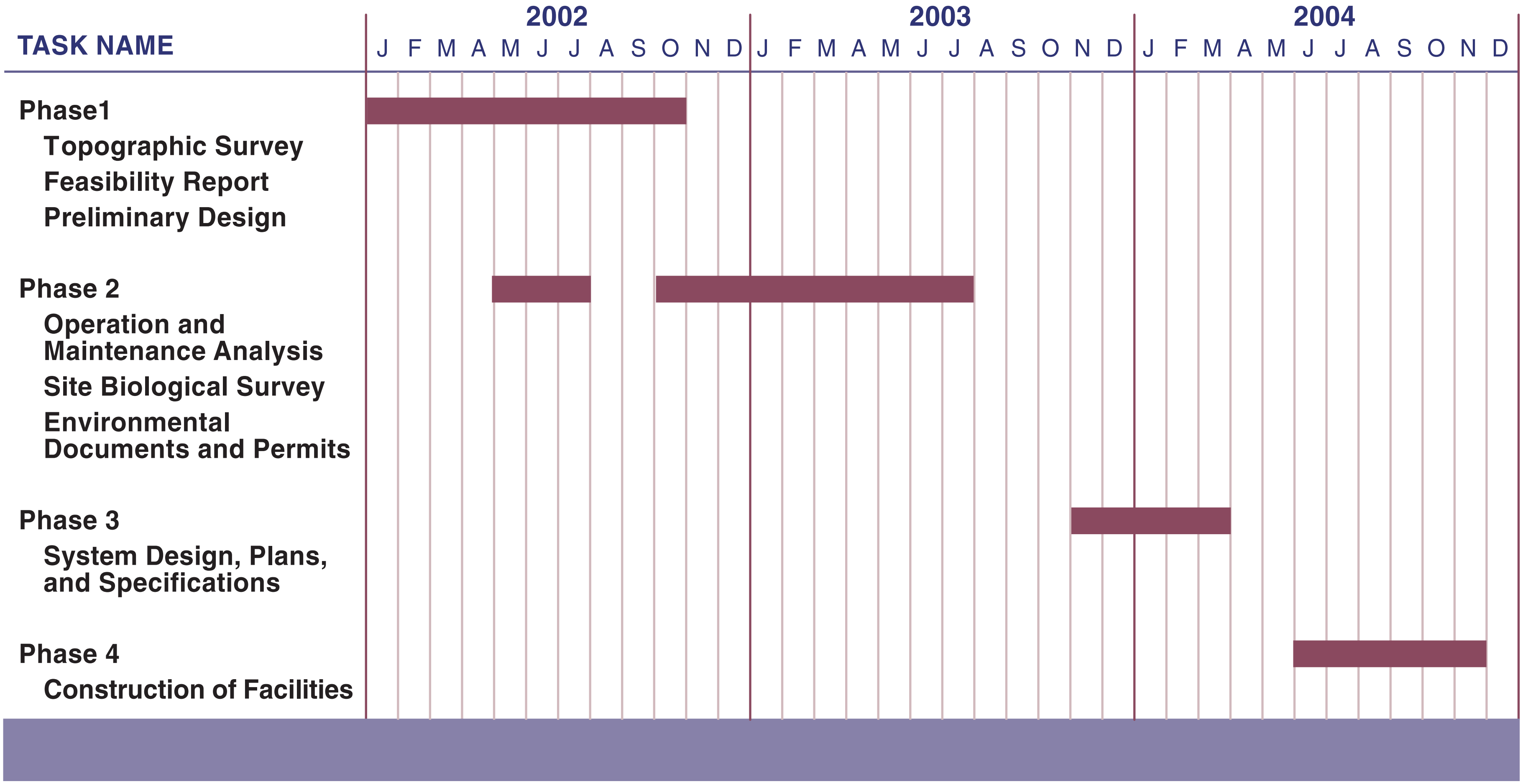

FIGURE 22B-3
PRELIMINARY IMPLEMENTATION SCHEDULE
SMWC IRRIGATION RECYCLE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
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MBK
SWRI

W072001014RDD_52 (10/23/01)

Project 22B—Draft CEQA Environmental Checklist

Project 22B—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________ ____________________

Signature Date

______________________________ ____________________

Printed Name For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐
III. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to a less than significant level.				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
See response to III (a) above.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☒	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☒	☐	☐
See response to IV (a) above.				
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace any vegetation removed during construction.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?. *See response to IV (e)above.*	☐	☒	☐	☐
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
<u>VI. GEOLOGY AND SOILS</u>—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?*.*	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
<u>VII. HAZARDS AND HAZARDOUS MATERIALS</u>—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☒	☐	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☒	☐	☐
Increases in turbidity would be likely to occur during any in-stream construction work. Additionally, there is a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan, and the implementation of BMPs to reduce any impacts to waterways in and around the project area.				
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☒	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☒	☐
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term noise levels are expected to increase for the duration of construction. These noise increases would be temporary, and mitigation measures would be implemented to reduce any impact to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

PROJECT 23A

Reclamation District No. 1500 Sutter Basin Groundwater Monitoring Well

1. Project Description

Project Type:	Conjunctive water management/groundwater/surface water planning
Location:	Sutter Basin, Sutter County
Proponents:	Reclamation District No. 1500 (RD 1500 or District), Sutter Mutual Water Company (SMWC or Company)
Project Beneficiaries:	Sutter Basin, RD 1500, SMWC, State Water Project, U.S. Bureau of Reclamation (USBR)
<u>Total Project Components:</u>	Development of sub-basin groundwater supply through conjunctive management in-lieu groundwater recharge and groundwater production wells based upon findings of the groundwater investigations performed during the short-term project component
Potential Supply:	8,000 to 12,000 acre-feet per year (ac-ft/yr)
Cost:	$3.9 million
Current Funding:	None
<u>Short-term Component:</u>	Pilot Study/Groundwater Program Feasibility Study
Potential Supply (by 2003):	1,500 to 2,000 ac-ft/yr
Cost:	$550,000
Current Funding:	None
Implementation Challenges:	Site selection, lack of groundwater data, National Environmental Policy Act/California Environmental Quality Act (NEPA/CEQA) compliance
Key Agencies:	SMWC, Sutter County, local landowners, USBR, environmental interest groups

Summary

RD 1500 in conjunction with SMWC proposes the design and construction of a groundwater monitoring well within the Sutter Basin in Sutter County. RD 1500 includes that portion of Sutter County bounded on the north and east by the Tisdale and Sutter Bypass and on the south and west by the Sacramento River, as shown on Figure 23A-1. The gross land area within the District is approximately 67,850 acres.

SMWC, Pelger Mutual Water Company, and landowners supply irrigation water to most of the lands within the District's service area. The majority of the irrigation water in the study area is surface water diverted from the Sacramento River with a small number of wells scattered along the westerly portion of the District. Limited development of the groundwater resource has occurred largely because of the existing extensive surface water rights and USBR contracts held by the companies.

Since implementation of the Groundwater Management Plan (under AB 3030) in 1997, RD 1500 has initiated a monitoring program to collect existing well-level data and surface water quality information within the Sutter Basin. Coordination of these activities with monitoring of groundwater in adjoining districts will provide a body of information necessary to proceed with further evaluation of the potential for groundwater development.

Several studies conducted since 1962 have isolated specific areas of poor-quality groundwater (connate or brackish water resulting from an artesian effect in the middle of the District) and indicated those sections within the District where relatively good water-quality supplies exist, particularly areas within the northwestern region of the basin. The objective of further investigative work is to develop recommendations regarding conjunctive use of groundwater and commingling with surface water supplies.

Short-term Component

Limited groundwater data is available for the Sutter Basin. It is necessary to cultivate a better and thorough understanding of the regional aquifer characteristics in order to develop a viable groundwater use program. Additional monitoring of both groundwater quantity and quality is necessary through a controlled environment such as a dedicated monitoring well. This project proposes a pilot program to investigate the feasibility of utilizing groundwater as part of the Basin's reliable water supply.

The short-term project component would likely include the following:

Pilot study—To determine aquifer characteristics and groundwater use feasibility (e.g. determine characteristics of aquifer recovery)

Feasibility study/collection of existing data—To determine the optimum location to conduct the pilot study and outline pilot study procedures

> This task would entail review of all existing groundwater monitoring data from existing agricultural wells and well logs from natural gas exploration conducted in prior years. From this data, groundwater aquifers would be defined, and water quality analysis information would be utilized to determine the most feasible location for the monitoring

well. Additionally, site selection must also identify strata with hydraulic connection to the river and eliminate those strata that may be directly influenced by surface water recharge. Information from previous studies within the basin would also be analyzed to correlate known features in the substrata that have a direct influence on water quality.

Well/study design—The pilot study is likely to include one monitoring well that would have the capability to act as a production well (approximately rated at 1,500 gallons per minute [gpm]) when not used for monitoring. The well would be equipped with data logging equipment and appurtenances allowing for continuous collection of data for the duration of the study.

Well construction—It is anticipated that the well would be drilled to an approximate depth of 900 feet, which exceeds most other well depths in the area. The various water-bearing strata would be isolated to enable the recording of specific information from each strata and then to coordinate the results with California Department of Water Resources (DWR) monitoring well testing from the adjoining Reclamation District No. 108 (RD 108) study. Currently a well with 1,000-gpm to 1,500-gpm capacity is considered sufficient to allow for the consideration of supplemental dependable supply of irrigation water to the Company.

Data Analysis and Recommendations

All short-term project components would be expected to be completed by December 2003.

Long-term Component

The primary purpose of this memorandum is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. As such, long-term component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The long-term goal of this project is to establish a reliable, well-defined groundwater supply within the Sutter Basin. However, an annual groundwater program cannot be instituted until reliable groundwater information is obtained and analyzed. A local groundwater program would be predicated upon reliable and thorough monitoring and modeling of the system.

Upon satisfactory completion of the pilot program, the proposed long-term project is anticipated to have the following components:

Groundwater modeling effort—The modeling effort should utilize information from such sources as the pilot program, existing DWR data and models on both the east and west sides of the Sacramento River, and monitoring results from local privately owned wells.

Utilization of private agricultural wells—The District and its sister company, SMWC, would eventually like to initiate a program that is similar to other Sacramento Valley Irrigation Districts, such as Glenn-Colusa Irrigation District to the north. The District would negotiate with local landowners to participate in a voluntary program where the landowners could contribute to SMWC water supply via their privately owned wells. The landowners would be reimbursed at a negotiated rate per acre-foot of water.

Installation of production wells—The District would install production wells (an estimated 10) that could be leased to SMWC for water supply. The monitoring/production well from the pilot study could potentially be part of this well field should the location be deemed suitable for long-term purposes.

Should the modeling effort indicate favorable circumstances for groundwater development, the privately owned agricultural wells could potentially be on-line by the 2005 irrigation season. The new production wells could potentially be on-line by the 2006 irrigation season.

2. Potential Project Benefits/Beneficiaries

The proposed monitoring well would further define the potential for the basin and enhance use of the groundwater resources. At this time the quantity and quality of ground water available is unknown. Although no direct water supply benefits would necessarily be gained from the pilot study, the intention is to derive direct benefits from the resulting long-term project components. Beneficiaries of additional groundwater supplies would include the State Water Project, USBR, SMWC, and environmental users during critically dry periods when surface supplies are deficient.

The District has corroborated with the SMWC in cooperatively working with other water purveyors within the Sacramento Valley in the formulation of the Sacramento River Basinwide Water Management Plan. Within the document that is nearing completion, Technical Memorandum No. 3, *Water Resources Characterization*; Technical Memorandum No. 5, *Water Management Supply Options*; and *Groundwater Hydrology Technical Memorandum* all relate to appropriate management of the groundwater resource. The stakeholders, consisting of 10 water suppliers, recognize the importance of a cooperative groundwater plan to ensure long-term availability of the resource as a supplement to the continually oversubscribed surface water supply. Additionally, USBR and DWR are acting sponsors and contributors to the preparation of the plan.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to –30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Tables 23A-1 and 23A-2 present an order-of-magnitude project cost estimate for the short-term and long-term project components, respectively. Future stages of the project, from feasibility study to final design would include progressively detailed cost estimates.

TABLE 23A-1
Short-term Project Costs
Reclamation District No. 1500 Sutter Basin Groundwater Monitoring Well

Item	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)	Assumptions
Pilot Study					
Land Acquisition	1	Acres	5,000	5	
Production/Monitoring Well	1	Each	170,000	170	900-ft deep at 1,500 gpm
I&C for Monitoring/telemetry	1	Each	20,000	20	
			Pilot Study Subtotal ->	195	
			Contingencies and Allowances (30%) ->	59	
			Total Construction Costs ->	254	
			Environmental Mitigation (5%)->	13	
			Environ. Documentation, Design, Project Admin. of Pilot Study (25%) ->	64	
			Initial Project Modeling Costs->	**220**	
			Phase 1 Project Cost ->	**551**	

TABLE 23A-2
Long-term Project Costs
Reclamation District No. 1500 Sutter Basin Groundwater Monitoring Well

Item	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)	Assumptions
Pilot Study					
Land Acquisition	10	Acres	5,000	50	
Production/Monitoring Well	10	Each	170,000	1,700	900-ft deep at 1,500 gpm
I&C for Monitoring/telemetry	10	Each	20,000	200	
			Subtotal ->	1,950	
			Contingencies and Allowances (30%) ->	590	
			Total Construction Costs ->	2,540	
			Environmental Mitigation (5%)->	130	
			Environ. Documentation, Design, Project Admin. of Pilot Study (25%) ->	640	
			Long-term Project Costs->	**3,310**	

4. Environmental Issues

Projects, similar in nature to that proposed, have been successfully constructed with no detrimental environmental impacts; and if groundwater resources prove to be plentiful, environmental benefits would be positive, especially during dry years.

During the permitting process for construction of the monitoring well, an initial study of environmental impacts would be prepared. It is not anticipated that the pilot study would have any significant environmental impacts. Implementation of the project may require permits from various regulatory agencies. However, until the monitoring well site is selected, the impacts are unknown. Should this project proceed to develop more extensive groundwater facilities in the region, more extensive environmental permitting and documentation may be required. Following is a summary of the likely permitting requirements for the short-term project component.

- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.
- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft CEQA checklist was not prepared for this proposed project because no physical alterations to the environment would occur as a result of this proposed action.

5. Implementation Challenges

Project implementation would cause some significant challenges. Some of these challenges are discussed below.

Coordination among Public and Private Entities

The District and Company have engaged in cooperative dialogue and planning with the Sutter County Public Works Department to develop joint and coordinated groundwater management projects and policies. Close coordination would be required among local, state, and federal entities. Reliable communication and integrated coordination would be required to create a successful project.

Lack of Sufficient Groundwater Data

The Sutter Basin has limited groundwater information available. DWR has been compiling data from its monitoring wells within RD 108 and elsewhere in the lower Colusa Basin and is working on a groundwater model for the basin.

Public Perception

Landowners may have concerns about possible groundwater overdraft. Aquifer recharge aspects of this project may tend to alleviate these concerns. Monitoring and modeling of groundwater levels would be an essential part of this project both technically and politically.

Land Acquisition

It is probable that land or easements would have to be acquired for the production wells and for new conveyance and delivery systems. Some landowners may object to acquisition of their lands.

6. Implementation Plan

The proposed short-term project would be conducted in a single phase, commencing as funding becomes available with completion in approximately 13 months. Following completion of the monitoring well construction, groundwater monitoring for quantity and quality would commence, and at the end of a 6-month period, a final report would be prepared with recommendations on the status of the groundwater resource and the viability of proceeding with production wells (see Figure 23A-2).

Task 1: Feasibility Study: Data Review and Site Selection

Landowner support would be an integral part of the site selection process along with environmental adaptability. A biological survey of the site would be accomplished prior to final site selection. (4 months)

Task 2: Monitoring Well Design, Environmental Clearance, and Permitting

The monitoring well would be designed for select strata monitoring to enable evaluation of individual aquifers to isolate those zones of poor quality and low yield in favor of those that show promise of high yield. All elements of the well would be defined including the size and type of well casing, screen type, pump and sampling equipment, and sampling procedure. An initial study of environmental impact and appropriate environmental clearance would be obtained prior to completion of the permitting process. (4 months)

Task 3: Bid Process

The bid process would include a cost proposal from a select list of qualified bidders followed by contractor selection and bid award. (1 month)

Task 4: Monitoring Well Construction

The contractor would construct a test hole and electric log the hole to determine the aquifers suitable for screening for monitoring purposes. The well would be developed and the sample extraction equipment provided to commence the monitoring program. (3 months)

Task 5: Well Monitoring, Sampling, and Report Preparation

The pilot program would be conducted over a period of 1 year and would be followed by data analysis to determine the results and probability of success in establishing additional test wells and/or production well facilities.

A report of the results would be prepared along with recommendations and conclusions on the feasibility of further development of the groundwater resource. (1 year)

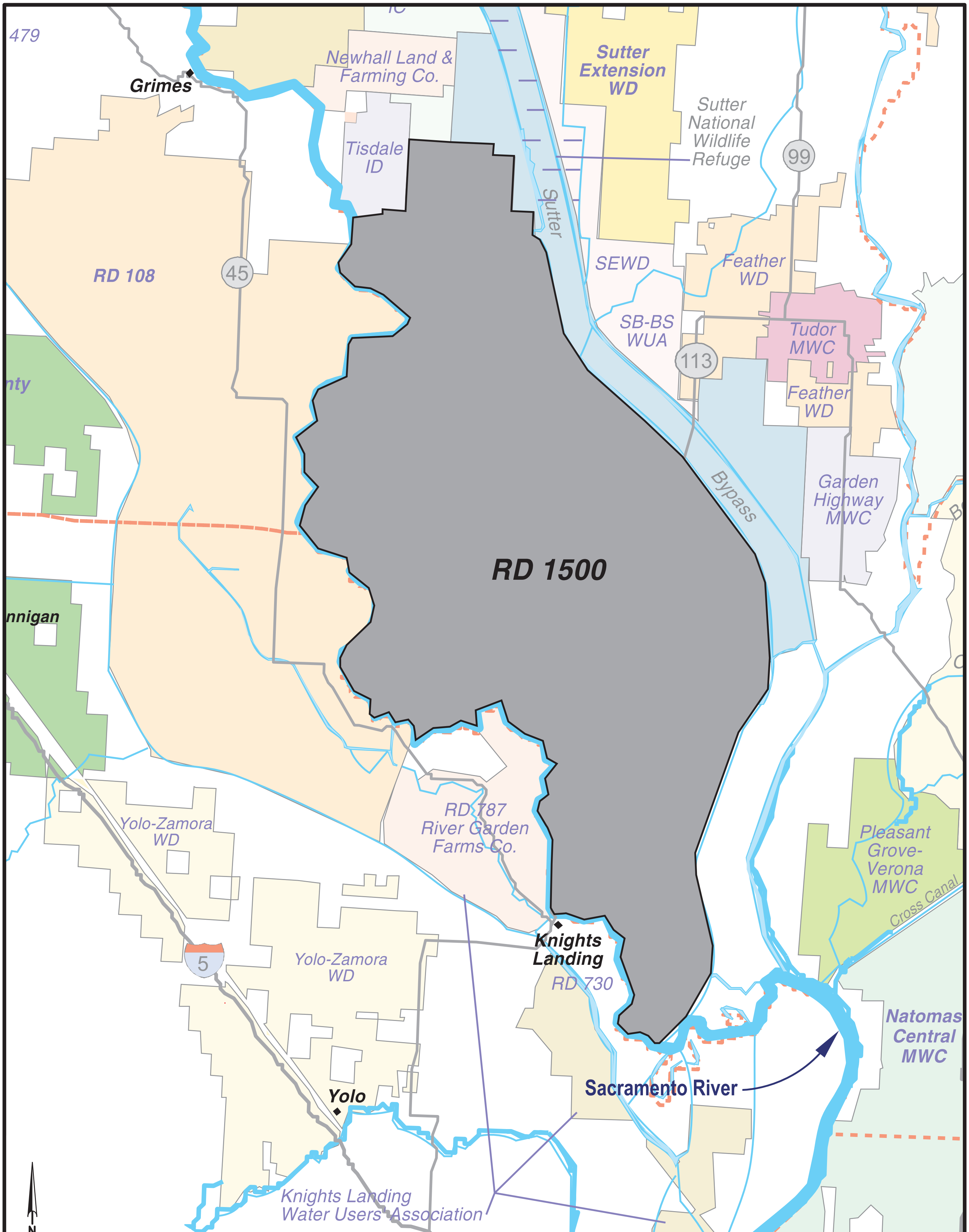

FIGURE 23A-1
PROJECT LOCATION MAP
RD 1500 SUTTER BASIN GROUNDWATER MONITORING WELL
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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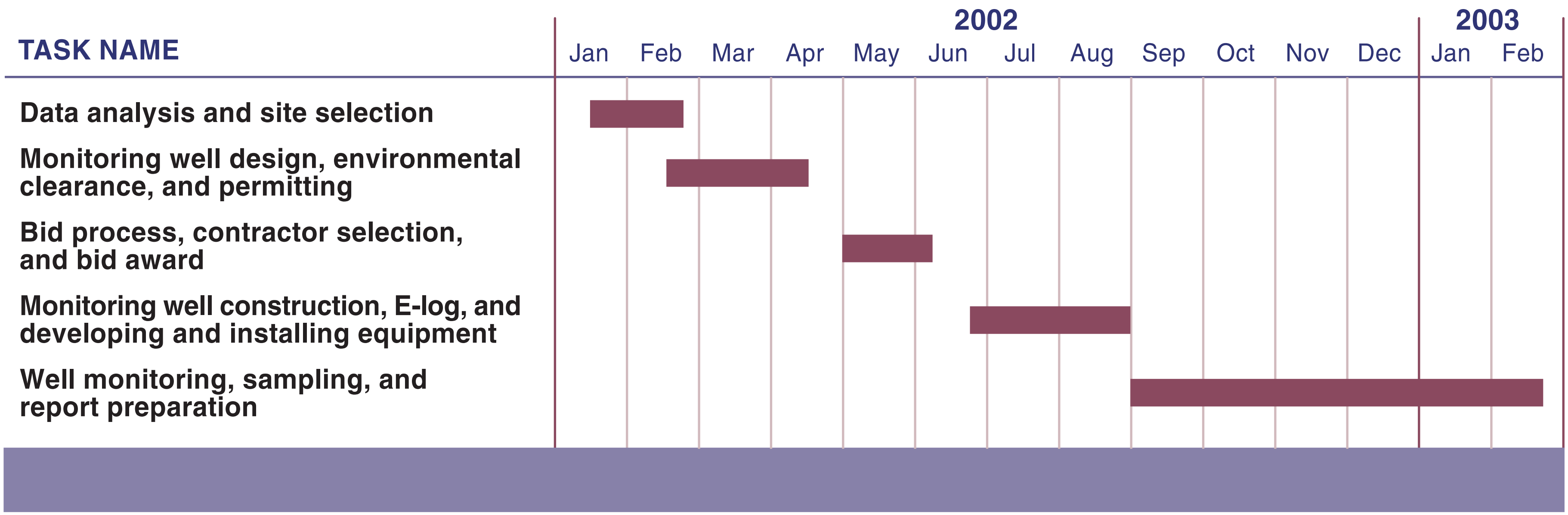

FIGURE 23A-2
PRELIMINARY IMPLEMENTATION SCHEDULE
RD 1500 SUTTER BASIN GROUNDWATER MONITORING WELL
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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American Sub-basin

PROJECT 7A

Natomas Central Mutual Water Company Conjunctive Use Project

1. Project Description

Project Type:	Conjunctive water management
Location:	Sacramento and Sutter counties
Proponent(s):	Natomas Central Mutual Water Company (Natomas or Company)
Project Beneficiaries:	Natomas, northeast Sacramento County, neighboring communities, local districts, state and federal agencies, Bay-Delta
<u>Total Project Components:</u>	Short-term components, full-scale operation that would consider modifications to Natomas' facilities to enable more efficient use of its groundwater and surface water supplies
Potential Supply:	30,000 acre-feet per year (ac-ft/yr)
Cost:	Has not yet been considered; likely to exceed $1 million and could possibly cost up to $5 million
Current Funding:	None
<u>Short-term Components:</u>	Pumping existing wells, monitoring and analyzing results after one season
Potential Supply (by 2003):	15,000 ac-ft
Cost:	$1.2 to $1.5 million
Current Funding:	None
Implementation Challenges:	Project funding
Key Agencies:	U.S. Bureau of Reclamation (USBR), California Department of Water Resources (DWR), Sacramento North Area Groundwater Management Authority (SNAGMA), American River Basin Cooperating Agencies (ARBCA), Sacramento County, Sutter County, Reclamation District (RD) 1000, RD 1001, City of Rio Linda, City of Sacramento, Pleasant Grove Verona Irrigation District, and South Sutter Water District

Summary

The Natomas conjunctive water management project would allow the Company the opportunity to develop and use groundwater on overlying lands or elsewhere while reducing Natomas' surface water diversions from the Sacramento River. The project potentially has three phases, depending on the outcome of the first phase. As a consequence, Natomas proposes to initiate a pumping and test program to demonstrate conjunctive use (pumping) operations and to observe and analyze stream-aquifer interconnection and third-party impacts. The ultimate intent is two-fold: (1) to devise appropriate mitigation measures for any substantial impact so that third parties are made whole, and (2) to pump extracts groundwater, yielding an equivalent amount of water in the river system by reducing Natomas' complete dependence on surface water diversions.

Phase 1 of the project would be a pilot study, which would make use of existing facilities to pump 15,000 ac-ft of groundwater in 2002 and allow an equivalent amount of surface water to remain in the river. This phase of the project would focus on a key impact issue–the potential of inducing surface water leakage via groundwater pumping in close proximity to the Sacramento River.

Phase 2 would be a continuation of pumping through existing facilities during 2003. This would be done in a manner that would offset or mitigate for any stream-aquifer interconnection, to the extent that such interconnection exists as determined during Phase 1 work, and make an attempt to determine the perennial yield of the basin.

Phase 3 would be a full-scale project that would consider modifications to Natomas' facilities to facilitate more efficient use of its groundwater and surface water supplies. This phase could potentially result in the pumping of as much as 30,000 ac-ft/yr of groundwater.

Short-term Component

Natomas recognizes the unique issue of groundwater pumping and resultant stream-aquifer interaction as a critical potential impact and possibly a constraint to implementation of conjunctive use operations near the river. As a result, the first phase of the project would be a pilot study and test for pumping approximately 15,000 ac-ft of groundwater from existing wells (Figure 7A-1) in 2002 for in- or out-of-basin use. During the study and test, the impacts of pumping on streamflow and on nearby third–party hydrologic conditions would be observed and analyzed.

The primary objective of this effort is to evaluate stream-aquifer interaction and characterize the underlying aquifer. The second phase of work, which would build on results of the pilot study, would be designed to determine the managed yield of the basin that would not create adverse impacts to other area users.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The long-term component of the project would be a full-scale operation that would consider modifications to Natomas' facilities to enable more efficient use of its groundwater and surface water supplies. The long-term component could potentially develop 30,000 ac-ft of water for in- or out-of-basin use each year. This component of the project would need to be further developed and evaluated in future phases of the project.

Historical Groundwater Use and Levels

Natomas covers approximately 36,000 acres in the American River Basin, which is located approximately 5 miles north of downtown Sacramento. Natomas is bordered by the Sacramento River on the west, Natomas Cross Canal on the north, the East Main Drain on the east, and the American River on the south (Figure 7A-1).

The Natomas area overlies a layered aquifer system of several hundred to more than 1,000 feet of thickness. The aquifer units include flood basin deposits and alluvium, generally near streams; the generally adjoining, shallow Modesto and Riverbank Formations; the widespread Laguna Formation; and the Mehrten Formation. The latter two underlie the entire area. Much of the area is predominated by relatively deep, poorly drained soils that preclude application of surface spreading, the most commonly practiced form of artificial groundwater recharge. Despite that constraint, DWR concluded in its lengthy investigation and feasibility report on the American Basin Conjunctive Use Project that in lieu recharge in its study area, which included Natomas and water districts immediately north, would effectively maintain the basin through dry- and critical-year groundwater pumping in the range of 37,000 to 67,000 ac-ft/yr in Natomas. According to that analysis, during the demonstration and test of the proposed conjunctive use pumping, the local groundwater system is expected to be recharged via in lieu groundwater pumping reductions in subsequent or wetter years. Ultimately, there is some possibility that a greater-than-historical level of pumping could be sustained to augment the managed yield of the Company.

Natomas has historically relied almost exclusively on surface water diverted from the Sacramento River to meet the agricultural water requirements within its service area. Except for historical drought periods (when some of the wells planned for use on this project were constructed), there has been no widespread need to develop groundwater for irrigation water supply. There is, however, some nearby (immediately outside Natomas' service area) groundwater use, thus giving rise to the need to address potential adverse impacts (i.e., hydraulic interference) that might result from operation of third-party conjunctive-use programs.

Near Natomas, in a large part of northern Sacramento County immediately to the east of Natomas, substantial historical pumping stress has resulted in a progressive groundwater-level decline on the order of 1 ½ feet per year for about the last 50 years (Figures 7A-2 and 7A-3). Despite those conditions, which have a slight boundary effect in the southeastern part of Natomas, the historical lack of groundwater development in Natomas has resulted in long-term, relatively stable, high groundwater levels in the Natomas area (Figure 7A-4). Recognition of both conditions (high water levels and underdeveloped groundwater in

Natomas; depressed water levels and overdraft east of Natomas) suggests that groundwater could be developed in Natomas and conjunctively used with ongoing historical diversions from the Sacramento River to achieve several objectives:

- Reduce dry-year water demand from the Sacramento River
- Achieve more efficient use of available water supplies
- Increase Delta inflows
- Ultimately, participate in a local regional solution to the northern Sacramento County overdraft problem

In identifying the potential for development of a conjunctive use project, Natomas also recognizes that similar opportunities, at least to increase dry-year yield and increase Delta inflows, are available elsewhere in the Sacramento Valley. As a result, great opportunity exists to increase overall yield throughout the valley via conjunctive use, and thus augment inflows to the Delta.

Questions that need to be addressed with regard to the impacts of implementing conjunctive use operations in close proximity to the Sacramento River and tributary streams include, but are not limited to:

1. Would pumping intercept surface water from the river by directly inducing infiltration in response to nearby groundwater pumping?
2. Would induced recharge occur, and if so, how, where, and when (e.g., purposeful artificial recharge vs. in lieu recharge)?
3. How would the basin be managed within its perennial yield?
4. Would third-party impacts (e.g., groundwater-level impacts) result from operations during pumping cycles?

The issue of in lieu recharge and the lack of need for artificial recharge facilities has been evaluated by DWR in its investigation, American Basin Conjunctive Use Project. Limited available data on the hydrogeologic configuration of the aquifer system and on the hydraulic characteristics of the aquifer materials limits the ability to directly address the stream-aquifer interconnection and third-party impacts.

2. Potential Project Benefits/Beneficiaries

The proposed project would provide valuable information regarding the interaction between surface- and groundwater. This information would facilitate a determination of how best to balance one area rich in both surface- and groundwater supplies (Natomas) with a neighboring area of smaller surface supplies and groundwater overdraft (northeast Sacramento County). Increased conjunctive use within Natomas would provide additional water supplies for Natomas; however, the objective of the overall program reaches beyond the supplies available to Natomas and considers maximizing benefits to neighboring communities and the overall system. Operation of multiple, comparatively small-capacity sources (wells) would also equip Natomas with locally distributed sources throughout its distribution system. This would allow for local introduction of water sources in response to real-time water demand based on irrigation scheduling, thus contributing toward overall increased efficiency. Because of Natomas' extensive reuse system, groundwater could be distributed throughout its conveyance system. This project would also be an early precursor for an eventual connection between the Sacramento and American River systems, thus providing greater flexibility to agencies and local districts.

The proposed project could potentially assist the state and federal agencies currently looking to expand conjunctive use throughout the state by answering the questions regarding the stream-aquifer interconnection. This issue currently limits the state and federal agencies from expanding or utilizing potential groundwater sources because of concern about inducing stream leakage .

The proposed project would fill a critical Bay-Delta need of improving in-stream flow in the Sacramento River. This Bay-Delta need is embodied in CALFED Quantifiable Objective 57. The water generated from the proposed project could be made available to critical needs downstream of the Delta and to Delta outflow. If the project should prove successful in identifying limited interconnection between the river and groundwater, this water could be made available far into the future by providing an alternate source of water for local needs.

In addition to this project providing valuable information as well as new water to the Delta, this project is also consistent with a regional plan. Several of the larger Sacramento River Settlement Contractors have been working cooperatively with USBR and DWR since 1997 in the development of the Sacramento River Basinwide Water Management Plan (BWMP). Natomas has been an active participant in that process. Among the recommendations identified in the BWMP is the management of water among districts and ultimately other entities at a hydrologic sub-basin level. Management at this level would help optimize the efficient use of surface water and groundwater supplies and achieves the appropriate level of drain and return flow water use between water users located within a given sub-basin. This project would provide the opportunity to help meet the increasing water supply and demands of Natomas, the Sacramento River, and the Bay-Delta Estuary.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

The first two phases of the proposed project have been estimated to be $1.2 to $1.5 million. The cost of the third phase of the project has not been estimated but would likely exceed $1 million and could easily be as much as $5 million. Table 7A-1 presents the estimated planning-level project costs.

TABLE 7A-1
Planning-level Project Costs
Natomas Central Mutual Water Company Conjunctive Use Project

Item	Amount	Quantity	Units	Total Cost	Assumptions
Supplies	$625,000	1	Lump Sum	$625,000	Estimated cost of PG&E power ($25/ac-ft) and portable generator rental
Conveyance Cost	$200,000	1	Lump Sum	$200,000	Includes incentive cost for landowner participation for 2 years
Consultants	$10,000	1	Lump Sum	$10,000	Meetings, public outreach, and report review for 2 years
Well Modification	$30,000	1	Lump Sum	$30,000	Meter installation, install well sounding access, 30-year life
Engineering	$110,000	1	Lump Sum	$110,000	Well site review and evaluation; well modification design and oversight; testing, analysis, and reporting for 3 years
Legal	$5,000	1	Lump Sum	$5,000	Well owner and funding agreements for 3 years
Mitigation Fund	$50,000	1	Lump Sum	$50,000	Pumping impacts mitigation for 3 years
Salaries and Wages	$50,000	1	Lump Sum	$50,000	Administration costs to develop conjunctive use program over 4 years
Salaries and Wages	$15,000	3	$/yr	$45,000	Administer and monitor conjunctive use program
			Project Cost	$1,125,000	
			Cost Paid by Natomas	$95,000	
			Balance to be Funded	**$1,030,000**	

4. Environmental Issues

The proposed study and project would continue to provide water supply to the flood irrigation of thousands of acres of rice in Natomas with the attendant wildlife habitat benefits. Further, the reduction of surface water diversions from the river and Delta system, particularly in dry years, would enhance fish and wildlife habitat, which is CALFED's Quantifiable Objective 57. The proposed project presents no known negative impacts to the environment.

Land subsidence is not considered to be a likely issue at the scale of the proposed demonstration and test. However, depending on the findings and any plans for ongoing conjunctive use, appropriate monitoring of subsidence, likely via interpretation of ongoing subsidence monitoring at the Sutter extensometer, would be added to ongoing monitoring. Whether that monitoring would be limited to land surveying, incorporation of existing extensometer monitoring, or ultimate construction of a new extensometer is unknown at present but would be factored into an evaluation of the demonstration and test.

A draft California Environmental Quality Act (CEQA) environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

The project implementation would occur in several incremental stages, each of which could have significant challenges. Many of these challenges would be inherent to any project of this size and complexity. Key environmental issues are related to long-term management of the basin, with the groundwater impacts and fishery issues being of greatest concern. The following lists some of the implementation challenges anticipated to be associated with this project.

Public Perception

Landowners have significant concern regarding possible groundwater overdraft. While the aquifer recharge aspects of this project may go a long way to alleviate these concerns, overdraft likely would remain a concern. Monitoring and modeling of groundwater levels would not only be an essential part of this project technically, but also politically. Furthermore, public concern accompanies any water delivery project (particularly during dry years) with regard to whom any project may or may not benefit.

Coordination among Public and Private Entities

Strong coordination would be required among local, state, and federal entities. The governmental agencies would have strong interests associated directly with the project and indirectly as it may affect other interests in the area. It is highly probable that competing interest may arise. Reliable communication and integrated coordination would be required to create a successful project.

Coordination between Concurrent Projects

Numerous parties are examining similar projects throughout the valley. To optimize the effectiveness of these projects, coordination between the projects would be required from the onset. The strongest motivation for such an effort is three-fold: (1) to avoid duplication of effort and as a result efficiently use available funds, (2) to avoid the nullification of project benefits through competing projects, and, perhaps most importantly, (3) to optimize the benefits of these projects to the watershed.

Lack of Sufficient Groundwater Data

A key data gap in this proposal is knowledge of the aquifer-stream hydraulic interconnection. The pilot project would be designed to address this issue, as well as other key hydrologic issues.

Water Rights Implications

Natomas' participation would be predicated on the operation of such a program and would occur within the guise of the Company's existing water rights. Decreases in surface water diversions would be anticipated in some years, while full contract quantities would be used in other years.

Environmental Regulatory Compliance

Environmental documentation, surveying, monitoring, and permitting would be required for this project. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of operation.

Land Acquisition

It is probable that land would have to be acquired for the production wells and conveyance systems. Some landowners may be resistant to the land purchases.

6. Implementation Plan

Natomas is prepared to begin Phase 1 of this project immediately. In fact, Natomas has completed a number of minor tasks associated with Phase 1 including local outreach, retaining the services of a groundwater consultant to perform the study and monitoring, identifying wells to be used, and determining work needed to be done to get the wells operational. These and other tasks that Natomas has completed have put Natomas in a position to begin the first phase of the project immediately and begin the groundwater pumping in the 2002 irrigation season. The second and third phase would build on the results of the Phase 1 pilot study. Figure 7A-5 illustrates the preliminary implementation schedule.

Phase 1

Pilot Study Pumping, Monitoring, and Analysis

To investigate stream-aquifer interconnection and third-party impacts, the Natomas workplan can be divided into three major parts.

1.1 Pumping test and report—The first part of Phase 1 would be a 2002 pumping test of approximately 15,000 ac-ft to determine if existing facilities with proposed monitoring are sufficient for a 2003 demonstration test. At the completion of the 2002 test, a single report would be provided summarizing the results and identifying the type of data that would be collected and provided for the 2003 demonstration and test.

1.2 Public outreach—The second part of Phase 1 work would be public outreach to receive input on the 2002 test results from local, state, and federal agencies through workshops. 2002 results would be reviewed and discussed, and possible modifications (depending on costs) to the workplan for the 2003 monitoring and analysis demonstration pumping program would be made.

1.3 Analysis of results—The dependence on in lieu groundwater recharge precludes the need for dedicated recharge facilities, identified recharge water supply, and conveyance facilities to deliver water to the recharge facilities. The pumping of groundwater, however, could be readily accomplished to the level described in this project by using existing facilities. As illustrated on Figure 7A-1, Natomas has access to at least 13 wells with pumping capacities from about 800 gallons per minute (gpm) to about 3,500 gpm that can effectively discharge into the Natomas system, thus substituting for surface water diversions. Pertinent details about the existing wells are summarized in Table 7A-2.

TABLE 7A-2
Existing Well Data
Natomas Central Mutual Water Company Conjunctive Use Project

Well #	Well	Pump Size (hp)	Pump Capacity (gpm)
1	Riego 2	100	2,100
2	Riego 8	200	3,500
3	Riego 9	30	800
4	Bianchi 1	60	2,000
5	Bianchi 2	80	2,000
6	Spangler	80	2,700
7	Morrison 1	40	1,000
8	Morrison 2	40	1,000
9	Morrison 3	40	1,000
10	Willey	40	1,500
11	Ose 1	150	3,000
12	Ose 2	200	3,000
13	Atkinson	80	2,500
Total			**26,100 gpm = 58 cfs**

hp = horsepower
cfs = cubic feet per second

The preceding pumping capacity equates to about 3,475 ac-ft per month. Over an 8-month rice pre-irrigation, irrigation, and re-flood period, this would reduce surface water diversions from the Sacramento River by up to approximately 20,000 ac-ft.

Results of the Phase 1 pilot study would be analyzed and then summarized in a report. The report would discuss the viability of the proposed Phase 2 demonstration test monitoring and analysis program. After distribution to local, state, and federal agencies, a workshop would be held to discuss the Phase 1 results and review the Phase 2 workplan.

Phase 2

Demonstration Testing

2.1 Monitoring and assessment using existing facilities—The principal objective of Phase 2 would focus on monitoring and assessing actual conjunctive use operations using existing facilities. It would monitor and analyze basin response, stream-aquifer interconnection, third-party impacts, and develop a final report made available to all local, state, and federal agencies. The 2003 demonstration testing would comprise the following:

- Pumping the same network of existing wells along with monitoring groundwater level responses in the pumped wells and in other wells
- Conducting the equivalent of aquifer tests in two or more wells (proximal and distal to the river)
- Surface- and groundwater quality sampling and analyses
- River stage monitoring

Basin response to pumping and in lieu recharge would be evaluated through analysis of groundwater levels and pumping rates during and after the pumping cycles. Off-site or other third-party impacts would be assessed the same way, via measurement and evaluation of groundwater levels with and without "project" pumping.

The analyses would include both time-related (hydrographs) and spatially related (contour maps) depictions of groundwater conditions. The stream-aquifer interconnection would be technically evaluated by conducting the equivalent of constant-rate pumping tests of selected wells proximal and distal to the river, while discharging the water into the distribution system for irrigation supply (i.e., as part of the conjunctive use demonstration). The groundwater level drawdown versus time relationships would be analyzed to estimate the hydraulic characteristics of the aquifer and also to evaluate the hydraulic impact of induced recharge effects of the river (i.e., to detect whether there is a direct hydraulic connection between the river and the aquifer materials in which the wells are completed). The groundwater level analyses would be complemented by interpretation of surface- and groundwater quality data for similarities, dissimilarities, and trends over the duration of an estimated 8-month pumping cycle.

2.2 Workplan development—The workplan would include interpretation of all the above in the context of the hydrogeologic setting and description of the aquifer system, along with the pumping well completions, to test and crosscheck the stream-aquifer hydraulic relationship and to determine the managed yield of the basin without creating adverse impacts to other users.

For the planned duration of the 2003 demonstration and test, interim reports would address the starting of the test, the completion of the test, the post-test basin response, and analysis of impacts. These reports would be provided to all local, state and federal agencies that have an interest in the outcome. Natomas anticipates that a successful ongoing conjunctive use program would evolve from the demonstration and test program.

Monitoring and Assessment

As described above, the proposed 2002 test and the 2003 demonstration and test program would provide monitoring and status reports. These reports would include the initiation of the project, status during a first irrigation season of pumping, monitoring and testing, post-pumping monitoring of basin recovery and in lieu recharge, and interpretation and analysis of benefits and impacts of the pumping and testing. As also described above, the 2002 test and 2003 demonstration and test program would involve a mixture of well and aquifer testing to investigate stream-aquifer interconnection, plus less rigorous "routine" surface- and groundwater monitoring. Idle wells near some of the project wells would be used, as feasible, in conjunction with the pumped wells for monitoring aquifer test and/or basin response. Nearby potentially impacted third-party wells have not yet been identified, but would be located prior to the start of demonstration and test pumping operations. These wells would be monitored on a regular basis, depending on distance from project wells. The frequency of planned monitoring would be defined as part of the workplan.

Tested wells and any nearby observation wells would be monitored (capacity, cumulative volume, groundwater levels) on a varying frequency as the tests progress, from every minute to every hour or longer, consistent with standard aquifer testing protocol, to allow appropriate interpretation in accordance with confined, unconfined, or leaky aquifer theory.

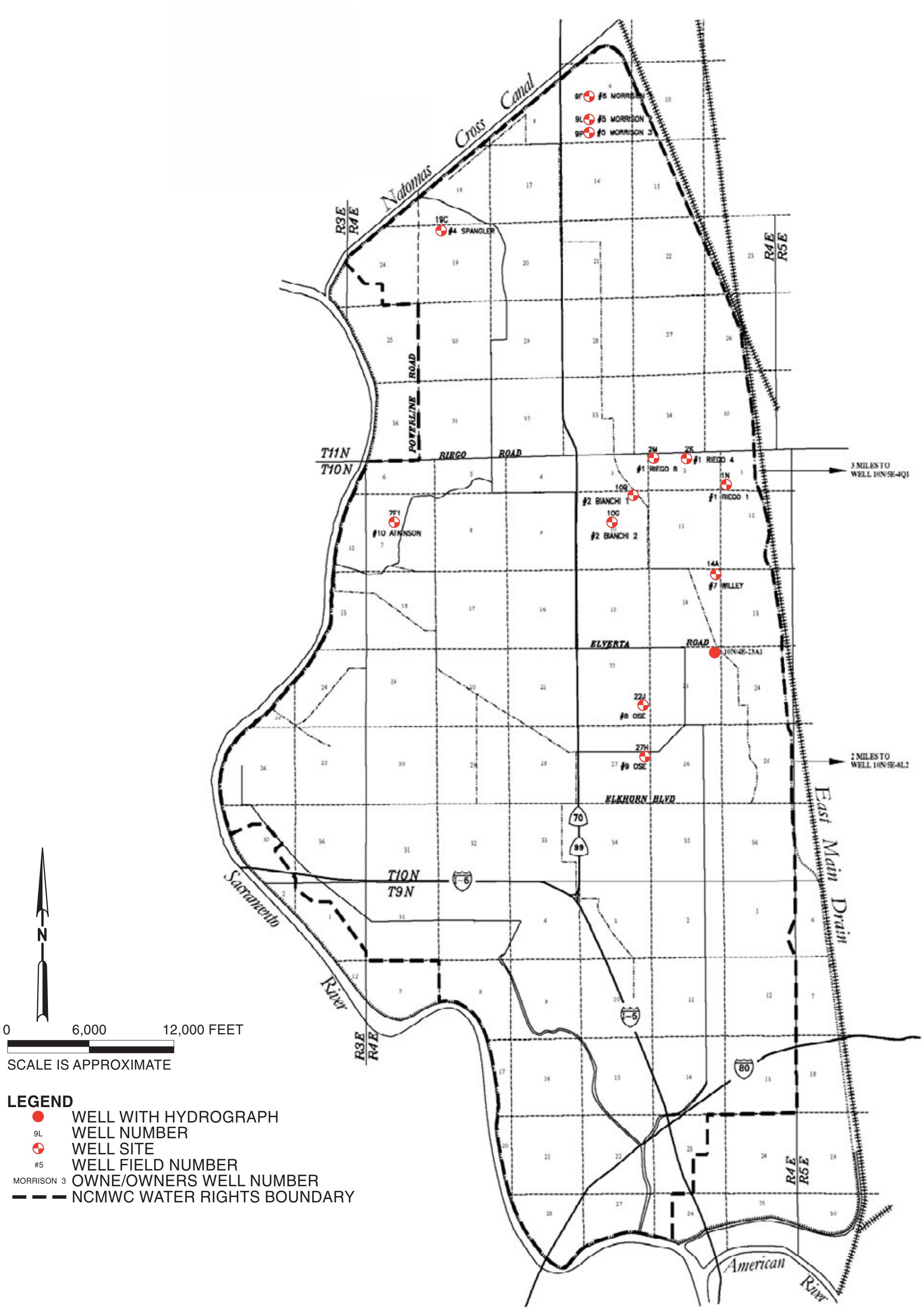

FIGURE 7A-1
PROJECT LOCATION MAP

NCMWC CONJUCTIVE USE PROJECT

SHORT-TERM PROJECT EVALUATIONS

SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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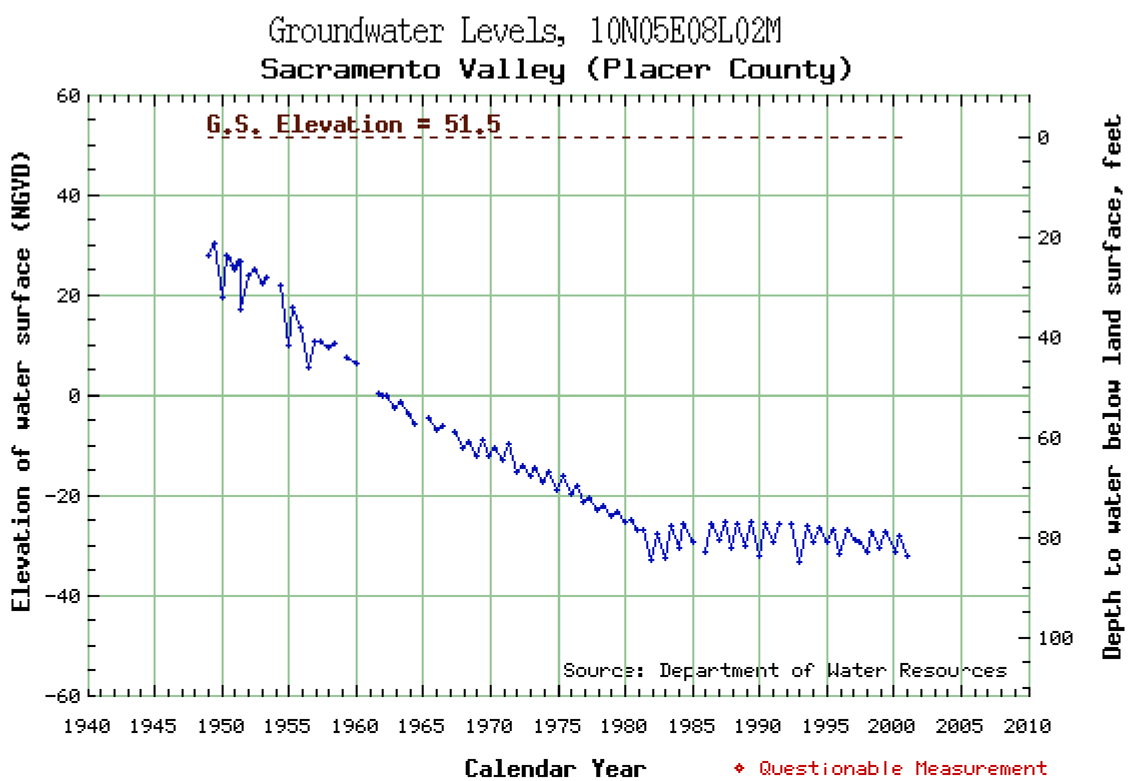

FIGURE 7A-2
HYDROGRAPH FOR WELL 10N/5E-8L2
NCMWC CONJUCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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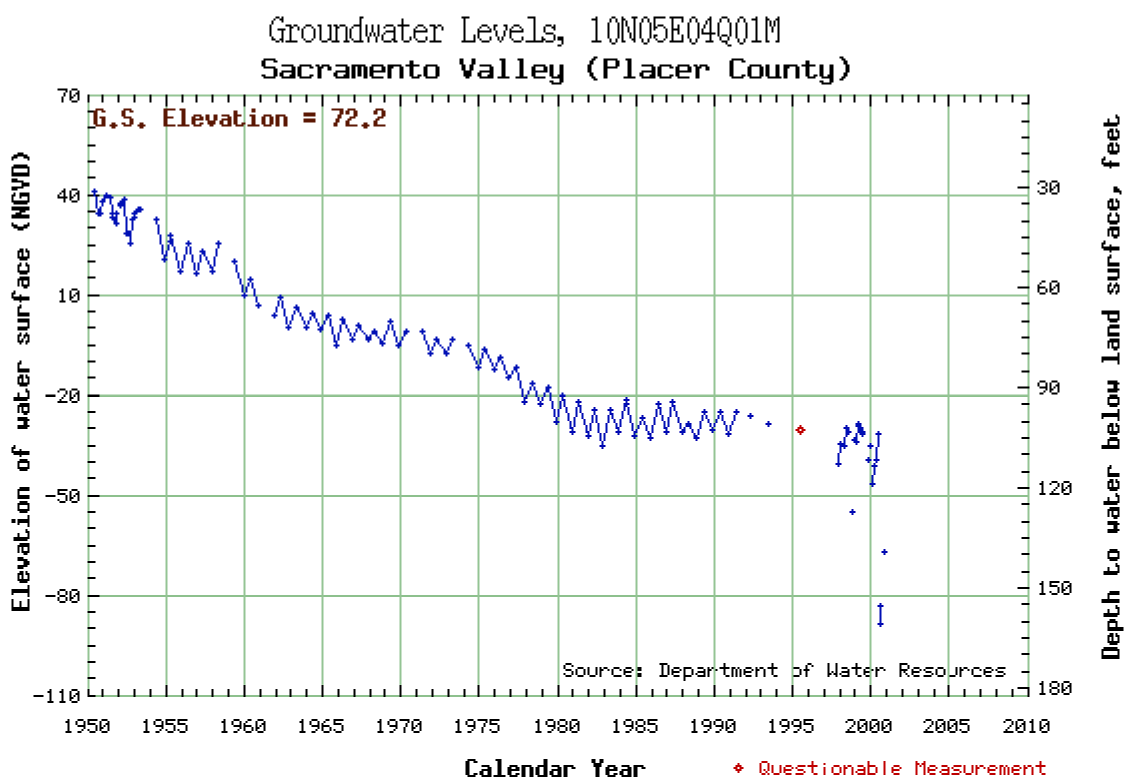

FIGURE 7A-3
HYDROGRAPH FOR WELL 10N/5E-4Q1
NCMWC CONJUCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

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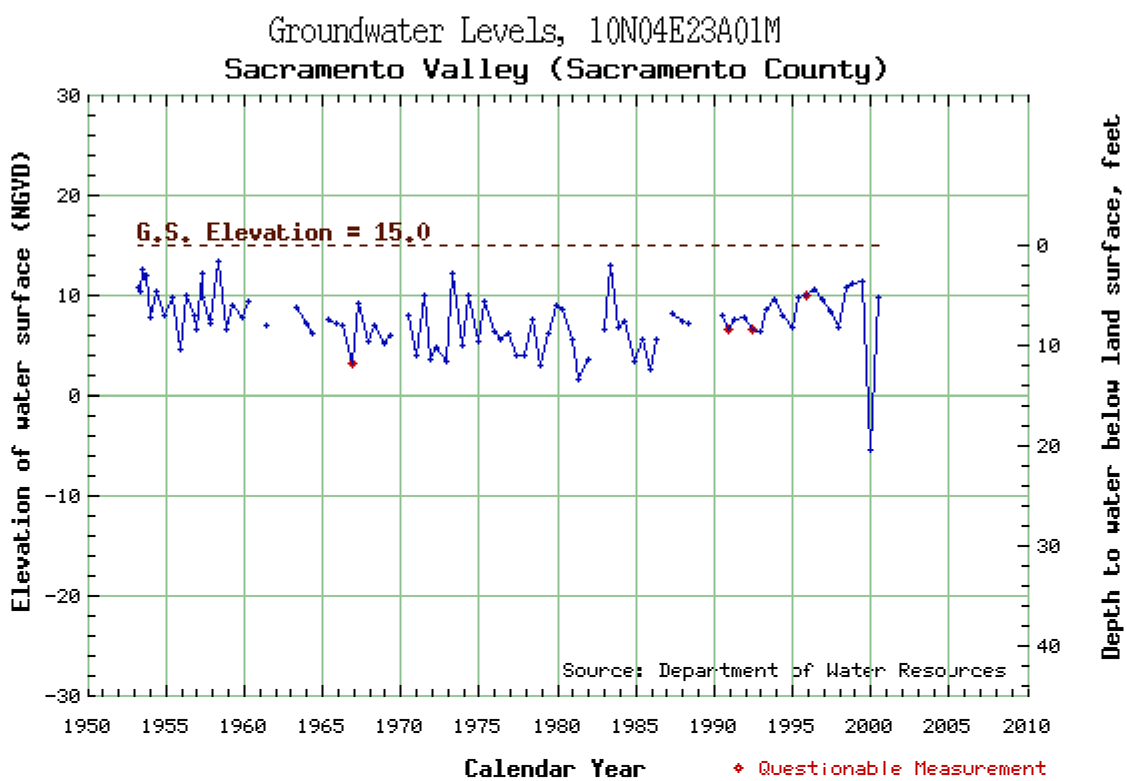

FIGURE 7A-4
HYDROGRAPH FOR WELL 10N/4E-23A1
NCMWC CONJUCTIVE USE PROJECT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

W072001014RDD_49 (10/26/01)

Project 7A—Draft CEQA Environmental Checklist

Project 7A—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☒ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

______________________________ ____________________

Signature Date

______________________________ ____________________

Printed Name For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>I. AESTHETICS</u>—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☐	☒	☐
Short-term impacts from increased noise and dust emissions may occur if the project involves construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
<u>II. AGRICULTURE RESOURCES—Would the project:</u>				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☐	☒
<u>III. AIR QUALITY</u>—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☐	☒	☐
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☐	☒	☐
Increased air emissions could result from potential construction activities. Best management practices (BMPs) would be implemented to reduce air emissions during construction activities.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
<u>IV. BIOLOGICAL RESOURCES</u>—Would the project::				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☐	☒	☐
Disturbance to local wildlife or habitat modifications may occur if the project involves construction. Mitigation measures would be implemented to reduce any potential impacts.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☐	☒	☐
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☐	☒	☐
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites?	☐	☐	☒	☐
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☐	☒	☐
The removal of some vegetation may be required if the project involves construction. Mitigation measures would be implemented to reduce any potential impacts.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?.	☐	☐	☐	☒
<u>V. CULTURAL RESOURCES</u>—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☐	☐	☒
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☐	☐	☒
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☐	☐	☒
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table 18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☐	☒	☐
If construction equipment is necessary, it would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☒	☐
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
<u>VIII. HYDROLOGY AND WATER QUALITY</u>—Would the project:				
a) Violate any water quality standards or waste discharge requirements?	☐	☐	☒	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted). *There are serious concerns about the long-term draw-down of the groundwater table and land subsidence, particularly in dry years. Model development would help in determining the effects of increased groundwater pumping. The impact that groundwater withdrawal would have on existing groundwater supplies is as yet undetermined; however, it is potentially significant because of the complexity of the issue.*	☒	☐	☐	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☐	☒
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☐	☒
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☒	☐
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
IX. LAND USE AND PLANNING—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☒	☐
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
X. MINERAL RESOURCES—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
XI. NOISE—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☐	☒	☐
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☒	☐
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☒	☐
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
<u>XVI. UTILITIES AND SERVICE SYSTEMS</u>—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project's projected demand in addition to the provider's existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project's solid waste disposal needs?	☐	☐	☒	☐
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☒	☐
<u>XVII. MANDATORY FINDINGS OF SIGNIFICANCE</u>				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☒	☐	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

Sacramento Valley

PROJECT 11A

Basinwide Water Management Plan Sub-basin-level Water Measurement

1. Project Description

Project Type:	Groundwater surface water planning
Location:	Sacramento Valley
Proponent(s):	Basinwide Water Management Plan (BWMP) participants (Anderson-Cottonwood Irrigation District (ID), Reclamation Distrct No. 108 (RD 108), Glenn-Colusa ID, Princeton-Codora-Glenn ID, Maxwell ID, RD 1004, M&T Chico Ranch, Sutter Mutual Water Company (MWC), Pelger MWC, Natomas Central MWC, Colusa Basin Drain MWC
Project Beneficiaries:	Water users throughout the Sacramento Basin including the environment, potential out-of-basin benefits
Total Project Components:	Feasibility study, design and construction of water measurement facilities
Potential Supply:	None (project intends to provide improved management of existing water supplies)
Cost:	$9.7 million, exclusive of land acquisition
Current Funding:	$100,000 CALFED Water Use Efficiency grant
Short-term Components:	Feasibility study, design, and construction of half of the required water measurement facilities
Potential Supply (by 2003):	None
Cost:	$5.6 million, exclusive of land acquisition
Current Funding:	$100,000 CALFED Water Use Efficiency grant
Implementation Challenges:	Coordination among public agencies
Key Agencies:	BMWP Participants, U.S. Bureau of Reclamation (USBR); California Department of Water Resources (DWR), U.S. Fish and Wildlife Service (USFWS), California Department of Fish and Game (CDFG), Corps of Engineers (COE), Regional Water Quality Control Board (RWQCB), and potentially Environmental Protection Agency (EPA; if listed species are present)

Summary

The Sacramento River BWMP Sub-basin-level Water Measurement Program is intended to facilitate improved water management at a sub-basin level. Currently, water management and measurement occur primarily at a district level throughout the Sacramento Valley. Several of the larger Sacramento River Settlement Contractors (SRSCs) have been working cooperatively with USBR and DWR since 1997 to develop the BWMP, which evaluates existing and future basin water requirements, supplies, and potential management options that would improve overall basinwide water management and use while providing environmental benefits.

Among the many BWMP recommendations is to manage water among districts and, ultimately, other entities at a hydrologic sub-basin level. This would help to optimize the efficient use of surface water and groundwater supplies and achieve the appropriate level of drain- and return-flow water use between water users located within a given sub-basin. Management at this level requires that inflows and outflows be tracked and quantified. Currently, measurement capabilities do not exist at the locations necessary to support this kind of tracking at a sub-basin level. This project proposes supervisory control and data acquisition (SCADA)-based water measurement capable of providing real-time flow data to facilitate improved water management operations. The sub-basins considered in the BWMP to implement the measurement program are listed below and also shown on Figure 11A-1.

- **Redding Sub-basin** (Anderson-Cottonwood ID)
- **Colusa Sub-basin** (RD 108, Glenn-Colusa ID, Princeton-Codora-Glenn ID, Provident ID, Maxwell ID, Colusa Basin Drain MWC, and Tehama-Colusa Canal Authority [TCCA])
- **Sutter Sub-basin** (Sutter MWC, Pelger MWC, Meridian Farms MWC, and Tisdale ID)
- **Butte Sub-basin** (RD 1004, M&T Chico Ranch)
- **American Sub-basin** (Natomas Central MWC)

Consistency with Local and Regional Water Management Plans

Redding Sub-basin: The Anderson-Cottonwood ID is one of the 14 water providers within the Redding Sub-basin working with the Redding Area Water Council on a regional water resources planning effort that began in 1996. In the first phase, current land uses and associated water demands were quantified for each purveyor. Current efforts are geared toward defining the core elements of a plan for regional management of the Redding Basin's water resources through the year 2030. This water measurement program proposes consistent solutions with the core elements of the regional plan that would help quantify water inflow and outflow at key locations within the Redding Sub-basin and assist in evaluating future water management options.

Colusa Sub-basin: Water users within this sub-basin began coordinating sub-basin management through the transfer of water between water users. This is possible because of the flexibility in project water transfers provided by the Central Valley Project Improvement Act (CVPIA). This sub-basin management has resulted in improved community relations and communication and has not increased consumptive use of water within the sub-basin. This management would assist in sustaining long-term production agriculture and is based on the collective knowledge of historical flows and water needs within the sub-basin, together with a mutual trust and desire to optimize water management. Measuring inflow and outflow would allow these water users to take another major step in optimizing water management and ensuring sustainable agriculture in Sacramento Valley.

American Sub-basin: Within this basin, sub-basin management effort has begun through the Sacramento Area Water Forum (of which Natomas Central MWC is a member). The Sacramento North Area Groundwater Management Authority and the American River Basin Cooperating Agencies are investigating various potential groundwater and conjunctive use projects. The proposed program complements these ongoing efforts.

Sacramento Basin: The primary goal of the project is to manage water at a sub-basin level, which is recommended in the BWMP as a beneficial method of assisting in improving water supply reliability, water quality, and maximizing environmental benefits, including reducing river diversions during critical periods to support fishery and wildlife resources. The critical step toward sub-basin management is the ability to measure inflow and outflow at a sub-region level. It is recognized that such an effort would require coordination across several user groups; the cooperative development of recommendations such as this program among SRSCs, USBR, and DWR has been a major step in developing the necessary support for such a program.

Another intent of the project is to provide the inflow and outflow information to all entities within each sub-basin as well as to USBR and DWR. Again, the availability of this information would allow for improved ability to track flows into and out of sub-basins and promote the benefits associated with managing supplies at a sub-basin level. The proposed program is an outgrowth of the ongoing BWMP and its participants, which includes the objective of providing sustainable water supplies across the entire Sacramento River basin, maximizing environmental benefits, and enhancing partnership opportunities.

The proposed sub-basin water measurement program is also consistent with the CVPIA, which calls for water conservation "with the purpose of promoting the highest level of water use efficiency reasonably achievable by project contractors." This program is also working toward the goals set forth by the CALFED Bay-Delta Program's Water Use Efficiency Program.

Short-term Component

The proposed water measurement program would not produce new water supply in the Sacramento Basin. The intention is to improve water management throughout the basin by measuring water at the sub-basin level to improve regional water use efficiency and make better use of existing water supplies. Since the total project comprises installation of many small measurement structures with minimal environmental impacts, it is proposed as a project that could be completed by December 2004. However, full project implementation could take 3 to 10 years, depending on funding and project coordination. The following tasks describe the short-term components, which are tasks to be completed by the end of 2003.

Task 1: Feasibility Study

Initial effort would focus on collecting and reviewing existing information to assist in identifying the appropriate hydrologic locations to install measurement facilities within each sub-basin. A consistent approach to selecting the measurement location and type of facility would be adopted by involving program participants across sub-basins. The task of selecting appropriate measuring locations would focus on existing knowledge of potential locations, including specific district knowledge and studies, existing and likely future land use and ownership, and associated facilities and infrastructure that may be required to support measurement at each location.

This task would also include additional investigation and site reviews to ensure the feasibility of all locations. Selection factors would include: hydrology (known or determined appropriate location to measure sub-basin inflow or outflow), existing and future land use, land ownership, site accessibility, and environmental impacts. The BWMP participants have estimated that 74 measurement sites would adequately measure inflows and outflows at the sub-basin level. Numerous potential locations for measurement devices have been identified in each sub-basin and are listed below.

- **Redding Sub-basin**: Anderson Creek, Crowley Gulch, North Fork Cottonwood Creek, Cottonwood Creek, Battle Creek, Bear Creek, Cow Creek
- **Colusa Sub-basin**: Tehama-Colusa Canal (at Stony Creek), Willow Creek, Logan Creek, Boundurant, Colusa Drain (at Maxwell Diversion, Highway 20, Davis Weir, Tule Road, Knights Landing), Northeast Drain, Stone Corral Creek, Freshwater/Salt Creek, Powell Slough, Riggs Pumping Plant, Rough and Ready Pumping Plant, El Dorado Pumping Plant, Knights Landing Ridge Cut
- **Sutter Sub-basin**: (south) RD 1500 Main Drain Pumping Facilities (Kamack), Sutter MWC Main Canal (below Tisdale Pumping Plant), Sutter MWC West Canal (below Tisdale Pumping Plant) Sutter MWC East Canal, Sutter MWC Central Canal; (North) RD 70 Pumping Plant, RD 1660 Main Pumping Plant (#2, #3, and #4), miscellaneous locations
- **Butte Sub-basin**: Big Chico Creek, Little Dry Creek, Cherokee Canal, Drumheller Slough, Angel Slough, Howard Slough
- **American Sub-basin**: Natomas Cross Canal, RD 1000 Pumping Plant, miscellaneous locations

Some potential locations may already have flow measurement devices or water quality monitoring devices operated by the U.S. Geological Survey (USGS) or DWR. These facilities may be incorporated and/or modified for the proposed sub-basin measurement program.

The potential exists that some measurement facility locations may not be within the boundaries of participating districts. In these cases, the siting of facilities would be coordinated directly with the affected landowners to the mutual satisfaction of the participating districts and landowners.

Task 2: Design of Measurement Facilities

Facility types would be evaluated and designed for locations determined feasible in Task 1. Designs would be based on site-specific hydraulics and site conditions. All devices would be sized appropriately for existing and projected in-channel flows. The design would include the measurement structure and an acoustical stage measurement device. The larger facilities would likely require hydraulic modeling to support facility sizing. Construction drawings and specifications would be developed for each facility to allow for construction by participating district personnel or outside contractors.

The design task would include providing environmental documentation and obtaining permits required prior to construction for each of the facilities. The measurement facilities, ranging from small meters to potentially larger weirs, would be sited to minimize environmental impacts. Overall, the environmental impact and required documentation is expected to be minimal.

A critical aspect of the design task would be to prioritize all of the measurement facility locations. While all potential measurement sites would produce valuable data to assist in water management decisions, the sites must be prioritized to provide positive results immediately (i.e., critical inflow or outflow points severely lacking flow data). Ideally, construction would begin on the critical sites as soon as design is completed. Designing of lower-priority sites would continue as the high-priority sites are constructed.

Another approach would be designing and constructing all facilities in one sub-basin at a time, thus maximizing the management benefits in regional increments. Initial work in this design phase would involve all stakeholders to develop the total program implementation plan.

Task 3: Construction of Measurement Facilities

Construction of approximately 74 new measurement facilities distributed throughout all five sub-basins is projected. It is anticipated that the facilities could be constructed over a two-year period after completion of Tasks 1 and 2. Construction would begin on individual measurement facilities soon after the construction documents are complete and necessary permits obtained. Approximately half of the required facilities could be constructed by the end of 2003. The remaining half would be constructed in the long-term component described below.

Long-term Component

The primary purpose of this evaluation is to evaluate the potential for this project to provide water supply benefits in the short-term (by end of 2003). As part of this initial evaluation, potential long-term components of the proposed project (defined as any part of the project proceeding past or initiated after December 2003) have been considered on a conceptual level. Further consideration and technical evaluation of long-term component feasibility and cost will occur as the next level of review under the Sacramento Valley Water Management Agreement. Long-term-component project descriptions are included in these short-term project evaluations only as a guide to the reader to convey overall project intent.

The proposed measurement project is planned for implementation over 3 years, although full implementation could take up to 10 years. Since the project involves five sub-basins with each basin having various water entities, coordination and funding would be the main factors determining the duration of project implementation. All remaining measurement facilities required to complete the sub-basin measurement network would be constructed in the long-term component. For cost estimating purposes, it is assumed that half of the facilities would be constructed after 2003.

2. Potential Project Benefits/Beneficiaries

The proposed construction of new water measurement facilities is expected to generate numerous benefits for both the local and regional water users. The beneficiaries of this program include BWMP participants (SRSCs), Central Valley Project (CVP) Service Contractors, other water users in the Sacramento Valley, downstream users, the environment, and the Sacramento-San Joaquin Delta. Measurement of inflows and outflows at the sub-basin level would promote efficient water management and operations that could assist in meeting local water demands, improving water quality, and reducing surface water diversions, thereby enhancing fish and wildlife habitat.

Water Supply

The project would not produce new water at the sub-basin level. The primary intention is the measurement of inflow-outflow of water at the sub-basin level toward management of each sub-basin across the valley. There may not be a direct increase in supply for water-short areas, but improved water management may allow increased water transfers to local water-short areas, such as TCCA member districts and out-of-basin users. Through improved management, additional water could become available to meet in-basin, and/or out-of-basin, and/or environmental needs.

Water Management

The most significant benefit and predominant goal of the project is increased water use efficiency. The sub-basin-level water measurement of the Sacramento Valley would provide the inflow and outflow data required to substantially improve water management decisions.

Environmental

As the Sacramento Valley's primary source of supply, the Sacramento River would be directly and most beneficially influenced by the efficient use of its water supply. Some environmental benefits that have been identified at this level of investigation include:

- **Sacramento-San Joaquin Delta**—A decrease in surface water diversions has the potential for increasing available seasonal inflows to the Delta
- **Aquatic/Riparian Habitat**—Improved in-stream flows would generate expected fisheries benefits, both in terms of water quality and flow requirements

Water Quality Benefits

Water quality benefits of the project generally stem from the increased in-stream flows. Improvements to both temperature and constituent properties of the river would be the most probable results of the increased flows. These benefits would need to be evaluated and modeled on a regional basis to determine impacts on water quality in the Sacramento River and the Delta.

Other Benefits

Improved measurement could support changing timing of river diversions to support meeting environmental or other needs. Also, by optimizing agricultural irrigation water supply management, water is potentially available for other beneficial uses in the Sacramento Basin and out-of-basin.

3. Project Costs

The cost opinions shown, and any resulting conclusions on project financial or economic feasibility or funding requirements, have been prepared for guidance in project evaluation from the information available at the time of the estimate. It is normally expected that cost opinions of this type, an order-of-magnitude cost opinion, would be accurate within +50 to -30 percent. Project costs were developed at a conceptual level only, using data such as cost curves and comparisons with bid tabs and vendor quotes for similar projects. The costs were not based on detailed engineering design, site investigations, and other supporting information that would be required during subsequent evaluation efforts.

The final costs of the project and resulting feasibility will depend on actual labor and material costs, competitive market conditions, actual site conditions, final project scope, implementation schedule, continuity of personnel and engineering, and other variable factors. As a result, the final project costs will vary from the opinions presented here. Because of these factors, project feasibility, benefit/cost ratios, risks, and funding needs must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

Table 11A-1 presents a planning-level estimate of project costs. The total project is estimated at $9.3 million dollars. Of this total, $270,000 was estimated for Task 1 (feasibility study), $1,630,000 for Task 2 (design) and $7,400,000 for Task 3 (construction). Task 1, Task 2, and half of Task 3 are planned for completion by the end of 2003 totaling $5.6 million. The remaining half of construction would cost $3.7 million.

Typical annual operations and maintenance (O&M) costs for similar projects would range from 1 to 2 percent of initial capital costs. Annual O&M costs would include power costs, inspection and maintenance of measuring devices, data collection, and data reporting. Annual operations and maintenance costs would approach $93,000 to $186,000 per year.

TABLE 11A-1
Planning-Level Project Costs
BWMP Sub-basin-level Water Measurement

	Quantity	Units	Unit Price ($)	Total Cost ($ x 1,000)	Assumptions
Redding Sub-Basin					
Water Measurement	7	Each	$75,000	$500	Weir & acoustic devices
Colusa Sub-Basin					
Water Measurement	16	Each	$75,000	$1,200	Weir & acoustic devices
Sutter Sub-Basin					
Water Measurement	10	Each	$75,000	$800	Weir & acoustic devices
Butte Sub-Basin					
Water Measurement	6	Each	$75,000	$500	Weir & acoustic devices
American Sub-Basin					
Water Measurement	2	Each	$75,000	$200	Weir & acoustic devices
Misc. Locations					
Water Measurement	33	Each	$75,000	$2,500	Weir & acoustic devices
			Subtotal ->	$5,700	
	Contingencies and Allowances (30%) ->			$1,700	
	Total Construction Costs ->			$7,400	
	Environmental Mitigation (5%)			$400	
	Engineering, Environmental, Admin (25%) ->			$1,900	Feasibility Study = $270,000
	Total Project Cost ->			**$9,700**	

Initial Funding Requirements and Sources

Earlier in 2001, the BWMP participants applied for funding of the entire sub-basin measurement project through the CALFED Water Use Efficiency Program. The project was awarded a grant of $100,000 that will be applied to Task 1, the feasibility study. This project requires an additional $170,000 to complete the feasibility study and an additional $9,030,000 for Tasks 2 and 3, the design and construction of approximately 74 measurement facilities.

4. Environmental Issues

As noted in Section 2, this project is anticipated to provide benefits in the form of increased water supply, more flexible water management, and improved water quality – all of which could improve the greater Sacramento River ecosystem.

Project implementation would also result in impacts to the environment, notably through the reduction of spills and surplus flows that may provide environmental benefits. Often, when these “surplus” flows have been present for an extended amount of time, various entities may consider the water to be an entitlement, and may oppose changes to the flows. In such cases, it is common for projects to be subject to additional environmental scrutiny. Efforts to address these concerns are noted in Section 5, Implementation Challenges. Construction-related impacts would also occur prior to project implementation. Construction-related impacts would be similar to other, common construction projects that occur near seasonal drainages and waterways; however, much of the work that is proposed to occur in the canal itself may be exempt from environmental review. It is likely that the appropriate level of environmental documentation necessary for this project would be a Programmatic environmental impact statement/environmental impact report (EIS/EIR), with site-specific documentation prepared for individual construction efforts.

Implementation of the project would also require issuance of permits from various regulatory agencies. Following is a summary of the likely permitting requirements for the site-specific actions. Additional permitting requirements may be identified pending further project refinement.

- **State Water Resources Control Board—**Applications for new water rights and changes in point of diversion would be required.
- **Regional Water Quality Control Board—**Large amounts of earthwork would be required for the recharge basins. Depending upon project configuration and location, Water Quality Certification under the federal Clean Water Act may be required for construction.
- **Federal and State Endangered Species Act—**Consultation with state and federal resource agencies (e.g., USFWS, NMFS, CDFG) may be required to protect special-status species and their habitat.
- **U.S. Army Corps of Engineers (COE)—**The project may affect wetland habitat and require a permit for discharge of dredged or fill material pursuant to Section 404 of the federal Clean Water Act.
- **State Lands Commission—**Project would need to consult with State Lands Commission on the public agency lease/encroachment permitting for use of state lands.
- **State Reclamation Board—**The project may be subject to rules regarding encroachment into existing floodways.
- **Federal Emergency Management Agency (FEMA)—**Letters of map revision need to be filed with FEMA for projects that affect Flood Insurance Rate Maps.
- **Division of Safety of Dams (DSOD)—**Design and configuration of the storage basins may require permitting and compliance with Dam Safety due to the height of the retention walls. DSOD is structured within DWR.
- **Advisory Council on Historic Preservation—**Consultation under Section 106 of the National Historic Preservation Act may be necessary if historical resources are affected by construction of the project.

- **California Department of Fish and Game—**If alterations to streams or lakes are required as part of project implementation, a Streambed or Lakebed Alteration Agreement may be required.
- **Local governments and special districts—**Specific agreements for rights-of-way, encroachments, use permits, or other arrangements may need to be made with local entities in the vicinity of the project.

A draft California Environmental Quality Act (CEQA) environmental checklist has been prepared for this proposed project and is included as an attachment to this evaluation. The checklist provides a preliminary assessment of the environmental areas of concern, as well as areas that are not likely to be of concern, associated with this project. The checklist would be finalized as part of the environmental compliance required for project implementation.

5. Implementation Challenges

The project implementation would occur in several incremental stages. Some political and environmental issues are related to long-term and consistent decrease in tailwater. The project would need to be developed in a manner that supports the objectives of the local and regional water management plans. The following lists some of the implementation challenges anticipated to be associated with this project:

Coordination among Public and Private Entities

Coordination would be required among local, state, and federal entities such as districts and water agencies, USFWS, USBR, and DWR. The governmental agencies would have interests associated directly with the project and indirectly as it may affect other interests in the area. Reliable communication and integrated coordination would be required to create a successful project.

Water Rights Implications

District and water agency participation would be predicated on the operation of such a program and would occur within the guise of the district and water agency existing water rights. Decreases in surface water diversions would be anticipated in some years, while full contract quantities would be used in other years.

Environmental Regulatory Compliance

Extensive environmental documentation, surveying, monitoring, and permitting would be required for this project. Habitat for known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake is present within in the project area. Project scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.

Downstream Water Users

Some downstream water users that do not belong to districts and water agencies rely on releases and tailwater as part of their water supply (e.g., Colusa Basin Drain Mutual Water

Company). Decrease of this supply could cause some discontent and political upheaval with such parties.

Key Stakeholders

Table 11A-2 lists the key stakeholders that are expected to be associated with or impacted by the proposed sub-basin level water measurement program.

TABLE 11A-2
Stakeholder Roles and Issues
Basinwide Water Management Plan Sub-basin-level-water Measurement

Stakeholder	Role/Concerns/Issues
BWMP Participants: Anderson-Cottonwood ID, RD 108, Glen-Colusa ID, Princeton-Codora-Glenn ID, Maxwell ID, RD 1004, M&T Chico Ranch, Sutter MWC, Pelger MWC, Natomas Central MWC	• BWMP participation • Sub-basin water management program lead agencies • Measurement cooperators • Land owners
Colusa Basin Drain MWC	• Participation in measurement program • Measurement cooperators
Other Sacramento Valley water users (CVP Water Service Contractors, other users)	• Sub-basin issues • Measurement cooperators • Land owners
USBR	• CVP Service Contracts, Settlement Contracts, CVPIA issues • BWMP participant
DWR	• BWMP participant
USFWS	• Refuge water use efficiency and supplies • Potential environmental issues
COE and RWQCB	• Potential permits
CDFG and EPA	• Potential environmental issues, permits

6. Implementation Plan

As noted above, the feasibility study of this program has been partially funded and would begin by the end of 2001. Figure 11A-2 shows a preliminary implementation schedule based on typical time requirements for each step in a project of this scale and assuming that full funding would be attained.

Task 1, the feasibility study, is expected to last 6 months. Task 2 comprises designing the measurement facilities and providing the required environmental documentation over the course of 1 year. Design and environmental work would be a parallel process for each individual measurement facility. Upon completion of construction documents and necessary permits, construction could begin on individual facilities. Task 3, the construction of facilities, is expected to last 2 years and could begin on individual facilities soon after construction documents are completed.

To facilitate the coordination of numerous measurement facilities spread throughout five sub-basins of the Sacramento Valley, each sub-basin would have a lead coordinator. The coordinators are listed in Table 11A-3.

TABLE 11A-3
Sub-basin Coordinators
Basinwide Water Management Plan Sub-basin-level-water Measurement

Sub-basin	Coordinator
Colusa	RD 108 manager
Redding	Anderson-Cottonwood ID manager
Sutter	Sutter MWC manager
Butte	RD 1004 manager
American	Natomas Central MWC manager

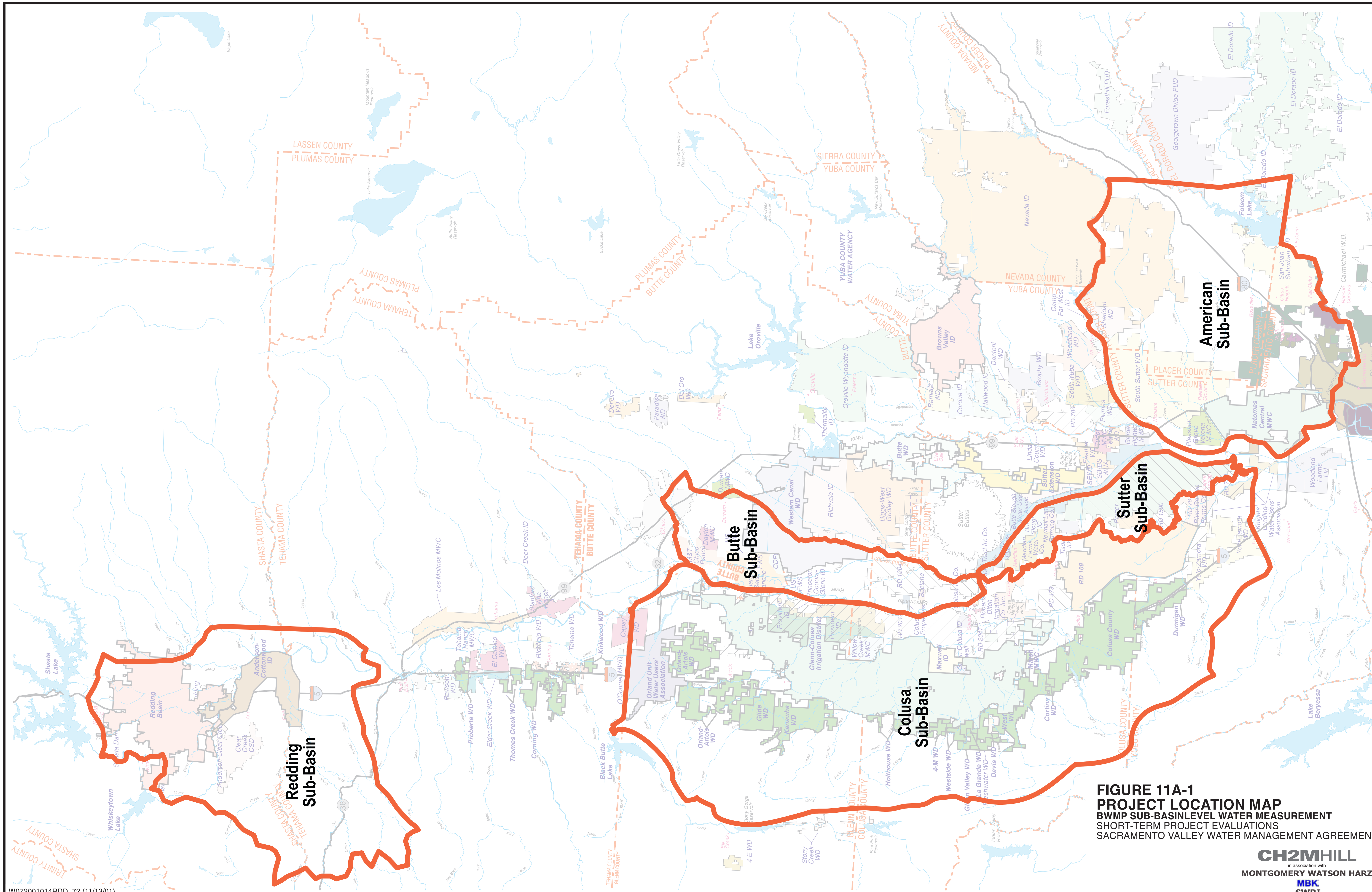

FIGURE 11A-1
PROJECT LOCATION MAP
BWMP SUB-BASINLEVEL WATER MEASUREMENT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

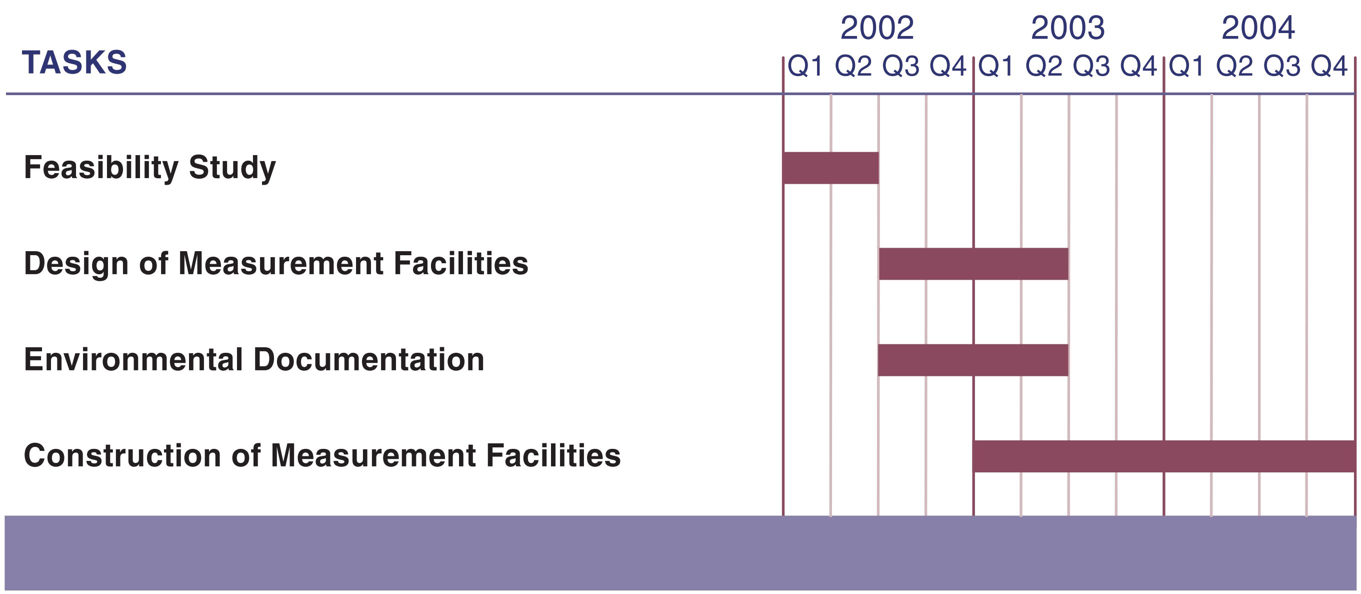

FIGURE 11A-2
PRELIMINARY IMPLEMENTATION SCHEDULE
BWMP SUB-BASIN-LEVEL WATER MEASUREMENT
SHORT-TERM PROJECT EVALUATIONS
SACRAMENTO VALLEY WATER MANAGEMENT AGREEMENT

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK
SWRI

Project 11A—Draft CEQA Environmental Checklist

Project 11A—Environmental Factors Potentially Affected:

The environmental factors checked below would be potentially affected by this project, involving at least one impact that is a "Potentially Significant Impact" as indicated by the checklist on the following pages.

☐ Aesthetics	☐ Agriculture Resources	☐ Air Quality
☐ Biological Resources	☐ Cultural Resources	☐ Geology/Soils
☐ Hazards & Hazardous Materials	☐ Hydrology/Water Quality	☐ Land Use/Planning
☐ Mineral Resources	☐ Noise	☐ Population/Housing
☐ Public Services	☐ Recreation	☐ Transportation/Traffic
☐ Utilities/Service Systems	☐ Mandatory Findings of Significance	

Determination:

(To be completed by the Lead Agency)

On the basis of this initial evaluation:

☐ I find that the proposed project COULD NOT have a significant effect on the environment, and a NEGATIVE DECLARATION will be prepared.

☐ I find that although the proposed project could have a significant effect on the environment, there will not be a significant effect in this case because revisions in the project have been made by or agreed to by the project proponent. A MITIGATED NEGATIVE DECLARATION will be prepared.

☐ I find that the proposed project MAY have a significant effect on the environment, and an ENVIRONMENTAL IMPACT REPORT is required.

☐ I find that the proposed project MAY have a "potentially significant impact" or "potentially significant unless mitigated" impact on the environment, but at least one effect 1) has been adequately analyzed in an earlier document pursuant to applicable legal standards, and 2) has been addressed by mitigation measures based on the earlier analysis as described on attached sheets. An ENVIRONMENTAL IMPACT REPORT is required, but it must analyze only the effects that remain to be addressed.

☐ I find that although the proposed project could have a significant effect on the environment, because all potentially significant effects (a) have been analyzed adequately in an earlier EIR or NEGATIVE DECLARATION pursuant to applicable standards, and (b) have been avoided or mitigated pursuant to that earlier EIR or NEGATIVE DECLARATION, including revisions or mitigation measures that are imposed upon the proposed project, nothing further is required.

Signature	Date
Printed Name	For

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
I. AESTHETICS—Would the project:				
a) Have a substantial adverse effect on a scenic vista?	☐	☐	☐	☒
b) Substantially damage scenic resources, including, but not limited to, trees, rock outcroppings, and historic buildings within a state scenic highway?	☐	☐	☐	☒
c) Substantially degrade the existing visual character or quality of the site and its surroundings?	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
d) Create a new source of substantial light or glare, which would adversely affect day or nighttime views in the area?	☐	☐	☐	☒
II. AGRICULTURE RESOURCES—Would the project:				
a) Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, to non-agricultural use?	☐	☐	☐	☒
b) Conflict with existing zoning for agricultural use, or a Williamson Act contract?	☐	☐	☐	☒
c) Involve other changes in the existing environment which, due to their location or nature, could result in conversion of Farmland, to non-agricultural use?	☐	☐	☒	☐
Ill. AIR QUALITY—Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations. Would the project:				
a) Conflict with or obstruct implementation of the applicable air quality plan?	☐	☒	☐	☐
Increased air emissions could result from construction of the project. Implementation of best management practices (BMPs) during construction would reduce the amount of emissions, and reduce the impact to a less than significant level.				
b) Violate any air quality standard or contribute substantially to an existing or projected air quality violation?	☐	☒	☐	☐
See response to III (a) above.				
c) Result in a cumulatively considerable net increase of any criteria pollutant for which the project region is non-attainment under an applicable federal or state ambient air quality standard (including releasing emissions which exceed quantitative thresholds for ozone precursors).	☐	☐	☒	☐
d) Expose sensitive receptors to substantial pollutant concentrations?	☐	☐	☒	☐
e) Create objectionable odors affecting a substantial number of people?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
IV. BIOLOGICAL RESOURCES—Would the project:				
a) Have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by the California Department of Fish and Game or U.S. Fish and Wildlife Service?	☐	☒	☐	☐
Known Endangered Species Act (ESA)-listed species such as the valley elderberry longhorn beetle and the giant garter snake are within the area. Additionally, sensitive riparian habitat exists in and around the project site. Project construction scheduling would have to reflect environmental regulatory requirements including any limitation on windows of construction.				
b) Have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations or by the California Department of Fish and Game or US Fish and Wildlife Service?	☐	☒	☐	☐
See response to IV (a) above.				
c) Have a substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act, (including, but not limited to, marsh, vernal pool, coastal, etc.) through direct removal, filling, hydrological interruption, or other means?	☐	☒	☐	☐
See response to IV (a) above.				
d) Interfere substantially with the movement of any native resident or migratory fish or wildlife species or, impede the use of native wildlife nursery sites? See Response to IV (a) above	☐	☒	☐	☐
e) Conflict with any local policies or ordinances protecting biological resources, such as a tree preservation policy or ordinance?	☐	☒	☐	☐
The removal of some vegetation may be required for construction of the project. Mitigation measures would be implemented to replace vegetation removed during construction, which would reduce the impact to a less than significant level.				
f) Conflict with the provisions of an adopted Habitat Conservation Plan, Natural Community Conservation Plan, or other approved local, regional, or state habitat conservation plan?. *See response to IV (a) above.*	☐	☒	☐	☐
V. CULTURAL RESOURCES—Would the project:				
a) Cause a substantial adverse change in the significance of a historical resource as defined in §15064.5?	☐	☒	☐	☐
A significant impact would occur if a cultural resource were to be disturbed by activities associated with project development. In the event that an archaeological resource was discovered, appropriate measures would be undertaken to minimize any impacts.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Cause a substantial adverse change in the significance of an archaeological resource pursuant to §15064.5?	☐	☒	☐	☐
See response to V (a) above.				
c) Directly or indirectly destroy a unique paleontological resource or site or unique geologic feature?	☐	☒	☐	☐
See response to V (a) above.				
d) Disturb any human remains, including those interred outside of formal cemeteries?	☐	☒	☐	☐
See response to V (a) above.				
VI. GEOLOGY AND SOILS—Would the project:				
a) Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:				
i) Rupture of a known earthquake fault, as delineated on the most recent Alquist-Priolo Earthquake Fault Zoning Map issued by the State Geologist for the area or based on other substantial evidence of a known fault? Refer to Division of Mines and Geology Special Publication 42.	☐	☐	☐	☒
ii) Strong seismic ground shaking?	☐	☐	☐	☒
iii) Seismic-related ground failure, including liquefaction?	☐	☐	☐	☒
iv) Landslides?	☐	☐	☐	☒
b) Result in substantial soil erosion or the loss of topsoil?.	☐	☐	☒	☐
c) Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslide, lateral spreading, subsidence, liquefaction, or collapse?	☐	☐	☐	☒
d) Be located on expansive soil, as defined in Table18-1-B of the Uniform Building Code (1994), creating substantial risks to life or property?	☐	☐	☐	☒
e) Have soils incapable of adequately supporting the use of septic tanks or alternative waste water disposal systems where sewers are not available for the disposal of waste water?	☐	☐	☐	☒
VII. HAZARDS AND HAZARDOUS MATERIALS—Would the project:				
a) Create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials?	☐	☒	☐	☐
Construction equipment would require the use of potentially hazardous materials. The potential for significant hazardous material spill would be unlikely because of the limited amount of such materials that would be used onsite. If a spill or release of such materials were to occur, it could potentially be significant unless BMPs were implemented.				

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
b) Create a significant hazard to the public or the environment through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment?	☐	☐	☒	☐
c) Emit hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school?	☐	☐	☐	☒
d) Be located on a site which is included on a list of hazardous materials sites compiled pursuant to Government Code Section 65962.5 and, as a result, would it create a significant hazard to the public or the environment?	☐	☐	☐	☒
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project result in a safety hazard for people residing or working in the project area?	☐	☐	☐	☒
g) Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.	☐	☐	☐	☒
h) Expose people or structures to a significant risk of loss, injury, or death involving wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands?	☐	☐	☐	☒
VIII. HYDROLOGY AND WATER QUALITY— Would the project:				
a) Violate any water quality standards or waste discharge requirements? *Increases in turbidity would be likely to occur during any in-stream construction work. Additionally, there would be a potential for an increase of erosion and sedimentation from construction activity. This could be a significant impact and would require an erosion control plan, and the implementation of BMPs to reduce any impacts to waterways in and around the project area.*	☐	☒	☐	☐
b) Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted).	☐	☐	☒	☐
c) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation on- or off-site?	☐	☐	☒	☐
d) Substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site?	☐	☐	☒	☐

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
e) Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?	☐	☐	☐	☒
f) Otherwise substantially degrade water quality?	☐	☐	☒	☐
g) Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map?	☐	☐	☐	☒
h) Place within a 100-year flood hazard area structures which would impede or redirect flood flows?	☐	☐	☐	☒
i) Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam?	☐	☐	☐	☒
j) Inundation by seiche, tsunami, or mudflow?	☐	☐	☐	☒
<u>IX. LAND USE AND PLANNING</u>—Would the project:				
a) Physically divide an established community?	☐	☐	☐	☒
b) Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect?	☐	☐	☒	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
c) Conflict with any applicable habitat conservation plan or natural community conservation plan?	☐	☐	☐	☒
<u>X. MINERAL RESOURCES</u>—Would the project:				
a) Result in the loss of availability of a known mineral resource that would be of value to the region and the residents of the state?	☐	☐	☐	☒
b) Result in the loss of availability of a locally-important mineral resource recovery site delineated on a local general plan, specific plan or other land use plan?	☐	☐	☐	☒
<u>XI. NOISE</u>—Would the project result in:				
a) Exposure of persons to or generation of noise levels in excess of standards established in the local general plan or noise ordinance, or applicable standards of other agencies.	☐	☒	☐	☐
Short-term impacts from increased noise and dust emissions could occur as a result of construction. Mitigation measures implemented for noise and air quality would reduce any impacts to a less than significant level.				
b) Exposure of persons to or generation of excessive groundborne vibration or groundborne noise levels.	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
c) A substantial permanent increase in ambient noise levels in the project vicinity above levels existing without the project?	☐	☐	☐	☒
d) A substantial temporary or periodic increase in ambient noise levels in the project vicinity above levels existing without the project.	☐	☐	☒	☐
e) For a project located within an airport land use plan or, where such a plan has not been adopted, within two miles of a public airport or public use airport, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
f) For a project within the vicinity of a private airstrip, would the project expose people residing or working in the project area to excessive noise levels?	☐	☐	☐	☒
XII. POPULATION AND HOUSING—Would the project:				
a) Induce substantial population growth in an area, either directly (for example, by proposing new homes and businesses) or indirectly (for example, through extension of roads or other infrastructure).	☐	☐	☐	☒
b) Displace substantial numbers of existing housing, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
c) Displace substantial numbers of people, necessitating the construction of replacement housing elsewhere?	☐	☐	☐	☒
XIII. PUBLIC SERVICES—Would the project:				
a) Would the project result in substantial adverse physical impacts associated with the provision of new or physically altered governmental facilities, need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services?	☐	☐	☐	☒
Fire protection?	☐	☐	☐	☒
Police protection?	☐	☐	☐	☒
Schools?	☐	☐	☐	☒
Parks?	☐	☐	☐	☒
Other public facilities?	☐	☐	☐	☒
XIV. RECREATION—Would the project:				
a) Would the project increase the use of existing neighborhood and regional parks or other recreational facilities such that substantial physical deterioration of the facility would occur or be accelerated?	☐	☐	☐	☒
b) Does the project include recreational facilities or require the construction or expansion of recreational facilities, which might have an adverse physical effect on the environment?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XV. TRANSPORTATION/TRAFFIC—Would the project:				
a) Cause an increase in traffic, which is substantial in relation to the existing traffic load and capacity of the street system (i.e., result in a substantial increase in either the number of vehicle trips, the volume to capacity ratio on roads, or congestion at intersections)?	☐	☐	☒	☐
b) Exceed, either individually or cumulatively, a level of service standard established by the county congestion management agency for designated roads or highways?	☐	☐	☒	☐
c) Result in a change in air traffic patterns, including either an increase in traffic levels or a change in location that results in substantial safety risks?	☐	☐	☐	☒
d) Substantially increase hazards due to a design feature (e.g., sharp curves or dangerous intersections) or incompatible uses (e.g., farm equipment)?	☐	☐	☐	☒
e) Result in inadequate emergency access?	☐	☐	☐	☒
f) Result in inadequate parking capacity?	☐	☐	☐	☒
g) Conflict with adopted policies, plans, or programs supporting alternative transportation (e.g., bus turnouts, bicycle racks)?	☐	☐	☐	☒
XVI. UTILITIES AND SERVICE SYSTEMS—Would the project:				
a) Exceed wastewater treatment requirements of the applicable Regional Water Quality Control Board?	☐	☐	☐	☒
b) Require or result in the construction of new water or wastewater treatment facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
c) Require or result in the construction of new storm water drainage facilities or expansion of existing facilities, the construction of which could cause significant environmental effects?	☐	☐	☐	☒
d) Have sufficient water supplies available to serve the project from existing entitlements and resources, or are new or expanded entitlements needed?	☐	☐	☐	☒
e) Result in a determination by the wastewater treatment provider, which serves or may serve the project that it has adequate capacity to serve the project’s projected demand in addition to the provider’s existing commitments?	☐	☐	☐	☒
f) Be served by a landfill with sufficient permitted capacity to accommodate the project’s solid waste disposal needs?	☐	☐	☐	☒
g) Comply with federal, state, and local statutes and regulations related to solid waste?	☐	☐	☐	☒

Issues:	Potentially Significant Impact	Less Than Significant With Mitigation Incorporation	Less Than Significant Impact	No Impact
XVII. MANDATORY FINDINGS OF SIGNIFICANCE				
a) Does the project have the potential to degrade the quality of the environment, substantially reduce the habitat of a fish or wildlife species, cause a fish or wildlife population to drop below self-sustaining levels, threaten to eliminate a plant or animal community, reduce the number or restrict the range of a rare or endangered plant or animal or eliminate important examples of the major periods of California history or prehistory?	☐	☒	☐	☐
b) Does the project have impacts that are individually limited, but cumulatively considerable? ("Cumulatively considerable" means that the incremental effects of a project are considerable when viewed in connection with the effects of past projects, the effects of other current projects, and the effects of probable future projects)?	☐	☐	☒	☐
c) Does the project have environmental effects, which will cause substantial adverse effects on human beings, either directly or indirectly?	☐	☐	☒	☐

Technical Memorandum No. 6

Sacramento River Basinwide Water Management Plan Future Water Management Alternatives

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

October 2004

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Acronyms and Abbreviations

AB	Assembly Bill
ac-ft	acre-feet
ACID	Anderson-Cottonwood Irrigation District
BWMP	Basinwide Water Management Plan
Cooperating Agencies	American River Basin Cooperating Agencies
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DWR	California Department of Water Resources
ESA	Endangered Species Act
GCID	Glenn-Colusa Irrigation District
ISI	Integrated Storage Investigation
JPA	joint powers authority
M&I	municipal and industrial
MFWC	Meridian Farms Water Company
MID	Maxwell Irrigation District
MOU	Memorandum of Understanding
MTCR	M&T Chico Ranch
NCMWC	Natomas Central Mutual Water Company
O&M	operations and maintenance
PCGID	Princeton-Condora-Glenn Irrigation District
PID	Provident Irrigation District
PMWC	Pelger Mutual Water Company
Pool	SRWCA Project Water Pool
RD 1004	Reclamation District No. 1004
RD 108	Reclamation District No. 108
SMWC	Sutter Mutual Water Company
SNAGMA	Sacramento North Area Groundwater Management Authority

SRSC	Sacramento River Settlement Contractor
SRWCA	Sacramento River Water Contractors' Association
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf/yr	thousand acre-feet per year
TCCA	Tehama-Colusa Canal Authority
TDR	total district water requirements
TIDC	Tisdale Irrigation and Drainage Company
TM	Technical Memorandum
Reclamation	U.S. Bureau of Reclamation
USFWS	U.S. Fish and Wildlife Service
WSC	water service contract

SECTION 1

Scope and Purpose

Technical Memorandum (TM) No. 6 develops and evaluates a wide range of future water management alternatives in support of the Sacramento River Basinwide Water Management Plan (BWMP). TM 6 builds off of the information and findings presented in the following previous TMs:

- *Technical Memorandum No. 1 – Project Goals and Objectives*
- *Technical Memorandum No. 2 – Current and Future Water Requirements*
- *Technical Memorandum No. 3 – Water Resources Characterization*
- *Technical Memorandum No. 4 – District Water Requirement and CVP Supply/Sub-basin Water Balances*
- *Technical Memorandum No. 5 – Water Management and Supply Options*

Water management alternatives are developed for each participating Sacramento River Settlement Contractor (SRSC), and a range of regional water management alternatives that could be cooperatively implemented on a sub-basin or basinwide basis, with the fundamental goal of finding effective means to meet both the individual SRSC water needs and the regional water needs. In TM 5, the individual management and supply actions (groundwater development, canal lining, drainwater reuse, transfers, and new storage) were developed and assessed in the context of the agricultural practices and regional water resources within the Sacramento Valley. This TM takes the next step toward new water management solutions by considering how these individual actions can be combined into comprehensive water management alternatives for each SRSC, and in turn how the alternatives for the individual SRSCs can be combined with cooperative regional water management alternatives to help meet regional water management goals and objectives.

The outcome of this TM is not a laundry list of specific water management programs to start implementing because it is recognized that it is impractical to attempt to provide specific prescriptive alternatives given the level of uncertainty regarding major factors such as water supply quantities, costs, legal issues, and the outcome of major state and federal initiatives such as CALFED, all of which will influence future management priorities and decisions. Rather, the basic goal of the alternatives presented here is to provide a framework for management decisions, both regionally and locally, as key events unfold over the next 3 to 5 years.

The key findings and recommendations from this TM build into the Sacramento River BWMP Summary Report. The Sacramento River BWMP Summary Report lays out the implementation process. It presents follow-up and supporting actions to be taken as needed to further refine alternatives through detailed study and assessment of key factors, beginning local and regional planning processes such as conjunctive water management investigations, and resolution of critical legal and institutional issues related to water resources management.

SECTION 2

Development of Individual Sacramento River Settlement Contractor Water Management Alternatives

Background

This section discusses the basis and methodology for the development of water management alternatives for each SRSC. The alternatives were developed based on establishment of common water management objectives, review of current water supply and management practices, a uniform ranking scheme for grouping individual actions, and combining these individual actions into a range of alternatives for each SRSC. The following section discusses each of these steps in greater detail.

Sacramento River Settlement Contractor Water Management Objectives

The development of future water management alternatives needs to be formulated around the basic management objectives that drive the decisions and action of each district's management and operations staff. The following are basic objectives that generally guide the operations and management decisions:

- Adequate water supply quantity – The water supply must be sufficient to meet the needs of the service area based on the crop types and management practices.
- Maintain water and soil quality – Water quality and its influence on soil quality should not negatively affect crop yields.
- Seasonal and inter-annual supply reliability – The water supply should be reliable in terms of its overall annual quantity and in terms of quantity available during critical stages of each irrigation season.
- Provide the most economical water supply – Water supply costs should be as low as possible to minimize the capital expenditures and resulting decline in net revenue from the service area's farms.
- Efficient operations and maintenance (O&M) practices – The water supply and management practices should seek to minimize the recurring O&M costs.
- Supply and operational flexibility – The service area should have the ability to draw on alternative sources of supply if one is reduced temporarily, or to supply a particular portion of the service area with alternative sources.

- Protection of water rights – The water management actions should ensure adequate protection of existing water rights.
- Environmentally sound water supply management practices – To the extent possible, continue to ensure environmental health through actions such as rice decomposition and flooding for waterfowl habitat, complying with applicable regulations regarding diversion operations, return flow water quality, and Endangered Species Act (ESA)-related operations modifications.

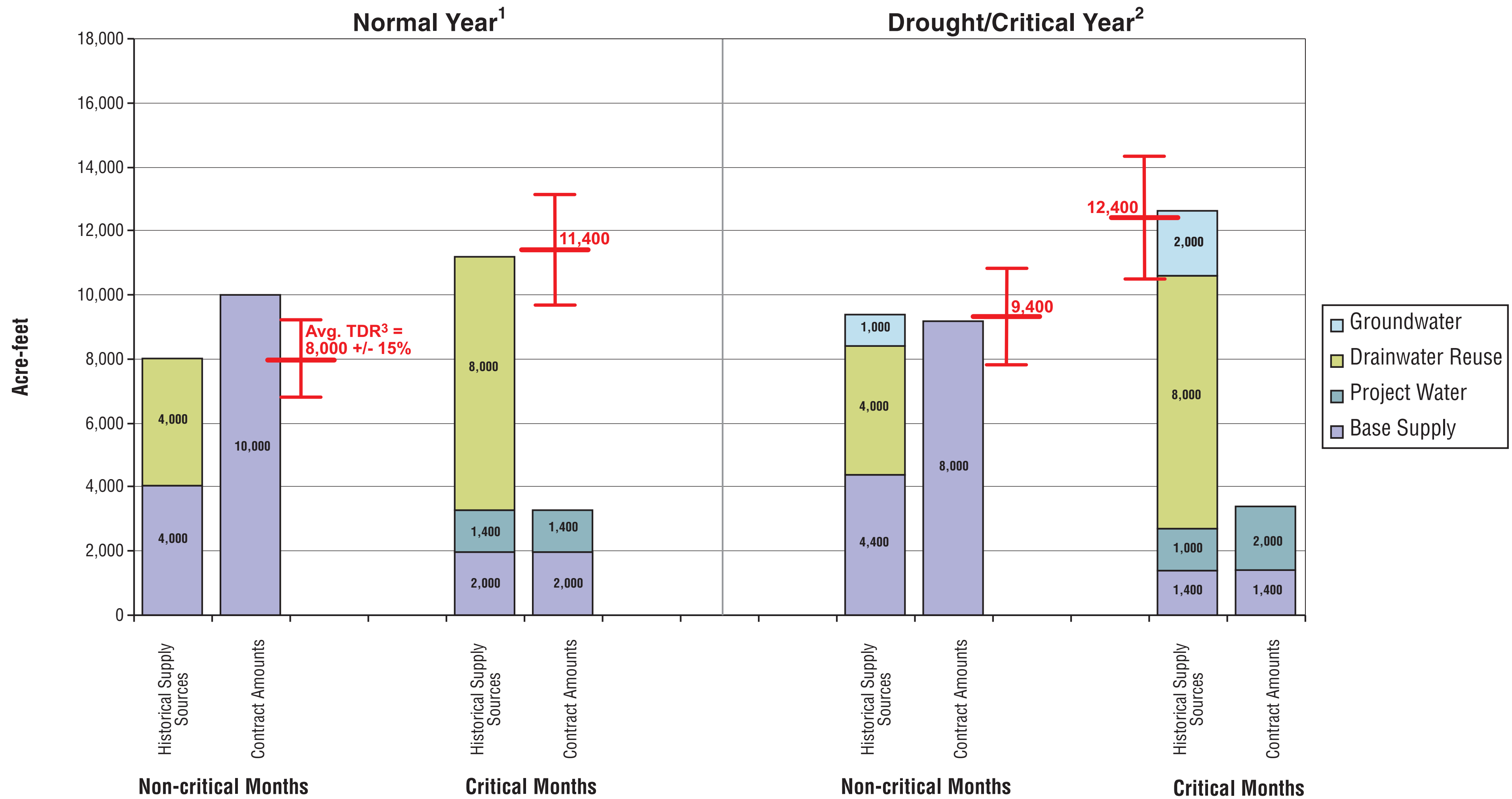
Review of Existing Water Supply and Management Practices

Each SRSC's water supply practices were summarized based on the last 10 to 15 years of water use data for each district. See sample Figure 2-1. Figure 2-1 has three key pieces of information for each of the four management periods (critical/non-critical years and non-critical and critical months), the average water source use, the Base and Project contract quantities, and the average total district water requirement (TDR). The use of "average" data can be misleading if the figures are interpreted as absolute values and consideration is not given to the large inter-annual variation in water supply and demand patterns. Factors that can influence water supply and demand patterns from year to year include seasonal and daily climate variations, changes in crop mix due to market and/or government price support programs, changes in irrigation practices, changes in cultural practices related to pesticide and herbicide application, soil salinity management, and regulatory requirements such as ESA-mandated restrictions on river diversions. However, with this caveat in mind, it is useful to have a uniform historical period selected for all districts as a baseline for comparison to past or future conditions.

The data presented for each SRSC are based on the following periods. For normal years, the average use for the periods 1987 to 1990, 1993, 1995, and 1996 to 1997 was used. For drought/critical years, the periods 1977, 1991, 1992, and 1994 were used. The drought/critical year represents a worst-case scenario, given such years assume water allocation reductions of 25 percent associated with contract provisions based on Shasta inflow. In many "drought" years in the past (as is likely to be the case in the future), contract water allocation reductions did not occur because sufficient Shasta inflow allowed full allocations. (Diversions versus allocation in TM 3 illustrate how variable the supply practices are from year to year.) Year-to-year variables such as hydrology and climate trends, water allocations, crop patterns, and farm commodity market forces can all influence water demands and supply practices.

The TDR figure is shown for each period, again representing an average water supply requirement based on average crop acreage and climate conditions. The TDR values are driven by all of the same factors listed above, and can vary as much as 15 percent above and below the historical average in any single year. For these reasons, the TDR figure should be considered a planning target, not an absolute water requirement. See TM 2 for details related to estimation of the TDR for each SRSC.

In the drought-year periods, TDR may be higher than SRSC supply. Again, TDR represents an ideal water supply that would allow optimum management of the full normal acreage and crop mix for the service area. In actuality, several factors combine to reduce water use



[1] Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2] The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3] TDR based on 1995 land use.

FIGURE 2-1
SAMPLE FIGURE –
CURRENT WATER USE AND CONTRACT AMOUNTS

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in severe droughts. These include reductions in planted acreage, changes in crop types to less water-intensive crop types, deficit irrigation with less than optimum applied water, and increased drainwater reuse.

Ranking of Individual Management Options

In TM 5, a uniform range of water management actions (options) was assessed for each SRSC, and factors were identified that may influence new or continued implementation of each action. The actions considered included groundwater development, drainwater reuse, conveyance systems automation, water measurement practices, Central Valley Project (CVP) purchases, pricing structure modifications, transfers, and canal lining. Those individual actions are categorized into standard tiers for each SRSC in the following sections.

The tier ranking is intended to refine the wide range of possible actions down to a ranked list of actions to help prioritize which actions can serve as the foundations for future water management alternatives, which actions need further assessment, and which actions clearly do not warrant further consideration at this time.

The ranking for each SRSC is district-specific and is based on discussions with key SRSC personnel. In each case, the assessment of water management options in TM 5 for the SRSC was presented to the SRSC representative, and each potential action was evaluated in the context of that particular SRSC's infrastructure, goals, institutional policies, funding availability, availability/status of related information (such as detailed studies), and expected benefit of implementation.

The tier-ranking classifications are intentionally broad, but provide a context for a cross-district classification system that is as consistent as possible. In the classification process used, a particular action can be demoted to a lower tier if it fails to meet any one of the criteria of the next higher tier.

The tier criteria follow.

Tier 1 Criteria

- The management option is already in place, fully developed, or in progress towards full development. An example would be canal automation for an SRSC who has automated all key facilities.
- The option has strong promise for net benefits based on TM 5 findings. An example would be increased canal automation for a district where analysis for TM 5 indicates that the net cost of the reduced conveyance losses is equal to or less than current unit water supply costs.
- The option has reasonable cost and may provide significant water supply. An example would be increased groundwater pumping in an area with a significant level of existing groundwater pumping and strong evidence of sufficient yield to increase pumping in the future without detrimental impacts.

Tier 2 Criteria

- Initial evaluation shows some promise of net benefit(s) but may require further study of key factors. An example would be groundwater development in an area anticipated to have useable groundwater supplies, but where there have not been detailed studies to verify yield and costs.
- The option requires further study and/or hinges on decisions or findings underway from third parties, for example, ongoing California Department of Water Resources (DWR) study, a court ruling on a key issue, or other factors that need resolution before proceeding.
- The option is marginally not cost effective compared to others, but may be given stronger future consideration with outside incentives/funding.

Tier 3 Criteria

- Initial evaluation shows little or no potential net benefits. An example would be groundwater development in an area with known poor-quality groundwater supply.
- The option has substantial implementation issues and/or prohibitive costs that make it very unlikely the district can pursue it.
- These options are not likely to be pursued by an individual district at any foreseeable time, even with outside incentives such as funding assistance.

Presentation of Alternatives

A range of future water management alternative for each SRSC was developed, building from the findings of the water supply/TDR assessment, the ranking of the individual options from TM 5, and the management objectives that any future alternatives must support. Alternatives are presented in a summary table for each of the four management periods, including summary findings of the current management practices, the pros and cons of each alternative, and what factors are most likely to be influenced if that alternative goes forward. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives are presented in a qualitative manner for this reason.

Sacramento Valley Water Management Agreement

The SRSCs participating in this BWMP, in addition to numerous other water districts and companies throughout the Sacramento Valley, executed the Sacramento Valley Water Management Agreement in December 2002. Parties to the Agreement include Reclamation, DWR, California Department of Fish and Game, U.S. Fish and Wildlife Service, and a large number of downstream water users including the State Water Contractors, San Luis & Delta-Mendota Water Authority, Westlands Water District, Kern County Water Agency, and Contra Costa Water District. The Sacramento Valley Water Management Agreement is intended to improve water management while assisting in meeting water supply, water quality, and environmental needs throughout the Sacramento Valley and the state. A key premise of the Sacramento Valley Water Management Agreement is the development of projects that contribute toward meeting Bay-Delta water quality requirements (thereby avoiding protracted litigation related to the California State Water Resources Control Board (SWRCB) Phase 8 Hearings), while improving inter- and intra-district water system management across the Sacramento Valley. The Short-term Workplan, released in October 2001, identified the following three types of projects across the Sacramento Valley:

- Conjunctive Water Management
- System Improvement
- Groundwater/Surface Water Planning

Regulatory and institutional issues that were agreed to impact water management were also investigated with respect to water transfer policy and unapproved diversions (e.g., Term 91).

With the implementation of the Agreement, water districts and companies across the Sacramento Valley, including the SRSCs participating in this BWMP, are moving toward the implementation of projects. State funding assistance (e.g., Propositions 13 and 50) are being jointly pursued to support project design and construction. Many of the concepts and proposals included in the BWMP, including those discussed in TM 5 and TM 6 of this BWMP have been carried forward as projects included in the Short-term Workplan.

Projects proposed by the participating SRSCs include the following:

- Conjunctive Water Management
  - ACID Conjunctive Use Program (Project 2B)
  - GCID Development of Conjunctive Water Management Facilities (Project 5B)
  - MID Conjunctive Use Project (Project 6A)
  - NCMWC Conjunctive Use Project (Project 7A)
  - RD 108 Pilot Well Development/Conjunctive Management Project (Project 10A)
  - Stony Creek Fan (GCID and Partners) Conjunctive Water Management Program (Project 8A)
- System Improvement
  - ACID Churn Creek Lateral Improvements (Project 2A)
  - ACID Main Canal Modernization Project (Project 2C)
  - GCID Flow Measurement Devices in Main Canal, Lateral System, and Drain Outflow Points/Existing Automation Program (Project 5C/D)
  - SMWC Irrigation Recycle Project (Project 22B)
- Groundwater/Surface Water Planning
  - GCID Regulatory Reservoirs and Off-canal Storage Feasibility Study (Project 5A)

- GCID Glenn County Groundwater Monitoring Program and Model Development (Project 5E)
- RD 1500 Sutter Basin Groundwater Monitoring Well (Project 22D formerly 23A)
- BWMP Sub-basin-level Water Measurement (Project 11A)

The project summary from the October 2001 Short-term Workplan for each of these projects is included in Appendix D of TM 5, *Water Management and Supply Options*. Many of these are currently (spring 2003) being updated in terms of yield, cost, and, in some cases, facilities. In addition, several new projects have been proposed by the SRSCs since October 2001. The parties to the Sacramento Valley Water Management Agreement are preparing a Long-term Workplan, which is scheduled for completion in June 2005. The Long-term Workplan will assist in the development of a subsequent Long-term Water Management Agreement.

SECTION 3

Anderson-Cottonwood Irrigation District

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Anderson-Cottonwood Irrigation District (ACID or District) are shown on Figure 3-1, for the period from 1985 through 1997, for normal and critical/drought years. Each of the four major analysis periods shown is discussed in detail below. In normal years, ACID has used Base Supply as its primary water source in both critical and non-critical months to meet the District water requirement, with minor supplements from drainwater reuse. In critical/drought years, the pattern is similar for non-critical months, while in critical months of drought years, Project Supply has been used to supplement reduced Base Supply. See TM 5 for more information on ACID's current water management practices. See TM 3 for details on the historical pattern of ACID's Sacramento River diversions.

In the non-critical months of a normal year, ACID has supplied its TDR of approximately 74,100 acre-feet (ac-ft) using Base Supply as its primary water source, and minor supplemental supply from drainwater reuse. Over 97 percent (84,000 ac-ft) of the total average supply is Base Supply from Sacramento River diversions, and approximately 3 percent (2,600 ac-ft) is from drainwater reuse.

In the critical months of a normal year, ACID has supplied its TDR of approximately 47,000 ac-ft using Base Supply and a minor amount of drainwater reuse. Approximately 95 percent (44,400 ac-ft) of the total average supply is Base Supply, and 5 percent (2,400 ac-ft) is drainwater reuse. The District's 10,000 ac-ft Project Supply has typically been used in transfers to the Sacramento River Water Contractors' Association (SRWCA), as discussed in further detail in Section 14 Redding Sub-basin.

In the non-critical months of a drought/critical year, ACID has supplied its TDR of approximately 90,200 ac-ft using Base Supply as its primary water source, and minor supplemental supply from drainwater reuse. Approximately 97 percent (81,000 ac-ft) is from Base Supply, and 3 percent (2,600 ac-ft) is from drainwater reuse.

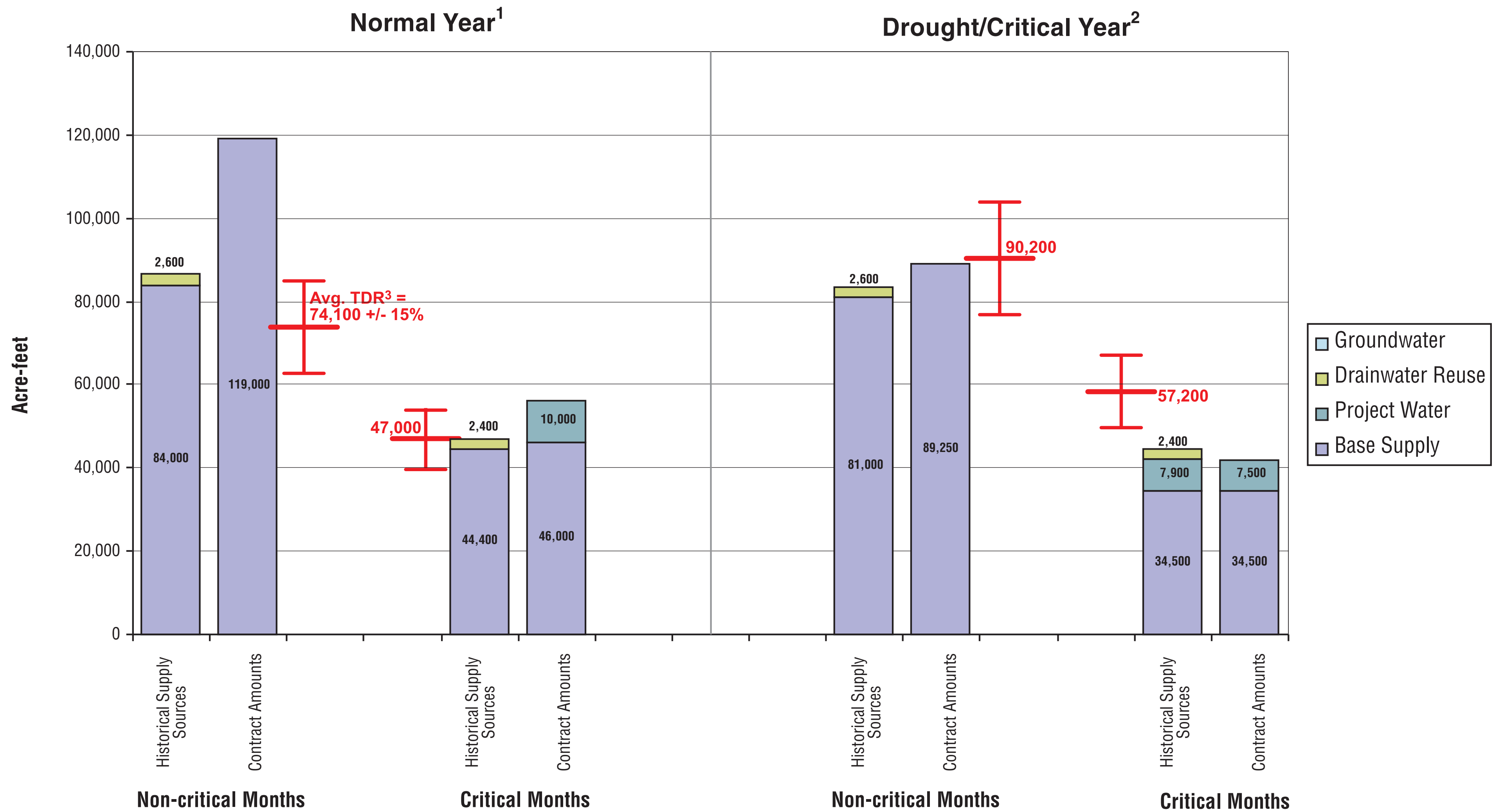
In the critical months of a drought/critical year, ACID has supplied its TDR of approximately 57,200 ac-ft using Base Supply, Project Supply, and a minor amount of drainwater reuse. Approximately 77 percent (34,500 ac-ft) of the total average supply is from Base Supply, 17 percent (7,900 ac-ft) is from Project Supply, and 6 percent (2,400 ac-ft) is from drainwater reuse.

Analysis and Ranking of Water Management Options

The tier classification of management options for ACID is shown in Table 3-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

TABLE 3-1
ACID Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Conveyance and distribution system automation	• Cooperative program with U.S. Bureau of Reclamation (Reclamation) underway now. Can be expanded to cover more of District's facilities. See TM 5 for improvements. • Will reduce operational spills.
	Improved operations water measurement	• Will improve water balance accounting, some conservation savings. See TM 5 for improvements.
	Water transfers	• Current policy prioritizes meeting Redding Basin needs, then Sacramento Valley agriculture and environmental needs. • District interested in considering Base and Project transfers. • District has been supplier in past transfers through SRWCA and State Drought Water Bank. • Potential for increased transfers if beneficial conjunctive water management program develops and/or state/federal transfer policies revised.
	CVP purchases	• Currently used through direct use and beneficial transfers. • Important source for drought/critical year reliability and flexibility.
	Drainwater reuse	• Continue current levels. Significant increases not practical.
Tier 2	New groundwater development	• Minor use by private wells now. May be potential for significant increase in groundwater use. • Can provide reliability and flexibility for drought/critical years. • May be opportunity for conjunctive water management program. • Requires further study to determine groundwater impacts and unit cost of water. • Large capital and O&M costs may require outside funding assistance.
	Canal lining	• Some potential lining areas identified. May require outside funding assistance. Piping of laterals may also be an option. • Leakage recharges groundwater, supports riparian habitat, and returns to Sacramento River. • Would provide improved water control and allow for greater reductions in diversions during low-demand periods.
	Farm-level measurement	• Option 1 – Use existing turnout gates, canal head measurement, and time of delivery to measure quantity. • Option 2 – Measure service lateral delivery for operational subunits composed of groups of customers (i.e., 500-acre block under common management). • Use measurement data to verify on-farm efficiency and target improvements as necessary.
	Quantity-based pricing	• Requires change from rotation to arranged price structure. • Significant institutional issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
Tier 3	None identified	



[1]Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2]The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3]TDR based on 1995 land use.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

W062004006RDD_09 TM 6 (9/30/04)

FIGURE 3-1
ANDERSON-COTTONWOOD IRRIGATION DISTRICT CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Future Water Management Alternatives

Table 3-2 summarizes future water management alternatives for ACID under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the District's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 3-2
ACID Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply	• Contract Base is greater than TDR and is the most affordable and reliable supply • Long-term issue may be protection of water rights for unused Base Supply	No apparent incentives for alternatives at this time	• N/A	• N/A	• Changes in Base transfer policy and water rights protection issues
Normal/Critical	Base Supply	• Base is sufficient to meet TDR and is the most affordable and reliable supply • Project Supply available, but cost is higher and typically not used • No long-term issues apparent at this time to impact current practices	Develop new groundwater sources	• Improved efficiency and supply flexibility • Potential for transfers of surface water supplies	• Groundwater impacts • Increased operating costs	• Future Project Water costs • State/federal transfer policy • Findings of conjunctive water management study
Drought/Non-critical Year	Base Supply	• Base Supply is sufficient to meet TDR and is most reliable and affordable source	No apparent incentives for other alternatives at this time	• N/A	• N/A	• Changes in Base transfer policy or beneficial conjunctive water management program
Drought/Critical Year	Base and Project Supply	• Base and Project are fully used, but are NOT sufficient to meet TDR	Develop new groundwater sources	• Improved efficiency and supply flexibility • Potential for transfer of surface water supply	• Groundwater impacts • Increased operating costs	• Future Project Water costs • State/federal transfer policy • Findings of conjunctive water management study

SECTION 4

Glenn-Colusa Irrigation District

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Glenn-Colusa Irrigation District (GCID or District) are shown on Figure 4-1, for the period from 1985 to 1997, for normal and critical/ drought years. Each of the four major analysis periods shown is discussed in detail below. In normal years, GCID has used Base Supply as its primary water source in both critical and non-critical months to meet the District water requirement. Supplemental supplies have included drainwater use in non-critical months, and a combination of drainwater and Project Water in critical months. In drought/critical years, reduced Base Supply has been supplemented with increased drainwater use, Project Water, and groundwater pumping. See TM 5 for more information on GCID's current water management practices such as system automation, water measurement, and drainwater reuse.

The Base and Project Water use on Figure 4-1 reflects temporary changes in GCID's use of Base and Project Water since 1990, caused by a combination of drought-year supply cut-backs and restrictions on GCID's pumping operations at the Main Pump Station on the Sacramento River resulting from ESA listings of winter-run salmon in 1992. The reduced Sacramento River diversions have been replaced by increased drainwater reuse. However, recent evidence of salinity impacts on fields in the GCID service area indicates that this aggressive level of drainwater reuse may not be sustainable. The District has a salinity study program in progress, with the goal of determining what the range of long-term sustainable levels of drainwater reuse may be. Following completion of the improvements at the Main Pump Station to address fishery concerns, diversions are expected to return to more typical historical levels. See TM 3 for details on the historical pattern of GCID's Sacramento River diversions.

In the non-critical months of a normal year, GCID has supplied its TDR of approximately 430,600 ac-ft using Base Supply as the primary water source, and supplemental supply from drainwater reuse. Approximately 83 percent (396,000 ac-ft) of the total average supply is Base Supply, and the remaining 17 percent (81,000 ac-ft) is from drainwater reuse. The District's Base Supply for non-critical months is 500,000 ac-ft, which is adequate to meet TDR. GCID has historically used drainwater to offset a portion of its Base Supply use to improve farm-level efficiency, overall conveyance system efficiency, and operational flexibility.

In critical months of normal years, GCID has supplied its TDR of approximately 317,800 ac-ft using Base Supply as the primary water source, and supplemental supply from drainwater reuse and Project Supplies. Approximately 63 percent (220,000 ac-ft) of the total average supply comes from Base Supply, 20 percent (74,000 ac-ft) comes from drainwater reuse, and 17 percent (56,200 ac-ft) comes from Project Supply. Historically, GCID has used its full Base and Project Supply during critical months, but has not been using its full Project Supply of 105,000 ac-ft since 1990 because of the temporary conditions described earlier.

Project Water use is expected to return to normal historical levels (pre-1990) following completion of the Main Pump Station improvements and the findings of ongoing soil salinity studies.

In the non-critical months of drought/critical years, GCID has supplied its TDR of approximately 476,800 ac-ft using Base Supply as its primary water source, and supplemental supply from drainwater reuse and groundwater pumping. Approximately 75 percent (332,800 ac-ft) of the total average supply is Base Supply, 20 percent (89,000 ac-ft) is from drainwater reuse, and 5 percent (30,000 ac-ft) is from groundwater pumping. Most of the groundwater pumping has been by private wells operated by GCID service-area farmers in a cooperative supply program with GCID. The increased drainwater and groundwater pumping, compared to normal years, have been used to offset the 25 percent cutback in Base Supply (to 375,000 ac-ft) and the Sacramento River diversion restrictions discussed above.

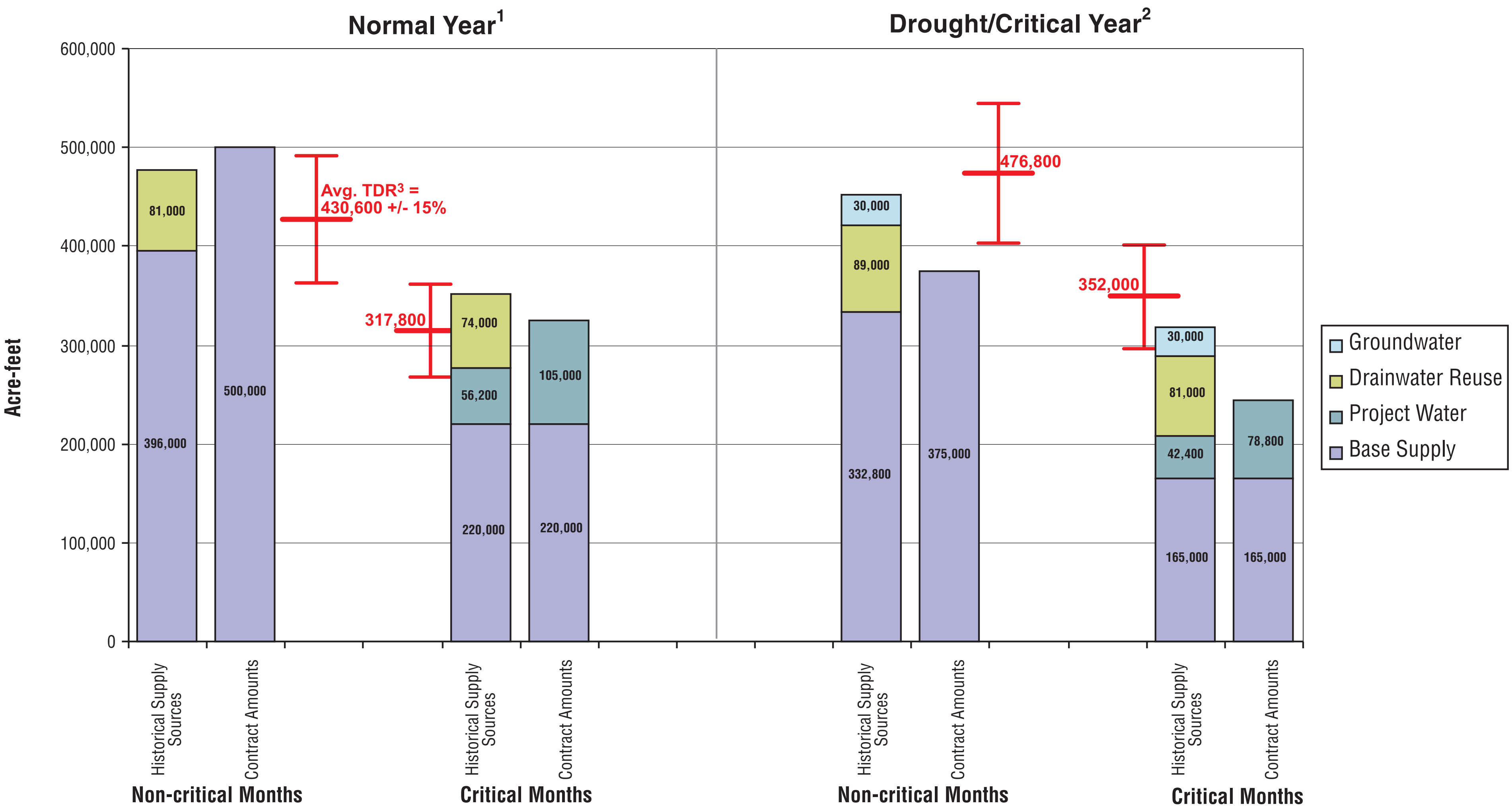
In the critical months of drought/critical years, GCID has supplied its TDR of approximately 352,000 ac-ft using Base Supply as the primary water source, and supplemental supply from drainwater reuse, Project Supply, and groundwater pumping. Approximately 52 percent (165,000 ac-ft) of the total average supply is Base Supply, 25 percent (81,000 ac-ft) is from drainwater reuse, 13 percent (42,400 ac-ft) is from Project Supply, and 10 percent (30,000 ac-ft) is from groundwater pumping. The drainwater reuse and groundwater pumping have been used to offset the 25 percent cutback in Base and Project Supply (to 165,000 and 78,800 ac-ft, respectively). Project Water use is expected to return to normal historical levels (pre-1990) with use of the full Project Supply, following completion of the Main Pump Station improvements. Drainwater use and groundwater pumping will likely be reduced when this happens, although the resulting supply from each source will depend on many factors such as Project Supply costs, groundwater pumping costs, and findings from the salinity studies.

Analysis and Ranking of Water Management Options

The tier classification of management options for GCID is shown in Table 4-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

Future Water Management Alternatives

Table 4-2 summarizes future water management alternatives for GCID under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the District's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water,



[1] Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2] The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3] TDR based on 1995 land use.

Notes:

1. Use patterns since 1990 reflect reduced river diversions caused by temporary restrictions on river withdrawals at GCID's Main Pump Station. River diversions are likely to increase in the future, replacing drainwater, which has been used temporarily to meet District requirements during the impairment.
2. Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

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FIGURE 4-1
GLENN-COLUSA IRRIGATION DISTRICT
CURRENT WATER USE AND CONTRACT AMOUNTS

TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits, drawbacks, and major issues for resolution or further study.

TABLE 4-1
GCID Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Current groundwater use	• Drought/critical-year source. • Provides operational and supply flexibility. • Private landowner wells used in cooperative program.
	Current drainwater reuse	• Extensive reuse now, but evidence of salinity impacts on crops. • Further study of soil and drainwater quality impacts needed.
	Conveyance automation	• Extensive automation in place now. Improvements and changes made year to year. Operational spills are at practical minimum.
	Water measurement	• Complete operations water measurement program in place now. Minor improvements being made on a regular basis.
	Water transfers	• Formal transfer policy in place. Supports in-basin agriculture and environmental needs as first priority. • District has been supplier in past transfers through SRWCA.
	CVP purchases	• Full Project Supplies historically used. Important source for reliability and flexibility of supply. • Increased costs may influence quantity of use. • May help in long-term salinity management by managing mixture of water use over long term.
Tier 2	Increase groundwater pumping	• Significant potential drought/critical-year supplemental supply. • Consider as part of regional conjunctive water management program. • Significant capital investment and O&M costs. • Sustainable groundwater yield unknown; requires further investigation to verify development goals.
	Increase drainwater reuse	• Potential supply for drought/critical years. • Evidence of existing salinity impacts; need to complete studies to determine sustainable levels. • May cause reduction in quantity and/or quality of drainwater for downstream Colusa Basin drainwater users.
	Farm-level measurement	• Currently meter service lateral delivery for operational sub-units composed of groups of customers (i.e., 1,000-acre block of users). • Can use existing measurement data to verify on-farm efficiency for sub-units and target improvements as necessary. • Option – use existing turnout gates, canal head measurement, and time of delivery to measure quantity.
	Quantity-based pricing	• Significant institutional and legal issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
Tier 3	Canal lining	• Uneconomic unit cost of “conserved” water. Leakage is recoverable in toe drains, groundwater, and Sacramento River. No net conservation benefits. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.

TABLE 4-2
GCID Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drain-water	• Base Supply is sufficient to meet TDR • Potential future issues are high reliance on drain-water and potential related salinity impacts	Increase Base and reduce drainwater reuse	• Base is economical and reliable supply • Increased Base use can free up drainwater for use by other drainwater users with no alternative sources • Reduces salinity impacts	• Lose flexibility and efficiency benefits of drainwater reuse	• Findings of salinity studies
			Increase drainwater reuse and reduce Base Supply use proportionally	• Improves district-level efficiency • Potential transfers	• Supply reduction impacts to downstream drainwater users • Potential salinity impacts • Water rights protection	• Findings of future salinity studies • Future state/federal transfer policy
Normal/Critical	Base Supply, Project Supply, and drainwater reuse	• Full Base and Project are sufficient to meet TDR • Expect to return to full Project Supply use following Main Pump Station improvements • Potential future issues are increased costs of Project Supply, high reliance on drainwater, and potential salinity impacts	Increase drainwater use, with proportional reduction in Project Water use	• Potential transfers • Increased efficiency	• Potential salinity impacts • Supply reduction impacts to downstream drainwater users	• Findings of future salinity studies • Future state/federal transfer policy • Future Project Supply costs
			Increase groundwater use with proportional reduction in drainwater or Project Supply	• Reduces salinity impacts • Potential transfers	• Cost and impacts of groundwater pumping	• Future state/federal transfer policy • Findings of future salinity studies • Findings of future groundwater investigations
Drought/Non-critical Year	Base Supply, drainwater, and groundwater	• Contract Base Supply NOT sufficient to meet TDR • Potential future issues are high reliance on drain-water and related salinity impacts	Increase Base to full contract supply, with corresponding reduction in drain-water or groundwater	• Base is economical and reliable supply • Reduces salinity impacts and/or groundwater pumping costs • Increased use can free up drainwater for use by other drainwater users with no alternative sources, reduces salinity impacts	• Lose flexibility and efficiency benefits of groundwater and drainwater reuse	• Findings of future salinity studies
			Increase drainwater reuse and/or groundwater pumping in some combination, with proportional reduction in Base Water use	• Increased district-level efficiency	• Salinity impacts (increased drainwater use) • Cost and impacts of groundwater pumping	• Findings of future salinity studies • Findings of future groundwater investigations • State/federal transfer policy
Drought/Critical Year	Base Supply, Project Supply, drainwater reuse, and groundwater	• Full Base and Project used, but NOT sufficient to meet TDR • Potential future issues are cost of Project Water and drainwater salinity impacts	Increase drainwater reuse and groundwater pumping in some combination with reduced Project Water use	• Increased district-level efficiency • Project Water transfer	• Salinity impacts (increased drainwater use) • Cost and impacts of groundwater pumping	• Findings of future salinity studies • New groundwater costs and pumping impacts • Project Supply costs • Transfer policies
			Increased groundwater pumping only	• Might free up some drain-water for downstream users	• Cost (groundwater pumping)	• Findings of future salinity studies, new groundwater costs and sustainable yield • Transfer policies

SECTION 5

Provident Irrigation District

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Provident Irrigation District (PID or District) are shown on Figure 5-1, for the period from 1985 to 1997, for normal and critical/drought years. Each of the four major analysis periods shown is discussed in detail below. In normal years, PID has used Base Supply as its primary water source in both critical and non-critical months to meet its TDR. Supplemental supplies have included primarily drainwater reuse, with a small quantity of Project Water in critical months. In drought/critical years, the use pattern is similar to normal years, with a minor amount of groundwater pumping. Beginning in 1998, PID has increased use of Project Water in critical months and reduced its dependence on drainwater to improve the District's overall supply reliability. In 1998, Base Supply use in non-critical months was 24,277, and Base and Project Supply use in critical months was 16,049 ac-ft and 4,314 ac-ft, respectively. In 1999, Base Supply use in non-critical months was 26,147 ac-ft, and Base and Project Supply use in critical months was 16,200 ac-ft and 3,879 ac-ft, respectively**.** This general pattern of supply, during normal years, will likely continue in the future. See TM 5 for more information on PID's current water management practices such as system automation, water measurement, and drainwater reuse. See TM 3 for details on the historical pattern of PID's Sacramento River diversions.

Prior to the above management changes to supply mix, in the non-critical months of a normal year PID has supplied its TDR of approximately 50,000 ac-ft with roughly equal amounts of Base Supply and drainwater reuse. Approximately 54 percent (24,300 ac-ft) of the total average supply is Base Supply, and the remaining 46 percent (21,000 ac-ft) is from drainwater reuse. The District's Base Supply for non-critical months is 33,500 ac-ft, which is not sufficient to meet its TDR. Historically, PID has used drainwater to offset a portion of its Base Supply use, primarily due to the lower operating costs, increased conveyance efficiency, and operational flexibility provided by drainwater use.

In critical months of normal years, PID has supplied its TDR of approximately 48,000 ac-ft using Base Supply as the primary source, and supplemental supply from drainwater reuse and Project Supplies. Historically, PID has used its total Base Supply allotment of 16,200 ac-ft, which makes up approximately 35 percent of the total average supply. Approximately 62 percent (29,000 ac-ft) comes from drainwater reuse, and the remaining 3 percent (1,300 ac-ft) comes from Project Supplies.

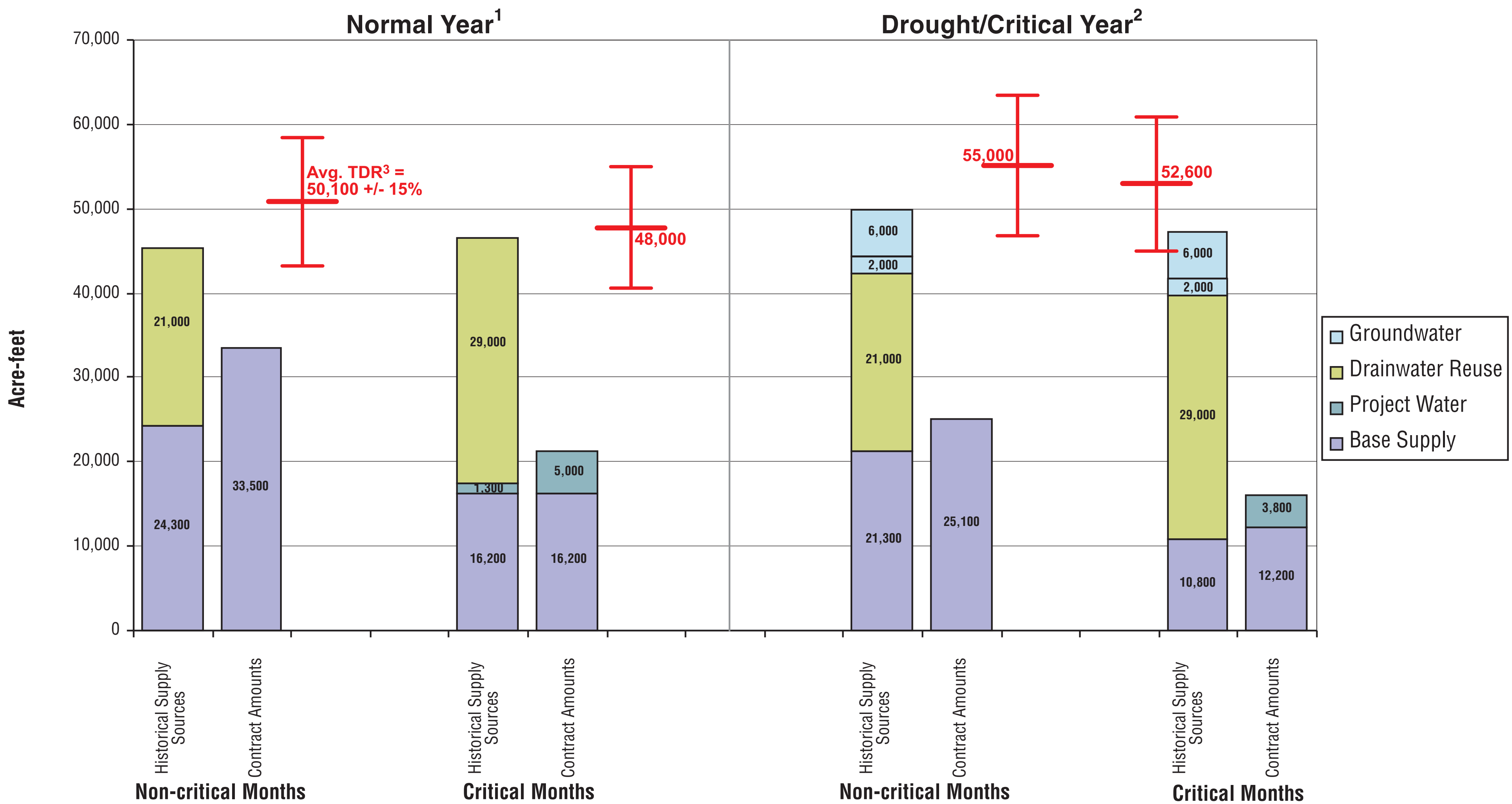
For non-critical months of drought years, PID's average TDR is approximately 55,000 ac-ft. As in normal years, PID has historically met this requirement primarily with Base Supply and drainwater reuse. Approximately 48 percent (21,300 ac-ft) of the total average supply is Base Supply, 47 percent (21,000 ac-ft) is from drainwater reuse, and 5 percent (2,000 ac-ft) is from PID-owned groundwater pumping. Private groundwater pumping by individual landowners is estimated to have averaged approximately 6,000 ac-ft during this period. For critical months of drought years, PID's average TDR is approximately 52,600 ac-ft. PID has historically met this requirement primarily using Base Supply, drainwater reuse, and a small amount of groundwater pumping. Approximately 25 percent (10,800 ac-ft) of the total average supply is Base, 69 percent (29,000 ac-ft) is from drainwater reuse, and 6 percent (2,000 ac-ft) is from PID-owned groundwater pumping. Private groundwater pumping by individual landowners is estimated to have averaged approximately 6,000 ac-ft during this period.

Analysis and Ranking of Water Management Options

The tier classification of management options for PID is shown in Table 5-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

TABLE 5-1
PID Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Increased groundwater development	• Minor use now. May be opportunity for regional conjunctive water management program. • Can provide additional reliability and flexibility as supplemental supply during drought/critical years. • Impacts on existing users and sustainable yield must be further assessed.
	Drainwater reuse	• Current levels are near practical limit. Minor increases may be achieved with peak diversion capacity increases. • Future supply dependent on actions by GCID. • Increased use will have supply reduction impact on other users downstream in Colusa drain.
	Conveyance automation	• In progress through cooperative Reclamation program. Future expansions planned. • Will reduce operational spills with small additional conservation savings.
	Water measurement	• See TM 5 items for PID. Will improve water balance accounting, small conservation savings.
	CVP purchases	• Currently fully used through direct use and beneficial transfers. • Important source for reliability and flexibility of supply.
Tier 2	Farm-level measurement	• Fields estimated to be near maximum practical efficiency as a result of on-farm improvements over last 10 years. • Option 1 – Use existing turnout gates, canal head measurement, and time of delivery to measure quantity. • Option 2 – Measure service lateral delivery for operational sub-units composed of groups of customers (i.e., 500- to 1,000-acre block under common management). • Use measurement data to verify on-farm efficiency and target improvements as necessary.
	Quantity-based pricing	• Significant institutional issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
Tier 3	Canal lining	• Uneconomic cost for "conserved" water. Leakage is all recoverable in toe drains, groundwater, or inflow to Sacramento River. No net benefits. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.



[1]Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2]The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3]TDR based on 1995 land use.

Notes:

1. Since 1998, PID has increased use of Project Water in critical months and reduced its dependence on drainwater to improve the District's overall supply reliability. This increased use of Project Water is likely to continue in the future.
2. Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 5-1
PROVIDENT IRRIGATION DISTRICT
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Future Water Management Alternatives

Table 5-2 summarizes future water management alternatives for PID under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the District's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 5-2
PID Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drainwater	• Contract Base Supply NOT sufficient to meet TDR • Full Base Supply typically not used • Potential future issues are high reliance on drain-water and related impacts, possible reduction in supply if upstream field/management or drainwater reuse pattern changes occur in GCID	Increase Base and reduce drainwater reuse proportionally	• Base is economical and reliable supply • Avoids potential salinity impacts from drainwater use	• Lose flexibility and efficiency benefits of drainwater reuse versus river diversions	• Findings of future salinity studies
Normal/Critical	Base Supply, drainwater reuse, small amount of Project Supply	• Full Base and Project NOT sufficient to meet TDR • Potential future issues are high reliance on drainwater and related impacts, and increases in Project Supply cost, possible reduction in supply if upstream field/management or drainwater reuse pattern changes occur	Increase groundwater pumping and reduce Project Water and/or drain-water reuse proportionally	• Reduces reliance on upstream drainwater supply • Potential transfers	• Cost and impacts of ground-water pumping	• Future practices in GCID service area and resultant drainwater supply • Future Project Supply costs • Findings of future salinity and groundwater studies • State/federal transfer policies
Drought/Non-critical Year	Base Supply, drainwater reuse, small amount of groundwater	• Contract Base Supply NOT sufficient to meet TDR • Potential future issues are high reliance on drainwater and related impacts, possible reduction in supply if upstream field/ management or drainwater reuse pattern changes occur in GCID	Increase groundwater pumping and reduce drainwater reuse proportionally	• Reduces reliance on drainwater	• Cost and impacts of ground-water development	• Future practices in GCID service area and resultant drainwater supply • Findings of future salinity and groundwater studies
Drought/Critical Year	Base Supply, drainwater reuse, small amount of groundwater	• Full Base and Project NOT sufficient to meet TDR • Potential future issues are high reliance on drainwater and related impacts, possible reduction in supply if upstream field/ management or drainwater reuse pattern changes occur in GCID	Increase groundwater pumping and reduce drainwater reuse or Project Supply proportionally	• Reduces reliance on upstream drainwater supply • Potential transfers	• Cost and impacts of ground-water development	• Future practices in GCID service area and resultant drainwater supply • Future Project Supply costs • Findings of future salinity and groundwater studies • State/federal transfer policies

SECTION 6

Princeton-Codora-Glenn Irrigation District

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Princeton-Codora-Glenn Irrigation District (PCGID or District) are shown on Figure 6-1, for the period from 1985 through 1997, for normal and critical/ drought years. Each of the four major analysis periods shown is discussed in detail below. In non-critical months of normal years, PCGID has used Base Supply as its primary water, and drainwater reuse as a supplemental water source. In critical months of normal years, PCGID has used roughly equal amounts of Base Supply, Project Supply, and drainwater reuse. In drought/critical years, the use pattern is similar to normal years, with some supplemental groundwater pumping. Beginning in 1998, PCGID increased use of Project Water in critical months to improve the District's overall supply reliability. In 1998, Base Supply use in non-critical months was 16,956, and Base and Project Supply use in critical months was 14,320 and 10,573 ac-ft, respectively. In 1999, Base Supply use in non-critical months was 33,337 ac-ft, and Base and Project Supply use in critical months was 14,320 and 16,009 ac-ft, respectively. Drainwater reuse averaged 28,000 ac-ft for the season. This general pattern of supply during normal years will likely continue in the future. See TM 5 for more information on PCGID's current water management practices such as system automation, water measurement, and drainwater reuse. See TM 3 for details on the historical pattern of PCGID's Sacramento River diversions.

In the non-critical months of a normal year, PCGID has supplied its TDR of approximately 34,500 ac-ft using Base Supply as its primary water source, and drainwater as a supplemental supply. Approximately 72 percent (26,600 ac-ft) of the total average supply is Base Supply from Sacramento River diversions, with the remaining 28 percent (10,500 ac-ft) coming from drainwater reuse. The District's contract Base Supply for non-critical months is 38,500 ac-ft, which is adequate to meet TDR. However, PCGID has historically used drainwater to offset a portion of its Base Supply use, primarily due to the lower operating costs and operational flexibility provided by drainwater use.

For critical months of normal years, PCGID's TDR is approximately 33,500 ac-ft. PCGID has used its full Base Supply of 14,300 ac-ft, which makes up approximately 36 percent of its total average supply. Project Water has supplied 28 percent (11,100 ac-ft), and drainwater reuse has supplied approximately 36 percent (14,500 ac-ft). The District has typically used drainwater to offset a portion of its Project Supply (14,500 ac-ft) to reduce costs and increase operations flexibility.

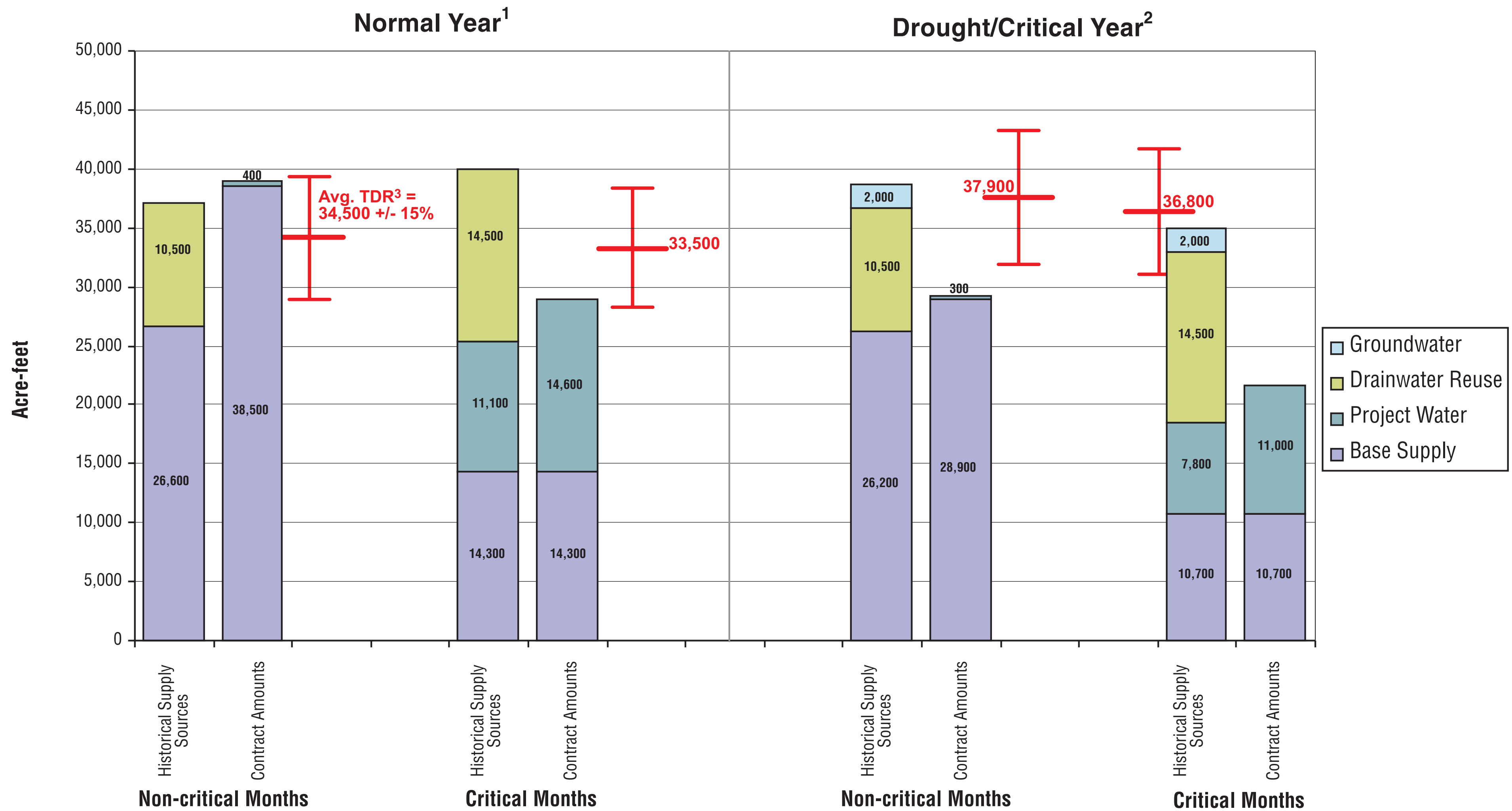
For non-critical months of drought years, PCGID has supplied its TDR of approximately 37,900 ac-ft using Base Supply as its primary source, with supplemental supply from drainwater reuse and a small amount of groundwater pumping. Approximately 68 percent (26,200 ac-ft) of the total average supply is Base Supply, 27 percent (10,500 ac-ft) is drainwater reuse, and 5 percent (2,000 ac-ft) is from groundwater. In critical months of drought/critical years, PCGID has supplied its TDR of approximately 36,800 ac-ft using a combination of drainwater reuse, Base Supply, Project Supply, and groundwater. Approximately 30 percent (10,700 ac-ft) of the total supply is Base Supply, 22 percent (7,800 ac-ft) is Project Supply, 41 percent (14,500 ac-ft) is drainwater reuse, and 6 percent (2,000 ac-ft) is from groundwater. Given the District's recent increase in Project Water use, it is expected that in future drought/critical years, PCGID will use its full Project Supply of 11,000 ac-ft, either through direct diversions or transfers.

Analysis and Ranking of Water Management Options

The tier classification of management options for PCGID is shown in Table 6-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

TABLE 6-1
PCGID Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Existing groundwater use	• Minor use now. Provides flexibility as supplemental supply.
	Drainwater reuse	• Current levels are near practical limit. Minor increases may be achieved with diversion capacity increase. • Supply dependent on upstream land use practices. Increased diversions by PCGID will reduce supply to downstream users.
	Conveyance automation	• In progress now. Future improvements planned. May provide small reduction in operational spills.
	Water measurement	• See TM 5 for PCGID. Improved measurement help with water balance accounting; small conservation savings possible.
	CVP purchases	• Currently fully used through direct diversions and transfers. • Important source for reliability and flexibility of supply. • Future cost may influence level of use.
Tier 2	Canal lining	• May provide reduction in Sacramento River diversions. Needs further study to assess leakage, potential net benefits. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.
	Increased groundwater development	• May offer benefit as drought-year supplemental supply and/or through participation in regional conjunctive water management program. • Requires further study to determine costs and impacts.
	Farm-level measurement	• Fields estimated to be near maximum practical efficiency as a result of on-farm improvements over last 10 years. • Option 1 – Use existing turnout gates, canal head measurement, and time of delivery to measure quantity. • Option 2 – measure service lateral delivery for operational sub-units composed of groups of customers (i.e., 500- to 1,000-acre block under common management). • Use measurement data to verify on-farm efficiency and target improvements as necessary.
	Quantity-based pricing	• Significant institutional issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
Tier 3	Water transfer	• Transfers of normal-year Project Water supplies to districts with salinity problems from drainwater/tailwater reuse to improve basin management.



[1] Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2] The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3] TDR based on 1995 land use.

Notes:

1. Since 1998, PID has increased use of Project Water in critical months and reduced its dependence on drainwater to improve the District's overall supply reliability. This increased use of Project Water is likely to continue in the future.
2. Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slightly from the quantities detailed on figures presented in TM 2.

W062004006RDD_07 TM 6 (10/5/04)

FIGURE 6-1
PRINCETON-CODORA-GLENN IRRIGATION DISTRICT
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Future Water Management Alternatives

Table 6-2 summarizes future water management alternatives for PCGID under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the District's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 6-2
PCGID Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drainwater	• Contract Base Supply is sufficient to meet TDR • Full Base Supply not typically used • Potential future issues are high reliance on drainwater and related impacts, possible reduction in supply if upstream field/ management or drainwater reuse pattern changes occur in GCID	Increase Base and reduce drainwater reuse proportionally	• Base is economical and reliable supply • Avoids potential salinity impacts from drainwater use	• Lose flexibility and efficiency benefits of drainwater reuse versus river diversions	• Findings of future salinity studies
Normal/Critical	Base Supply, drainwater reuse, and Project Supply	• Full Base and Project NOT sufficient to meet TDR • Potential future issues are high reliance on drainwater and related impacts, possible reduction in drainwater supply if upstream field/management or drainwater reuse pattern changes occur in GCID, and future Project costs	Increase groundwater pumping and reduce Project Water and/or drain-water reuse proportionally	• Reduces reliance on upstream drainwater supply • Potential transfers	• Cost and impacts of ground-water pumping	• Future practices in GCID service area and resultant drainwater supply • Future Project Supply costs • Findings of future salinity and groundwater studies • State/federal transfer policies
Drought/Non-critical Year	Base Supply, drainwater, and small amount of groundwater	• Contract Base Supply NOT sufficient to meet TDR • Potential future issues are high reliance on drainwater and related impacts, and possible reduction in supply if upstream field/ management or drainwater reuse pattern changes occur in GCID	Increase groundwater pumping and reduce drainwater reuse proportionally	• Reduces reliance on drainwater	• Cost and impacts of ground-water development	• Future practices in GCID service area and resultant drainwater supply • Findings of future salinity and groundwater studies
Drought/Critical Year	Base Supply, drainwater reuse, Project Supply, minor amount of groundwater	• Full Base and Project NOT sufficient to meet TDR • Potential future issues are high reliance on drainwater and potential salinity impacts, and future cost of Project Water	Increase groundwater pumping and reduce drainwater reuse or Project Supply proportionally	• Reduces reliance on upstream drainwater supply • Potential transfers	• Cost and impacts of ground-water development	• Future practices in GCID service area and resultant drainwater supply • Future Project Supply costs • Findings of future salinity and groundwater studies • State/federal transfer policies

SECTION 7

Maxwell Irrigation District

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Maxwell Irrigation District (MID or District) are shown on Figure 7-1, for the period from 1985 through 1997, for normal and drought/critical years. The data on Figure 7-1 do not reflect recent changes in supply patterns since 1995, which are discussed below. In normal years, MID has used drainwater recapture from internal drains and diversions from regional drains, such as the Colusa Basin Drain, as its primary water source in both critical and non-critical months to meet its TDR. Supplemental supplies have included Base Supply in non-critical months, and a combination of Base and Project Supplies in critical months. In drought/critical years, reduced Base and Project Supply has been supplemented with increased drainwater reuse. See TM 5 for more information on MID's current water management practices such as system automation, water measurement, and drainwater reuse.

Prior to 1995, MID was unable to regularly use its Sacramento River pump station diversion to use its Base and Project Supplies because of sediment buildup in the slough where the pump intake was located. This condition was mitigated by heavy use of drainwater from upstream areas. The District built a new pump station directly on the river in 1995, allowing increased utilization of its Sacramento River supplies. The District has since reduced its diversions from the regional drains, freeing up these supplies for downstream drain users in the Colusa Basin area. See TM 3 for details on the historical pattern of GCID's Sacramento River diversions.

In the non-critical months of a normal year, MID has supplied its TDR of approximately 16,400 ac-ft using drainwater reuse as the primary water source, and supplemental supply from Base Supply. Approximately 76 percent (12,500 ac-ft) of the total average supply has been drainwater reuse, and the remaining 24 percent (3,900 ac-ft) has been from Base Supply. The District's Base Supply for non-critical months is 11,000 ac-ft, which is not adequate to meet TDR. Historically, MID has used drainwater to offset a portion of its Base Supply use to improve farm-level efficiency, overall conveyance system efficiency, and operational flexibility. Use of Base Supply for this period has increased to an average of 9,300 ac-ft, based on the 1998 and 1999 irrigation seasons, with a corresponding decrease in drainwater reuse.

In critical months of normal years, MID has supplied its TDR of approximately 15,500 ac-ft using drainwater reuse as the primary water source, and supplemental supply from Base and Project Supply. Approximately 85 percent (13,100 ac-ft) of the total average supply comes from drainwater reuse, 6 percent (1,000 ac-ft) comes from Base Supply, and 9 percent (1,400 ac-ft) comes from Project Supply. The District has typically not used its full Base and Project Supplies in this period, using drainwater to offset those sources and to increase overall District efficiency and operating flexibility. Use of Base and Project Supply for this period has increased to an average of 960 ac-ft and 4,700 ac-ft, respectively, based on the 1998 and 1999 irrigation seasons, with a corresponding decrease in drainwater reuse.

In the non-critical months of a drought/critical year, MID has supplied its TDR of approximately 18,000 ac-ft using drainwater reuse as the primary water source, and supplemental supply from Base Supply. Approximately 73 percent (13,100 ac-ft) of the total average supply has been drainwater reuse, and the remaining 27 percent (4,900 ac-ft) has been from Base Supply. The District's Base Supply for non-critical months is 8,300 ac-ft, which is not adequate to meet TDR. Historically, MID has used drainwater to offset a portion of its Base Supply use to improve farm-level efficiency, overall conveyance system efficiency, and operational flexibility. Based on the changes in supply patterns since 1995, with increased use of Base and Project Supplies, it is anticipated that, in the future, MID will more fully use its Base Supply and decrease its use of drainwater, freeing up the drainwater supply for downstream users in the Colusa Basin Drain area that rely on this supply.

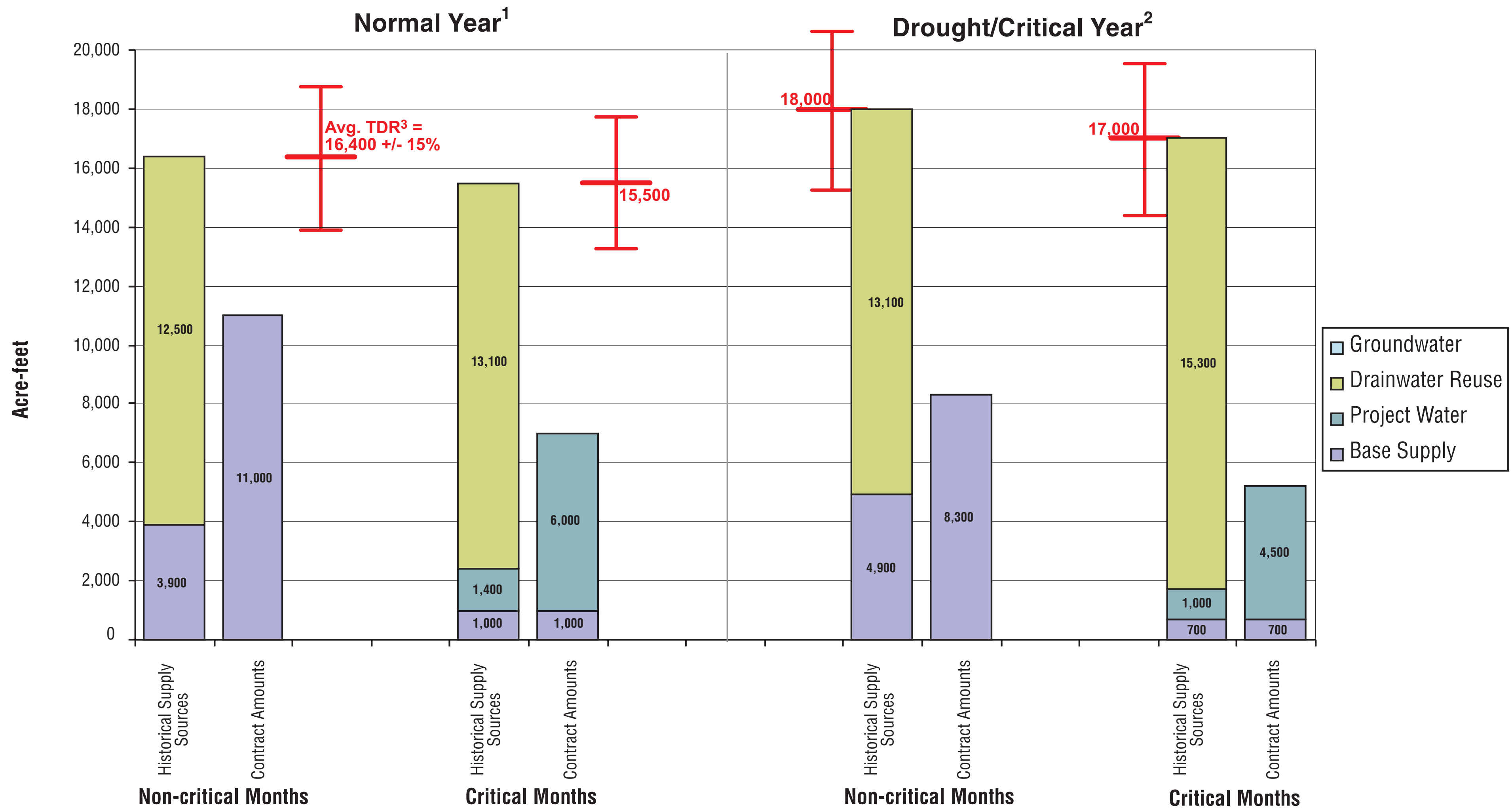
In critical months of drought/critical years, MID has supplied its TDR of approximately 17,000 ac-ft using drainwater reuse as the primary water source, and supplemental supply from Base and Project Supply. Approximately 90 percent (15,300 ac-ft) of the total average supply comes from drainwater reuse, 4 percent (700 ac-ft) comes from Base Supply, and 6 percent (1,000 ac-ft) comes from Project Supply. The District has typically used its full Base and a portion of its Project Supply in this period. Based on the change in supply patterns since 1995, it is anticipated that, in the future, MID will continue to use its full Base and increase its use of Project Supply, with a corresponding decrease in drainwater use. Again, this would free up the drainwater supply for downstream users that do not have ready alternative sources of water.

Analysis and Ranking of Water Management Options

The tier classification of management options for MID is shown in Table 7-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

Future Water Management Alternatives

Table 7-2 summarizes future water management alternatives for MID under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the District's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a



[1]Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2]The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3]TDR based on 1995 land use.

Notes:
1. Prior to 1995, MID river diversions were reduced because of pump station problems. This led to a heavy reliance on drainwater. A new pump station, brought online in 1995, has allowed MID to resume river diversions, a practice that will likely continue in the future.
2. Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

W062004006RDD_08 TM 6 (10/5/04)

FIGURE 7-1
MAXWELL IRRIGATION DISTRICT
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 7-1
MID Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Current drainwater reuse	• Extensive drainwater reuse now, at practical maximum. • Significant increases in drainwater reuse are not feasible due to supply impacts to downstream drainwater divertors. • Salinity impacts noted in some cases from past high use.
	Conveyance automation	• See TM 5 for potential conveyance automation improvements. May provide minor conservation savings. • May pursue cooperative study and funding effort with Reclamation for implementing improvements.
	Water measurement	• See TM 5 for supply and distribution measurement improvements. May provide minor conservation savings, and will improve water balance accounting.
	Water transfers	• District has been supplier in past transfers in 1991 and 1992 through State Drought Water Bank and SRWCA. • May be opportunity for participation in future transfers to improve regional water supply flexibility.
	CVP purchases	• Project Supplies historically used. Important source for reliability and flexibility of supply. • Increased costs may influence quantity of use. • May help in long-term salinity management by managing mixture of water use over long term.
Tier 2	Groundwater development	• Significant potential drought/critical-year supplemental supply. • Consider as part of regional conjunctive water management program. • Significant capital investment and O&M costs. • Sustainable groundwater yield unknown; requires further investigation to verify development goals.
	Farm-level measurement	• Option 1 – Use existing turnout gates, canal head measurement, and time of delivery to measure quantity. • Option 2 – Measure service lateral delivery for operational subunits composed of groups of customers (i.e., 500-acre blocks of users). • Use measurement data to verify on-farm efficiency and target farm-level improvements as necessary.
	Quantity-based pricing	• Significant institutional issues in changing rate structure. • Remaining practical margin of conservation may be achievable with other methods such as grower training and information programs.
Tier 3	Canal lining	• Uneconomic unit cost of “conserved” water. Leakage is recoverable in toe drains, groundwater. No net benefits. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.

TABLE 7-2
MID Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drainwater reuse	• Contract Base Supply is NOT sufficient to meet TDR • Drainwater use at practical upper limit • Potential future issues include high reliance on drainwater and potential related salinity impacts and impacts to drainwater supply from changes in upstream land use or management practices • Existing practices have no critical problems	Increase Base Supply use and reduce drainwater reuse proportionally	• Base is economical and reliable supply • Avoids potential salinity impacts from drainwater use • Increases drainwater supply to downstream users in Colusa Basin Drain	• Lose flexibility and efficiency benefits of drainwater reuse versus river diversions	• Findings of future salinity studies • Overall operations costs of drainwater versus Base Water diversions
Normal/Critical	Drainwater and Base and Project Supplies	• Contract Base and Project Supplies are NOT sufficient to meet TDR • Drainwater use maximized in past • Potential future issues include high reliance on drainwater, potential related salinity impacts, and future cost of Project Supply • Existing practices have no critical problems	Develop new groundwater pumping and reduce Project Water or drainwater reuse proportionally	• Reduces reliance on drainwater • New reliable supply	• Costs of new groundwater development • Impacts on other users	• Future practices in upstream service areas and resultant impacts on drainwater supply • Future Project Supply costs • Findings of future salinity and groundwater studies • State/federal transfer policies
			Increase Project Supply to full contract quantity and reduce drainwater use proportionally (similar to recent practices since 1995)	• Reduces reliance on upstream drainwater	• Future cost increase for Project Supply • More restrictive cut-back criteria	• Future practices in upstream service areas and resultant impacts on drainwater supply • Future Project Supply costs • Findings of future salinity studies
Drought/Non-critical Year	Base Supply and drainwater reuse	• Contract Base Supply is NOT sufficient to meet TDR • Drainwater use at practical upper limit • Potential future issues include high reliance on drainwater and potential related salinity impacts and impacts to drainwater supply from changes in upstream land use or management practices • Existing practices have no critical problems	Increase Base Supply use and reduce drainwater reuse proportionally	• Base is economical and reliable supply • Avoids potential salinity impacts from drainwater use • Increases drainwater supply to downstream users in Colusa Basin Drain	• Lose flexibility and efficiency benefits of drainwater reuse versus river diversions	• Findings of future salinity studies • Overall operations costs of drainwater versus Base Water diversions
Drought/Critical Year	Drainwater and Base and Project Supplies	• Contract Base and Project Supplies are NOT sufficient to meet TDR • Drainwater use maximized in past • Potential future issues include high reliance on drainwater, potential related salinity impacts, and future cost of Project Supply • Existing practices have no critical problems	Develop groundwater and reduce Project Water or drainwater reuse proportionally	• Reduces reliance on upstream drainwater • Reliable drought-year supply • Potential transfers	• Costs and impacts of new groundwater development	• Future practices in upstream service areas and resultant impacts on drainwater supply • Future Project Supply costs • Findings of future salinity and groundwater studies • State/federal transfer policies
			Increase Project Supply to full contract quantity (75 percent of total) and reduce drainwater use proportionally	• Reduces reliance on drainwater	• Future cost increase for Project Supply	• Future practices in upstream service areas and resultant impacts on drainwater supply • Future Project Supply costs • Findings of future salinity studies

SECTION 8

Reclamation District No. 108

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Reclamation District No. 108 (RD 108 or District) are shown on Figure 8-1, for the period from 1985 through 1997, for normal and critical/drought years. Each of the four major analysis periods shown is discussed in detail below. In normal years, RD 108 has used Base Supply as its primary water source in both critical and non-critical months, and supplemented this supply with drainwater use and minor use of Project Water in critical months. In drought/critical years, Base Supply has been supplemented with drainwater, increased use of Project Supply, and a minor amount of groundwater pumping by District-owned and landowner wells. See TM 5 for more information on RD 108's current water management practices such as system automation, water measurement, and drainwater reuse.

Recent changes in RD 108's supply management practices are not reflected on Figure 8-1. Beginning in 1998, RD 108 reduced its use of drainwater to address concerns with salinity impacts on crop yields and has increased its use of Base and Project Supplies. In 1998, Base Supply use in non-critical months was 44,700 ac-ft, and Base and Project Supply use in critical months was 64,000 and 17,700 ac-ft, respectively. In 1999, Base Supply use in non-critical months was 85,200 ac-ft, and Base and Project Supply use in critical months was 64,000 ac-ft and 36,000 ac-ft, respectively. Drainwater reuse averaged 10,000 ac-ft and 7,000 ac-ft for 1998 and 1999, respectively. Although it is too early to assess the yield impacts of the reduction in drainwater reuse, yields from lands within the southern area of the District that were impacted by the drainwater quality are expected to recover over time. Drainwater reuse is expected to continue to be an important part of RD 108's supply mix. However, the supply patterns from 1998 and 1999, with increased use of Base and Project Supplies and reduced drainwater use, are expected to be more typical of future practices. See TM 3 for details on the historical pattern of RD 108's Sacramento River diversions.

In the non-critical months of a normal year, RD 108 has supplied its TDR of approximately 113,100 ac-ft using Base Supply as the primary water source, with supplemental supply from drainwater reuse and a minor amount of landowner groundwater and drainwater reuse. Approximately 64 percent (62,000 ac-ft) of the total average supply is Base Supply; 33 percent (31,000 ac-ft) is from drainwater reuse; and the remaining 3 percent (3,600 ac-ft) is from landowner groundwater wells. The District's Base Supply for non-critical months is 135,000 ac-ft, which is adequate to meet the its TDR. However, RD 108 has historically used drainwater to offset a portion of its Base Supply use, primarily because of the lower operating costs and operational flexibility provided by drainwater reuse. As described above, future water supply patterns for this period are expected to be similar to the 1998 to 1999 period.

In critical months of normal years, RD 108 has supplied its TDR of approximately 100,400 ac-ft using Base Supply as the primary water source, with supplemental supply from drainwater reuse, Project Supply, and a minor amount of landowner groundwater and drainwater reuse. Historically, RD 108 has used its total Base Supply of 64,000 ac-ft, or about 66 percent of its total supply for the period. The remainder of TDR has been met with drainwater reuse (29,000 ac-ft), Project Supply (1,000 ac-ft), and landowner groundwater wells (3,200 ac-ft), resulting in a very similar pattern to that for non-critical months. As described above, future water supply patterns for this period are expected to be similar to the 1998 to 1999 period, with full Base and increased Project Supply use.

In the non-critical months of drought/critical years, RD 108 has supplied its TDR of approximately 125,000 ac-ft using Base Supply as the primary water source, with supplemental supply from drainwater reuse and a minor amount of landowner groundwater and drainwater reuse. Approximately 68 percent (79,000 ac-ft) of the total average supply is Base Supply, 27 percent (31,000 ac-ft) is from drainwater reuse, and 5 percent (6,100 ac-ft) is from groundwater pumping and landowner drainwater reuse. Based on the District's recent reduction in drainwater use, it is expected that, in the future, RD 108 will use its full Base Supply of 101,000 ac-ft, with approximately 17,000 ac-ft of drainwater and some minor quantity of groundwater pumping from landowner wells to meet TDR.

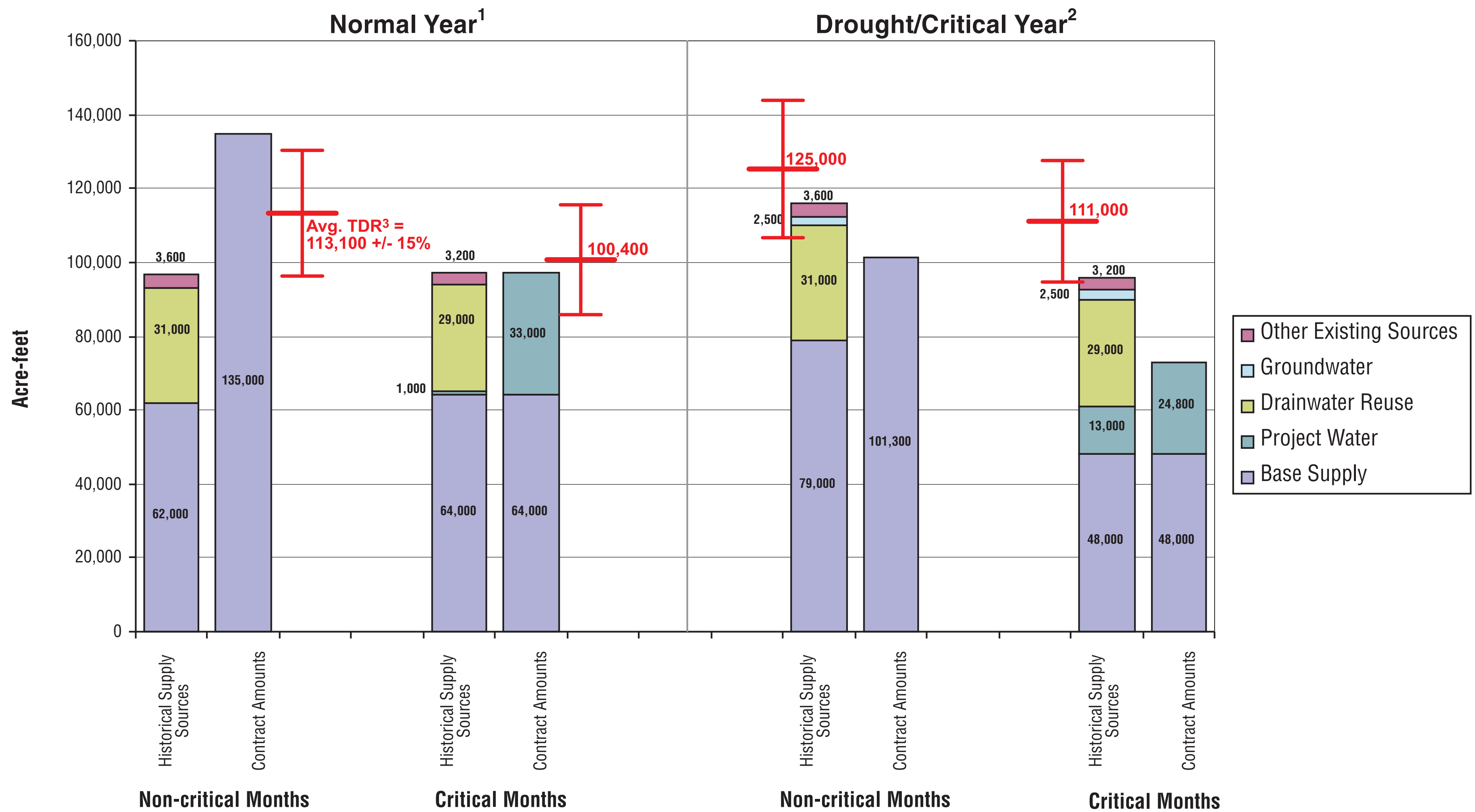
In the critical months of drought/critical years, RD 108 has supplied its TDR of approximately 111,000 ac-ft using Base Supply as the primary water source, with supplemental supply from drainwater reuse and a minor amount of landowner groundwater and drainwater reuse. Approximately 50 percent (48,000 ac-ft) of the total average supply is Base Supply, 30 percent (29,000 ac-ft) is from drainwater reuse, 14 percent (13,000 ac-ft) is from Project Supply, and 6 percent (5,700 ac-ft) is from groundwater pumping and landowner drainwater reuse. With the District's recent reduction in drainwater use, it is expected that, in the future, RD 108 will use most of its reduced drought/critical Project Supply (25,000 ac-ft), with approximately 17,000 ac-ft of drainwater and some minor quantity of groundwater pumping from landowner wells.

Analysis and Ranking of Water Management Options

The tier classification of management options for RD 108 is shown in Table 8-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

Future Water Management Alternatives

Table 8-2 summarizes future water management alternatives for RD 108 under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the District's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major



[1]Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2]The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3]TDR based on 1995 land use.

Notes:
1. Figure does not reflect recent changes in RD 108 water source use. Since 1998, RD 108 has reduced its use of drainwater and increased use of Base and Project supplies to address concerns with salinity impacts on crop yields.
2. Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

W062004006RDD_05 TM 6 (10/5/04)

FIGURE 8-1
RECLAMATION DISTRICT NO. 108
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 8-1
RD 108 Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Increased groundwater development	• Some minor use now. May be opportunity for conjunctive water management program pending findings of ongoing DWR study. • Can provide additional reliability and flexibility as supplemental source during drought/critical years.
	Current drainwater reuse	• District has maximized this action in past years to practical limit. • Salinity problems noted in portions of District. • Will continue reduced usage of drainwater. • Salinity studies may show potential for return to increased use with modified blending strategies.
	Canal lining	• Leakage problem areas are lined. • No significant benefits from further lining.
	Conveyance automation	• Extensive automation and monitoring in place. Operational spills are at practical minimum. • Minor improvements are ongoing.
	Water measurement	• Supply and distribution measurement is nearing full implementation. Some opportunities for minor improvements.
	Water transfers	• District has been supplier in past transfers through SRWCA and the State Drought Water Bank. • Project water transferred to SRWCA. Groundwater pumping used to allow transfers to the State Drought Water Bank.
	CVP purchases	• Project Supply maximized in 1998 to 1999. • Important source for reliability and flexibility of supply. • May offer option for salinity management by rotation of sources.
Tier 2	Farm-level measurement	• Option 1 – Use existing turnout gates, canal head measurement, and time of delivery to measure quantity. • Option 2 – Measure service lateral delivery for operational subunits composed of groups of customers (i.e., 500- to 1,000-acre block under common management). • Use new measurement data to verify on-farm efficiency and target improvements as necessary.
	Quantity-based pricing	• Existing rate structures charges per irrigation, which approximates quantity-based pricing. • Significant institutional issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
Tier 3	None identified	

TABLE 8-2
RD 108 Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drainwater	• Contract Base Supply is sufficient to meet TDR • Can continue Base Supply and drainwater reuse • District may need to continually revise quantity mix, as shown by recent shift to increased Base and reduced drainwater use • Existing practices have no critical problems	Increase Base and reduce drainwater reuse (in practice since 1998)	• Base is economical and reliable supply • Avoids potential salinity impacts from drainwater use	• Lose flexibility and efficiency benefits of drainwater reuse	• Findings of future salinity studies
			Return to increased drainwater use and reduce Base Supply (pre-1998)	• Improved efficiency • Potential transfers	• Potential salinity impacts • Water rights protection	• Findings of future salinity studies • Future state/federal transfer policy
Normal/Critical	Base Supply, drainwater reuse, Project Supply, and minor groundwater	• Base and Project are sufficient to meet TDR • Potential future issues are drainwater salinity impacts, Project Supply costs, and that the District may need to continually revise quantity mix, as shown by recent shift to increased Project Supply and reduced drainwater use • Existing practices have no critical problems	Maximize Base and Project Supply, minimize drain reuse (In practice since 1998)	• Avoids salinity impacts from drainwater use	• Lose flexibility and efficiency benefits of drainwater reuse	• Findings of future salinity studies • Overall operations costs of drainwater versus Project Water costs (both contract rate and operations costs of pumping from Sacramento River)
			Increase drainwater use (closer to pre-1998 levels) and groundwater pumping, reduce Project Supply use	• Potentially improved efficiency • Potential transfers	• Potential salinity impacts • Groundwater impacts • Increased operating costs	• Findings of future salinity studies • Future Project Water costs • Transfer policy • Findings of DWR conjunctive water management study
Drought/Non-critical Year	Base Supply, drainwater, and minor groundwater	• 75 percent of Base Supply NOT sufficient to meet TDR, but can meet 80 percent of TDR • Potential future issues are level of reliance on drainwater and related salinity impacts	Increase Base Supply use to full cutback quantity (101,000 ac-ft), supplement with drainwater use (at lower than historical levels)	• Base is economical and reliable supply • Avoids potential salinity impacts from drainwater use	• Lose flexibility and efficiency benefits of drainwater reuse	• Findings of future salinity studies, overall operations costs of drainwater versus Base Water diversions
			Increase Base Supply use to full cutback quantity (101,000 ac-ft), supplement with new groundwater pumping and reduced drainwater reuse	• Base is economic and reliable supply • Avoids potential salinity impacts from drainwater use	• Cost (increased river diversions and groundwater pumping versus drain reuse)	• Findings of future salinity studies • Findings of DWR conjunctive water management study • State/federal transfer policy
			Maintain Base use at historical level (76,000 ac-ft), new groundwater pumping and reduced drainwater reuse	• Avoids potential salinity impacts from drainwater use	• Cost and impacts of groundwater pumping • Water rights protection	• Findings of future salinity studies • Findings of DWR conjunctive water management study • State/federal transfer policy
Drought/Critical Year	Base Supply, drainwater reuse, Project Supply, and groundwater	• Full Base and Project are NOT sufficient to meet TDR • Full Project Supply (at 25 percent cutback) has not been typically used • Potential future issues are cost of Project Water and drainwater salinity impacts	Use full Project Supply and reduce drainwater reuse proportionally	• Reduces/prevents salinity impacts	• Increased cost of Project Supply versus drainwater reuse	• Findings of future salinity studies • Future Project Supply costs
			Use new groundwater development to reduce drainwater reuse or Project Supply use	• Reduces/prevents salinity impacts from drainwater use • Frees up Project Water for beneficial transfer • Potential cost savings over future Project Supply costs	• Cost and impacts of groundwater pumping	• Findings of future salinity studies • DWR conjunctive water management study findings • State/federal transfer policies

SECTION 9

Reclamation District No. 1004

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Reclamation District No. 1004 (RD 1004 or District) are shown on Figure 9-1, for the period 1985 through 1997, for critical and non-critical months, under normal and drought/critical year conditions. Each of the four major analysis periods shown is discussed in detail below. In normal years, RD 1004 has used a combination of Base Supply drainwater reuse and diversions from Butte Creek during non-critical months. During critical months, the District has supplemented these sources with Project Supplies. In drought/critical years, the supply mix has been similar to normal years, with reduced Butte Creek diversions and groundwater pumping by private wells to offset reductions in Base and Project Supplies. See TM 5 for more information on RD 1004's current water management practices such as system automation, water measurement, and drainwater reuse. See TM 3 for details on RD 1004's historical Sacramento River Base and Project diversions.

In the non-critical months of a normal year, RD 1004 has supplied its TDR of approximately 45,100 ac-ft using Base Supply as the primary water source, and supplemental supply from Butte Creek diversions and drainwater reuse. Approximately 67 percent (34,000 ac-ft) of the total average supply is Base Supply, 17 percent (8,500 ac-ft) is from Butte Creek diversions, and the remaining 16 percent (8,000 ac-ft) is from drainwater reuse.

In critical months of normal years, RD 1004 has supplied its TDR of approximately 48,400 ac-ft using Base Supply, Butte Creek diversions, drainwater reuse, and Project Supply. Approximately 38 percent (17,900 ac-ft) of the total average supply comes from Base Supply, 18 percent (8,700 ac-ft) comes from Project Supply, 25 percent (12,000 ac-ft) comes from drainwater reuse, and 18 percent (8,500 ac-ft) comes from Butte Creek diversions.

In the non-critical months of drought/critical years, RD 1004 has supplied its TDR of approximately 49,300 ac-ft using Base Supply as its primary water source, and supplemental supply from drainwater reuse, Butte Creek diversions, and private groundwater wells. Approximately 71 percent (31,500 ac-ft) of the total average supply is Base Supply, 18 percent (8,000 ac-ft) is from drainwater reuse, and 11 percent (5,000 ac-ft) is from Butte Creek diversions (1,500 ac-ft) and groundwater pumping (3,500 ac-ft).

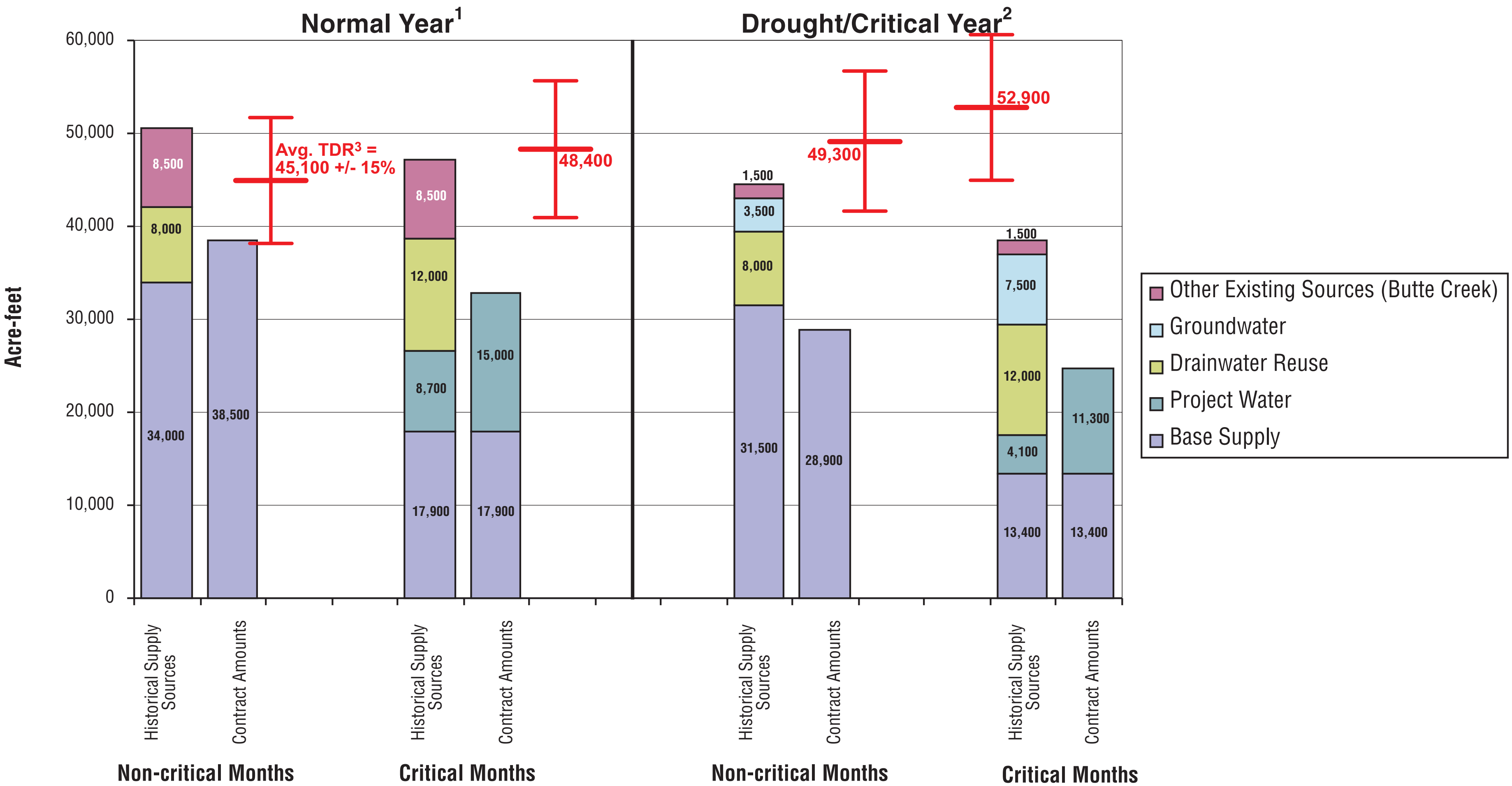
In the critical months of drought/critical years, RD 1004 has supplied its TDR of approximately 52,900 ac-ft using Base Supply, drainwater reuse, Project Supply, Butte Creek diversions, and private groundwater pumping. Approximately 35 percent (13,400 ac-ft) of the total average supply is Base Supply, 31 percent (12,000 ac-ft) is from drainwater reuse, 11 percent (4,100 ac-ft) is from Project Supply, and 23 percent (9,000 ac-ft) is from private groundwater pumping (7,500 ac-ft) and Butte Creek diversions (1,500 ac-ft).

Analysis and Ranking of Water Management Options

The tier classification of management options for RD 1004 is shown in Table 9-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

TABLE 9-1
RD 1004 Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Current groundwater use	• Has provided drought/critical-year source. • Provides operational and supply flexibility. • Done entirely using private wells only. District policy to not own/operate wells.
	Current drainwater reuse	• Extensive reuse now at practical limit. District topography and distribution system function as "bathtub," with almost 100 percent recapture of drainwater supplies.
	Conveyance automation	• Range of facility automation in place now. Improvements and changes made year to year. • Operational spills are at practical minimum.
	Water measurement	• Complete operations water measurement program in place now. Minor improvements being made on a regular basis.
	Farm-level measurement	• District deliveries are metered using propeller meters. Rate and quantity measured, used in pricing.
	Quantity-based pricing	• Quantity-based price structure in place now ($/ac-ft), with target duties and rebate incentives to customers.
	Water transfers	• District has been supplier in past transfers through the State Drought Water Bank and SRWCA Project Water Pool (Pool). • Will continue to use as cooperative regional management tool. • Future transfers may depend on ability to coordinate a cooperative groundwater program with private well owners.
	CVP purchases	• Full Project Supplies not historically used. Important source for reliability and flexibility of supply. • Increased costs may influence quantity of use.
Tier 2	Increased ground-water pumping	• Significant potential drought/critical-year supplemental supply. • Consider as part of regional conjunctive water management program. • Significant capital investment and O&M costs. • Sustainable groundwater yield unknown, requires further investigation to verify development goals. • Would require change in District policy, coordination with private well owners.
	Canal lining	• Main Canal supply partially in pipeline, and canal lined through high-loss area by Sacramento River. • Remaining system has uneconomic unit cost of "conserved" water. Leakage is recoverable in drains, groundwater. No net conservation benefits. District may undertake further lining for O&M reasons, in limited areas. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.
Tier 3	None identified	



[1] Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2] The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3] TDR based on 1995 land use.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 9-1
RECLAMATION DISTRICT NO. 1004
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Future Water Management Alternatives

Table 9-2 summarizes future water management alternatives for RD 1004 under each of the four major analysis periods: normal years – critical and non-critical months; and drought/ critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the District's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 9-2
RD 1004 Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply, drainwater reuse, and Butte Creek	• Contract Base Supply is NOT sufficient to meet TDR • Potential future issues include future developments along lower Butte Creek that might impact diversion capability, such as ESA listings • Existing practices have no critical problems	Increase Base Supply to full contract amount, with corresponding reduction in drainwater or Butte Creek diversions	• Base is economical and reliable supply • Minimizes potential drainwater reuse impacts	• Lose flexibility and efficiency benefits of drainwater reuse • Some areas in District might need new conveyance facilities to replace drainwater supply	• Findings of future salinity studies • Overall operations costs of drainwater versus Base Supply diversions • Future developments affecting Butte Creek water management
			Develop normal-year groundwater supply, with equivalent reduction in drainwater use or Butte Creek diversions	• Reliable water supply • Minimizes potential drainwater reuse impacts • Potential transfers	• Cost and impacts to groundwater basin from increased pumping	• Findings of future salinity studies • Findings of future groundwater investigations • Overall operations costs of groundwater supply • Future developments affecting Butte Creek water management • State/federal transfer policies • Ability to develop cooperative groundwater supply plan with private landowners or revise District policy on groundwater development
Normal/Critical	Base Supply, Project Supply, drainwater reuse, and Butte Creek	• Contract Base Supply is NOT sufficient to meet TDR • Potential future issues include future developments along lower Butte Creek that might impact diversion capability (such as ESA listings), and future cost of Project Supply • Existing practices have no critical problems	Increase Project Supply to full contract amount, with corresponding reduction in drainwater or Butte Creek diversions	• Reliable supply • Minimizes potential drainwater reuse impacts • Potential transfers	• Lose flexibility and efficiency benefits of drainwater reuse • Water rights protection • Some areas in District might need new conveyance facilities to replace Butte Creek or drainwater supply • Higher cost of Project Supply	• Findings of future salinity studies • Overall operations costs of drainwater versus Project Supply diversions • Future developments affecting Butte Creek water management • State/federal transfer policies
			Develop normal-year groundwater supply, with equivalent reduction in drainwater use, Butte Creek diversions, or Project Supply	• Reliable supply • Minimizes potential drainwater reuse impacts • Potential transfers	• Cost and impacts to groundwater basin from increased pumping	• Findings of future salinity studies • Findings of future groundwater investigations • Overall operations costs of groundwater supply • Future developments affecting Butte Creek water management • Ability to develop cooperative groundwater supply plan with private landowners or revise District policy on groundwater development • State/federal policies in transfers
Drought/Non-critical Year	Base Supply, drainwater reuse, Butte Creek, and private groundwater pumping	• Contract Base Supply is NOT sufficient to meet TDR • Potential future issues include future developments along lower Butte Creek that might impact diversion capability, such as ESA listings • Existing practices have no critical problems	Develop increased drought/critical-year groundwater supply, with equivalent reduction in drainwater use or Butte Creek diversions	• Reliable drought/critical-year water supply • Minimizes potential drainwater reuse impacts	• Cost and impacts to groundwater basin from increased pumping	• Findings of future salinity studies • Findings of future groundwater investigations (yield, level Impacts) • Overall operations costs of groundwater supply

TABLE 9-2
RD 1004 Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
						• Future developments affecting Butte Creek water management • State/federal transfer policies • ability to develop cooperative groundwater supply plan with private landowners or revise District policy on groundwater development
Drought/Critical Year	Base Supply, Project Supply, drainwater reuse, private groundwater pumping, and Butte Creek	• Contract Base and Project Supplies are NOT sufficient to meet TDR • Potential future issues include future developments along lower Butte Creek that might impact diversion capability (such as ESA listings), future cost of Project Supply, and level and yield impacts of uncoordinated groundwater pumping • Existing practices have no critical problems	Increase Project Supply to full contract amount, with corresponding reduction in drainwater or Butte Creek diversions	• Reliable supply • Minimizes potential drainwater reuse impacts • Potential transfers	• Lose flexibility and efficiency benefits of drainwater reuse • Some areas in District might need new conveyance facilities to replace Butte Creek or drainwater supply • Higher cost of Project Supply	• Findings of future salinity studies • Overall operations costs of drainwater versus Project Supply • Future developments affecting Butte Creek water management • State/federal transfer policies
			Develop increased drought/critical-year groundwater supply, with equivalent reduction in drainwater use or Butte Creek diversions or Project Supply	• Reliable water supply • Minimizes potential drainwater reuse impacts • Potential transfers	• Cost and impacts to groundwater basin from increased pumping	• Findings of future salinity studies • Findings of future groundwater investigations • Overall operations costs of groundwater supply • Future developments affecting Butte Creek water management • Ability to develop cooperative groundwater supply plan with private landowners or revise District policy on groundwater development • State/federal transfer policies

SECTION 10

Meridian Farms Water Company

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Meridian Farms Water Company (MFWC or Company) are shown on Figure 10-1, for the period 1985 through 1997, for normal and critical/drought years. Each of the four major analysis periods shown is discussed in detail below. In normal years, MFWC has used Base Supply as its primary water source in non-critical months, with supplemental drainwater reuse. critical-month supplies have included roughly equal quantities of Base, Project, and drainwater reuse, with a small amount of groundwater pumping. The drought/critical year supply mix has been approximately the same, with increased drainwater and groundwater use to make up for cutbacks in Base and Project Supply. See TM 5 for more information on MFWC's current water management practices such as water measurement and drainwater reuse. See TM 3 for details on MFWC's historical Sacramento River Base and Project diversions.

In the non-critical months of a normal year, MFWC has supplied its TDR of approximately 23,500 ac-ft using Base Supply as the primary water source, and supplemental supply from drainwater reuse. Approximately 62 percent (11,600 ac-ft) of the total average supply is Base Supply, and the remaining 38 percent (7,200 ac-ft) is from drainwater reuse. The Company's Base Supply for non-critical months is 16,500 ac-ft, which is nearly adequate to meet TDR. However, MFWC has historically used drainwater to offset a portion of its Base Supply use to improve farm-level efficiency, overall conveyance system efficiency, and operational flexibility.

In critical months of normal years, MFWC has supplied its TDR of approximately 22,200 ac-ft using roughly equal amounts of Base Supply, Project Supply, and drainwater reuse, with a small amount of groundwater pumping. Approximately 31 percent (6,500 ac-ft) of the total average supply comes from use of the full Base Supply, 26 percent (5,500 ac-ft of a 12,000-ac-ft contract supply) comes from Project Supply, 38 percent (7,800 ac-ft) comes from drainwater reuse, and 5 percent (1,000 ac-ft) comes from groundwater pumping.

In the non-critical months of drought/critical years, MFWC has supplied its TDR of approximately 25,300 ac-ft using Base Supply as its primary water source, and supplemental supply from drainwater reuse. Approximately 62 percent (11,900 ac-ft of a 12,400-ac-ft contract quantity) of the total average supply is Base Supply, and 38 percent (7,200 ac-ft) is from drainwater reuse.

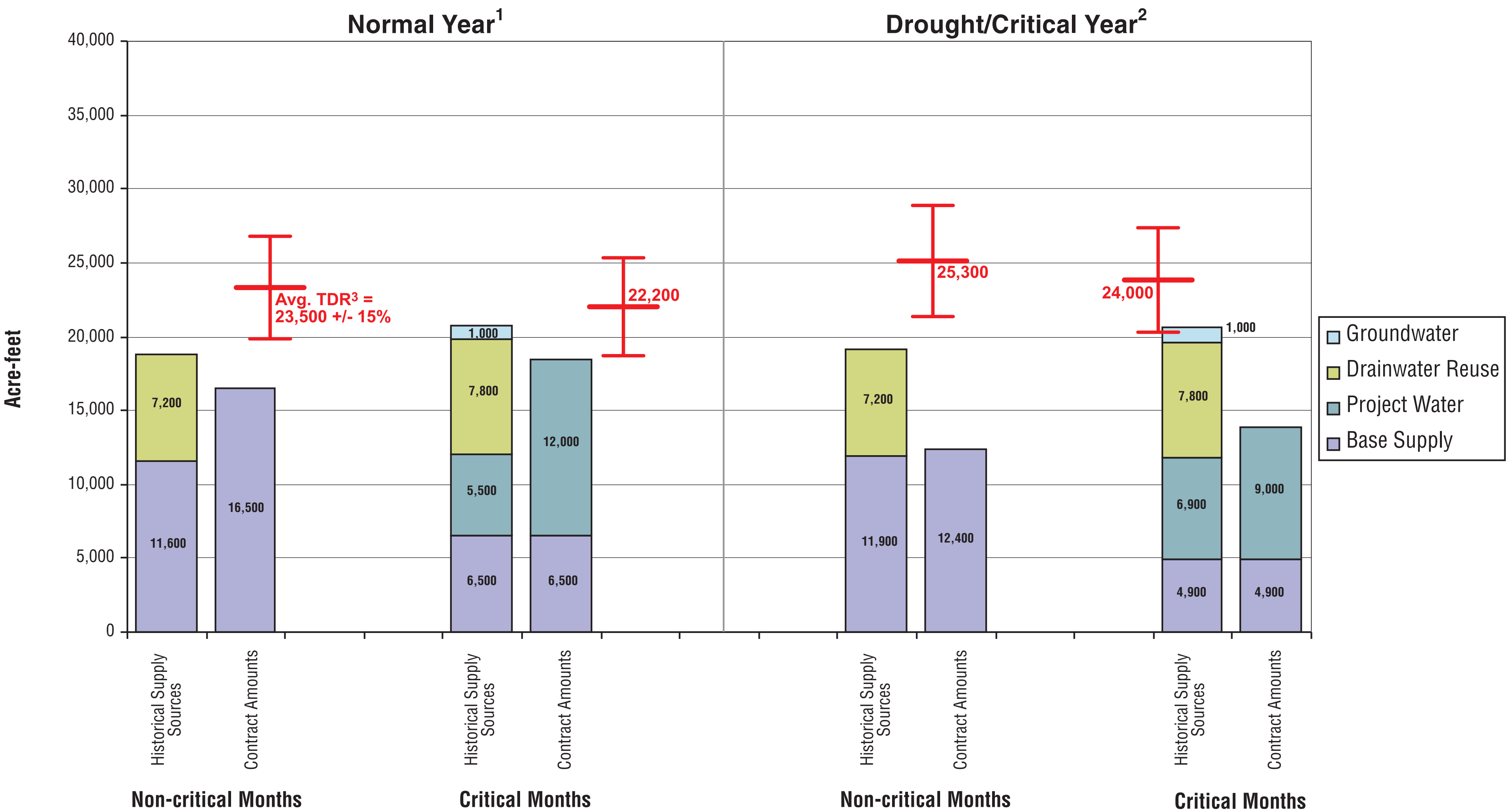
In the critical months of drought/critical years, MFWC has supplied its TDR of approximately 24,000 ac-ft using drainwater reuse, Project and Base Supply, and groundwater pumping. Approximately 38 percent (7,800 ac-ft) of the total average supply is from drainwater reuse, 33 percent (6,900 ac-ft) is from Project Supply, 24 percent (4,900 ac-ft) is from Base Supply, and 5 percent (1,000 ac-ft) is from groundwater pumping.

Analysis and Ranking of Water Management Options

The tier classification of management options for MFWC is shown in Table 10-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

TABLE 10-1
MFWC Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Current groundwater use	• Used now in both normal and drought/critical-year source. • Provides operational and supply flexibility.
	Current drainwater reuse	• Extensive reuse now, at practical limit of supply. Company topography and distribution system function as "bathtub," with almost 100 percent recapture of drainwater supplies. • Very minor increase possible with increased drainwater pumping capacity. See TM 5.
	Conveyance automation	• See potential improvements in TM 5. Minor conservation savings due to minimal existing operations spills.
	Water measurement	• See potential improvements in TM 5. Will improve water accounting, minor conservation savings.
	Water transfers	• Company has been both supplier and receiver in SRWCA pool.
	CVP purchases	• Important source for reliability and flexibility of supply. • Increased costs may influence quantity of use.
Tier 2	Increase groundwater pumping	• Potential drought/critical-year supplemental supply. • May consider as part of regional conjunctive water management program. • Significant capital investment and O&M costs. • Sustainable groundwater yield unknown, requires further investigation to verify development goals.
	Farm-level measurement	• Use existing turnout gates, canal head measurement, and time of delivery to measure quantity. • Consider measuring for blocks of users along single laterals. • Can use new measurement data to verify on-farm efficiency and target improvements as necessary.
	Quantity-based pricing	• Significant institutional issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
	Canal lining	• Uneconomic unit cost of "conserved" water. Leakage is recoverable in toe drains, groundwater. No net benefits. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.
Tier 3	None identified	



[1]Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2]The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3]TDR based on 1995 land use.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 10-1
MERIDIAN FARMS WATER COMPANY
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Future Water Management Alternatives

Table 10-2 summarizes future water management alternatives for MFWC under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the Company's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 10-2
MFWC Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drainwater reuse	• Contract Base Supply is sufficient to meet TDR • Potential future issues include high reliance on drainwater and potential related salinity impacts • Existing practices have no critical problems	Increase Base and reduce drainwater reuse	• Base is economical and reliable supply • Reduce potential salinity impacts	• Lose flexibility and efficiency benefits of drainwater reuse • Need distribution system improvements to reach drain-served lands	• Findings of future salinity studies
Normal/Critical	Base Supply, Project Supply, drainwater reuse, and groundwater	• Contract Base and Project Supplies are sufficient to meet TDR • Base fully used, but Project typically not fully used • Potential future issues include high reliance on drainwater and potential related salinity impacts • Existing practices have no critical problems	Increase Project Water use, up to full contract amount, with corresponding decrease in drainwater reuse	• Reliable water supply • Minimizes potential salinity impacts	• Future increases in Project costs	• Future Project Supply costs • State/federal transfer policies • Findings of future salinity studies
			Increase groundwater use with pro-portional reductions in drainwater or Project Supply	• Reduces salinity impacts • Potential transfer	• Cost and impacts of groundwater pumping	• Future state/federal transfer policy • Findings of future salinity studies • Findings of future groundwater investigations
Drought/Non-critical Year	Base Supply and drainwater reuse	• Contract Base Supply is NOT sufficient to meet TDR • Potential future issues include high reliance on drainwater and potential related salinity impacts • Existing practices have no critical problems	Increase groundwater with corres-ponding reduction in drainwater reuse	• Reliable water supply • Reduce potential salinity impacts	• Lose flexibility and efficiency benefits of drainwater reuse • Need distribution system improvements to reach drain-served lands • Cost and impacts of increased groundwater pumping	• Findings of future salinity studies • Findings of future groundwater investigations
Drought/Critical Year	Base Supply, Project Supply, drainwater reuse, and groundwater	• Contract Base and Project Supplies are NOT sufficient to meet TDR • Potential future issues include high reliance on drainwater, potential related salinity impacts, and future cost of Project Supply • Existing practices have no critical problems	Increase Project Water use up to full contract amount, with corresponding decrease in drainwater reuse	• Reliable water supply • Minimizes potential salinity impacts	• Future increases in Project Supply cost	• Future Project Supply costs • State/federal transfer policies
			Increase groundwater use with proportional reductions in drainwater or Project Supply	• Reduces potential salinity impacts • Potential transfer	• Cost and impacts of groundwater pumping	• State/federal transfer policy • Findings of future salinity studies • Findings of future groundwater investigations • Future cost of Project Supply

SECTION 11

Sutter Mutual Water Company

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Sutter Mutual Water Company (SMWC or Company) are shown on Figure 11-1, for the period 1985 through 1997, for normal and drought/critical years. Each of the four major analysis periods shown is discussed in detail below. In normal years, SMWC has used Base Supply as its primary water source in non-critical months. In critical months, SMWC has used Project Supply as its primary water source, with supplemental Base Supply and drainwater reuse. In drought/critical years, the supply source mix has been similar to normal years. See TM 5 for more information on SMWC's current water management practices such as system automation, water measurement, and drainwater reuse. See TM 3 for details on SMWC's historical Sacramento River Base and Project diversions.

In the non-critical months of a normal year, SMWC has supplied its TDR of approximately 117,400 ac-ft using Base Supply as the primary water source, and a minor supplemental supply from drainwater reuse. Approximately 92 percent (99,600 ac-ft) of the total average supply is Base Supply, and the remaining 8 percent (7,800 ac-ft) is from drainwater reuse. There is typically a minor amount (2,000 ac-ft) of drainwater pumping by landowners. The Company's Base Supply for non-critical months is 128,900 ac-ft, which is adequate to meet TDR. Historically, SMWC has used drainwater to offset a portion of its Base Supply use to improve farm-level efficiency, overall conveyance system efficiency, and operational flexibility.

In critical months of normal years, SMWC has supplied its TDR of approximately 115,300 ac-ft using Project Supply as the primary water source, and supplemental supply from Base Supply and drainwater reuse. Approximately 39 percent (44,000 ac-ft) of the total average supply comes from Base Supply, 44 percent (50,200 ac-ft) comes from Project Supply, 11 percent (12,000 ac-ft) comes from SMWC drainwater reuse, and 6 percent (8,000 ac-ft) comes from private drainwater reuse.

In the non-critical months of drought/critical years, SMWC has supplied its TDR of approximately 125,300 ac-ft using Base Supply as its primary water source, and supplemental supply from drainwater reuse. Approximately 95 percent (96,600 ac-ft) of the total average supply is Base Supply and 5 percent (5,000 ac-ft) is from drainwater reuse.

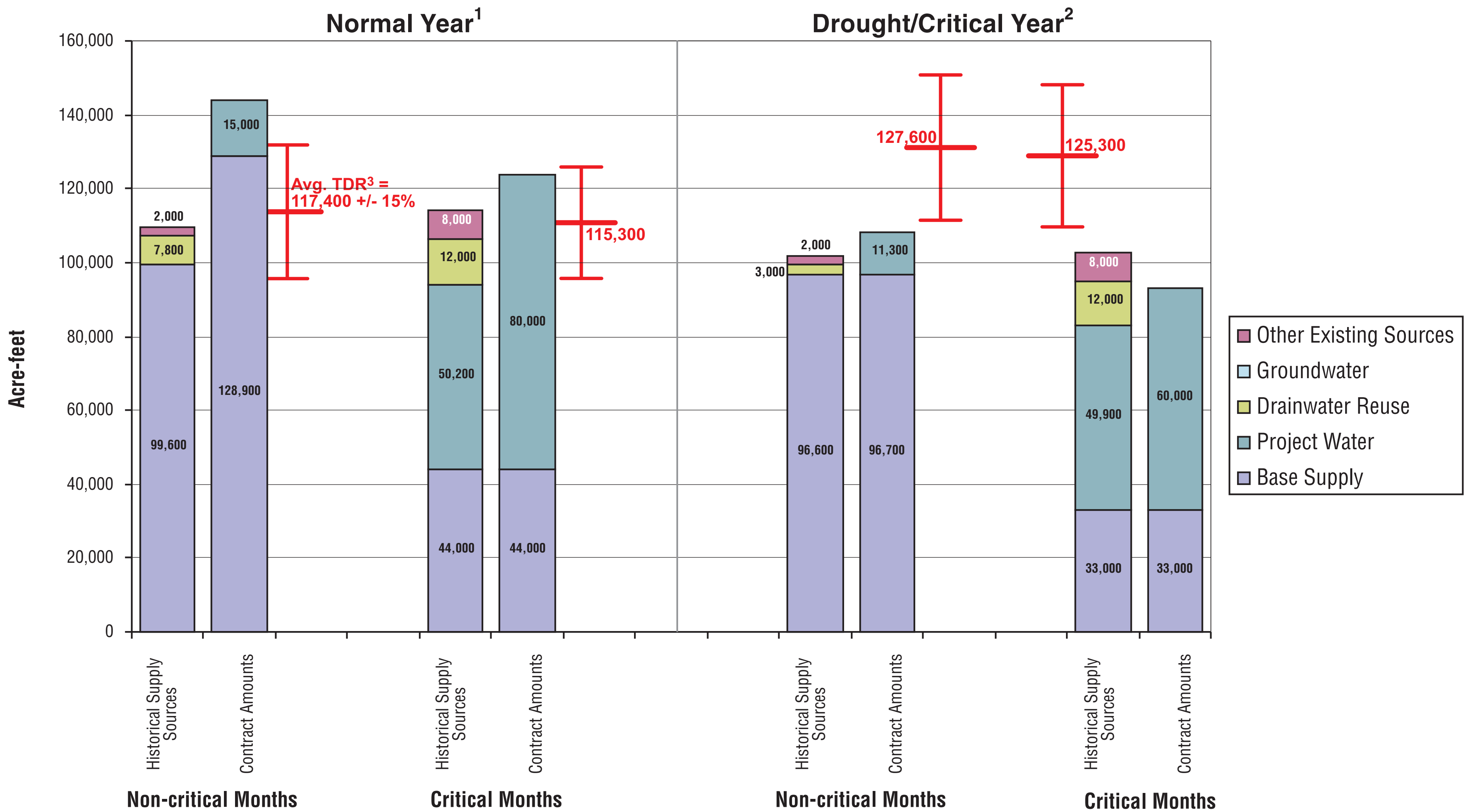
In the critical months of drought/critical years, SMWC has supplied its TDR of approximately 125,300 ac-ft using Project Supply as the primary water source, with supplemental supply from Base Supply and drainwater reuse. Approximately 32 percent (33,000 ac-ft) of the total average supply is Base Supply, 48 percent (49,900 ac-ft) is from Project Supplies, and 20 percent (20,000 ac-ft) is from drainwater reuse.

Analysis and Ranking of Water Management Options

The tier classification of management options for SMWC is shown in Table 11-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

TABLE 11-1
SMWC Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Existing drainwater reuse	• Supplemental use now. Provides supply and operations flexibility.
	Farm-level measurement	• Farm delivery measured using gate position, canal head measurement, and time of delivery to measure quantity. • Can use existing measurement data to verify on-farm efficiency and target improvements as necessary.
	Quantity-based pricing	• Company has a $ per ac-ft rate structure in place.
	Conveyance automation	• In progress, cooperative Reclamation program. Future improvements in planning stage. Will help minimize operations spills and improve conveyance efficiency.
	Water measurement	• See potential improvements list in TM 5. Some in progress now, others in planning stage. Will improve water balance accounting.
	Water transfers	• Company has been supplier in past transfers through SRWCA and direct transfers to other contractors. • Will continue to use as cooperative regional management tool.
	CVP purchases	• Portion of contract supplies historically used. Important source in critical months for reliability and flexibility of supply. • Increased costs may influence quantity of use.
Tier 2	Canal lining	• Potential canal reaches identified in Natural Resource Conservation Service study. May provide increased conveyance efficiency. • Field study to verify leakage losses, and net benefits of lining are required. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.
	Increased drainwater reuse	• Increased use limited by available supply (cropping pattern for rice) and water quality impacts from inflow of shallow saline groundwater to drains. • Feasibility studies indicate some potential for increased recapture, but requires major drainage infrastructure improvements.
	Groundwater use	• No groundwater use currently. • Well documented connate water quality problems in large portion of SMWC service area. Further investigation required to determine if feasible groundwater development possible.
Tier 3	None identified	



[1] Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2] The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3] TDR based on 1995 land use.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 11-1
SUTTER MUTUAL WATER COMPANY
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Future Water Management Alternatives

Table 11-2 summarizes future water management alternatives for SMWC under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the Company's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 11-2
SMWC Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drainwater reuse	• Base Supply is sufficient to meet TDR • Project Supply generally not used during this period • Drainwater reuse is minimal • There are no identified potential future issues that would impact current practices • Existing practices have no critical problems	No apparent incentives for alternatives at this time.	• NA	• NA	• N/A
Normal/Critical	Project Supply, Base Supply, and drainwater reuse	• Contract Base and Project Supplies together are sufficient to meet TDR • Project Supplies not typically fully used and are offset by drainwater reuse • Potential future issues include high reliance on Project Water and impacts of future price changes • Existing practices have no critical problems	Increased Project Supply use with corresponding decrease in drainwater reuse	• Prevents potential salinity impacts	• Increasing cost of Project Water • Reliability may decrease under CVPIA shortage criteria • Lose flexibility of drainwater reuse	• Future Project Supply costs and reliability • Findings of future salinity studies
			Increase drainwater reuse with corresponding decrease in Project Water use	• Supply cost savings if drainwater reuse less than future Project costs • Potential transfer opportunities	• Potential salinity impacts • Reliance on variable supply (tied to cropping patterns and other factors)	• Future Project Supply costs • State/federal transfer policy • Findings of future salinity studies
Drought/Non-critical Year	Base Supply and drainwater reuse	• Base Supply is fully used and is NOT sufficient to meet TDR • Project Supply generally not used during this period • Drainwater reuse is minimal, limited by available supply • There are no identified potential future issues that would impact current practices • Existing practices have no critical problems	Increase Project Supply use to meet TDR, keep drainwater reuse at existing levels	• Maximizes available water supply	• Increasing cost of Project Water • Reliability may decrease under CVPIA shortage criteria	• Findings of future salinity studies • Overall operations cost of Project Water diversions versus drainwater reuse
Drought/Critical Year	Project Supply, Base Supply, and drainwater reuse	• Contract Base and Project Supplies together are NOT sufficient to meet TDR • Project Supplies are fully used via diversions and transfers • Potential future issues include high reliance on Project Water, impacts of future price, and reliability under shortage criteria • Existing practices have no critical problems	Increased Project Supply use, with same or corresponding decrease in drainwater reuse	• Maximizes available water supply • Prevents potential salinity impacts	• Increasing cost of Project Water • Reliability might decrease under shortage criteria • Lose flexibility of drainwater reuse	• Future Project Supply costs and shortage criteria • Findings of future salinity studies
			Increase drainwater reuse with corresponding decrease in Project Water use	• Supply cost savings if drainwater reuse less than future Project costs • Potential transfer opportunities	• Potential salinity impacts • Reliance on variable supply (tied to cropping patterns and other factors)	• Future Project Supply costs and shortage criteria • State/federal transfer policy • Findings of future salinity studies

SECTION 12

Pelger Mutual Water Company

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Pelger Mutual Water Company (PMWC or Company) are shown on Figure 12-1, for the period from 1985 to 1997, for normal and drought/critical years. Each of the four major analysis periods shown is discussed in detail below. In normal years, PMWC has used a mix of Base Supply and drainwater reuse during non-critical months, and a mix of Base Supply, Project Supply, and drainwater reuse in critical months. In drought/critical years, reduced Base and Project Supplies has been supplemented with drainwater reuse and groundwater. See TM 5 for more information on PMWC's current water management practices.

The Company serves a relatively small area, with approximately 10 separately managed farms. Therefore, changes in crop selection by one or a few growers can drastically change the relative percentage mix of crop types. This makes the use of "average" data potentially misleading, compared to larger districts which have a more stable relative mix of crop types. The influence of this more varying mix of crop acreage is reflected in the TDR values on Figure 12-1, which are based on 1995 land use data. In 1995 there was an above average portion of the Company service area planted in rice (70 percent in 1995 versus 50 percent average). The resulting increased water supply requirement, higher than average, is evident in the gap between the *average* supply and the TDR for critical months of normal years. See TM 3 for details on the historical pattern of PMWC's Sacramento River diversions.

In the non-critical months of a normal year, PMWC has supplied its TDR of approximately 4,300 ac-ft using roughly equal quantities of Base Supply and drainwater reuse. Approximately 53 percent (2,300 ac-ft) of the total average supply is Base Supply, and the remaining 47 percent (2,000 ac-ft) is from drainwater reuse. The Company's Base Supply for non-critical months is 6,200 ac-ft, which is adequate to meet its TDR. Historically, PMWC has used drainwater to offset a portion of its Base Supply use to improve farm-level efficiency, overall conveyance system efficiency, and operational flexibility.

In critical months of normal years, PMWC has supplied its TDR of approximately 6,600 ac-ft using drainwater reuse as the primary water source, and supplemental supply from Base and Project Supplies. Approximately 16 percent (900 ac-ft) of the total average supply comes from Base Supply, 71 percent (4,000 ac-ft) from drainwater reuse, and 13 percent (700 ac-ft) from Project Supply. The Company's use of its Project Supply varies from year to year based on Project Supply costs, distribution system operations costs, and overall system operation efficiency considerations. In some years, the full Project Supply is used, while in other years a portion of the Project Supply may be offset by increased use of drainwater.

In the non-critical months of drought/critical years, PMWC has supplied its TDR of approximately 4,500 ac-ft using a combination of Base Supply, drainwater reuse, and groundwater pumping. Approximately 47 percent (2,200 ac-ft) of the total average supply is Base Supply, 43 percent (2,000 ac-ft) is from drainwater reuse, and 11 percent (500 ac-ft) is from groundwater pumping. The Company's contract Base Supply of 4,600 ac-ft is adequate to meet its TDR; however, the extensive use of drainwater and supplemental groundwater pumping have offset the unused portion of the Base Supply. These actions have improved the conveyance efficiency and improved the Company's operational and supply flexibility.

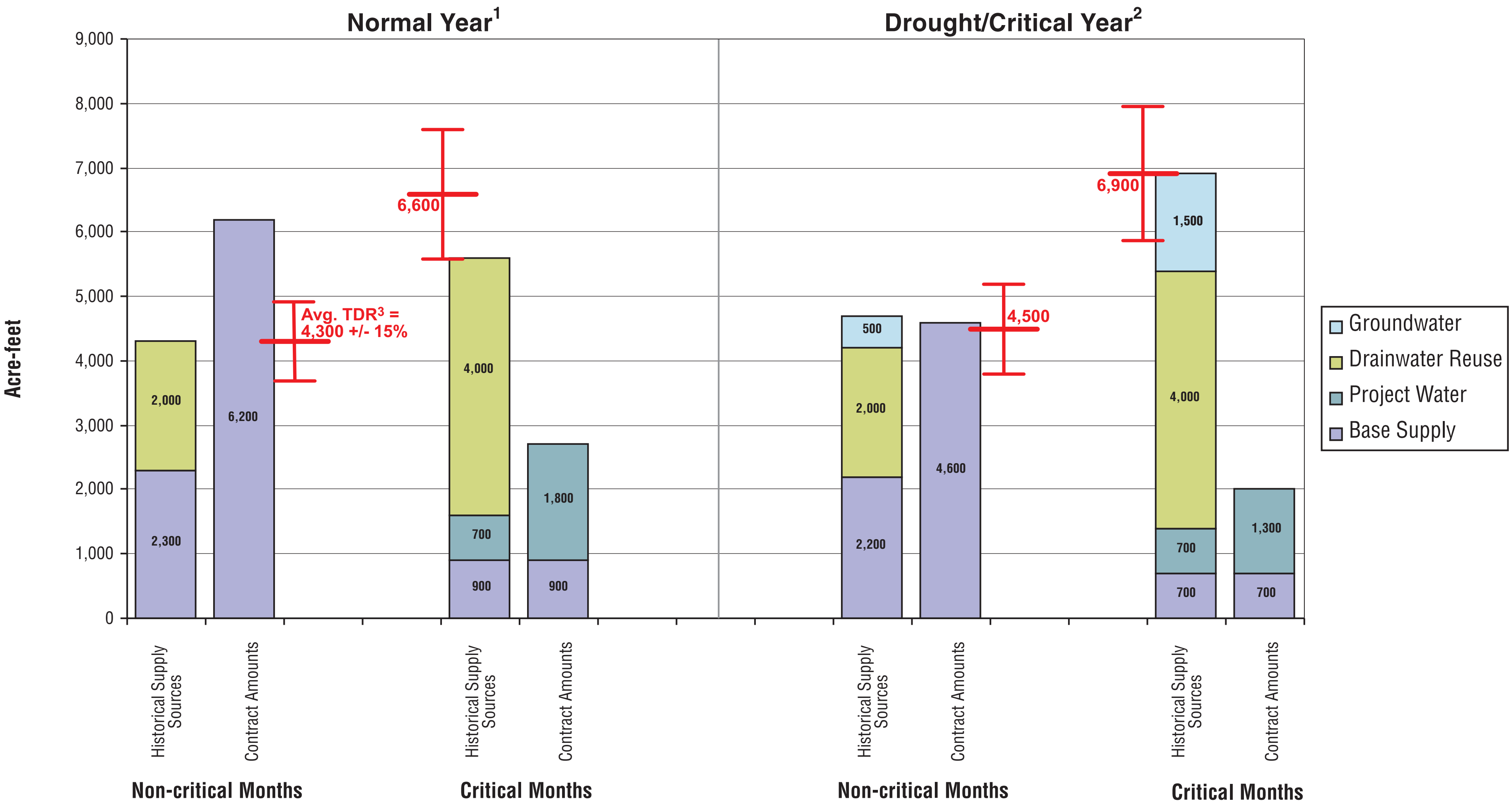
In the critical months of drought/critical years, PMWC has supplied its TDR of approximately 6,900 ac-ft using drainwater reuse as the primary supply, with supplemental supply from Base and Project Supplies and groundwater pumping. Approximately 10 percent (700 ac-ft) of the total average supply is Base Supply, 58 percent (4,000 ac-ft) is from drainwater reuse, 10 percent (700 ac-ft) is from Project Supply, and 22 percent (1,500 ac-ft) from groundwater pumping. The Company's full Base and Project Supplies together are insufficient to meet TDR. Drainwater reuse and groundwater pumping have been used to close this deficit.

Analysis and Ranking of Water Management Options

The tier classification of management options for PMWC is shown in Table 12-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

Future Water Management Alternatives

Table 12-2 summarizes future water management alternatives for PMWC under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the Company's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.



[1] Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2] The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3] TDR based on 1995 land use.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 12-1
PELGER MUTUAL WATER COMPANY
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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TABLE 12-1
PMWC Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Current groundwater use	• Drought/critical-year source. • Provides operational and supply flexibility. • Water quality is marginal due to high total dissolved solids.
	Current drainwater reuse	• Extensive reuse now, at practical upper limit. • Further study of soil and drainwater quality impacts needed.
	Conveyance automation	• Applicable automation in place now. Supply system is simple, more elaborate automation would have negligible benefits.
	Water measurement	• Complete operations water measurement of program in place now. Minor improvements being made on a regular basis.
	Farm-level measurement	• Currently use existing turnout gates, canal head meas-urement, and time of delivery to measure quantity.
	Water transfers	• Formal drought/critical-year transfer policy in place. Private landowners pump groundwater and reimbursed with receipts from Project Supply transfers. • Company has been supplier in past transfers through the State Drought Water Bank.
	CVP purchases	• Portion of Project Supplies historically used. Important source for reliability and flexibility of supply. • Increased costs may influence quantity of use. • May help in long-term salinity management by managing mixture of water use over long term.
Tier 2	Increase groundwater pumping	• Potential drought/critical-year supplemental supply. • Significant capital investment and O&M costs. Company does not own wells, relies on private groundwater pumping. • Increased pumping may cause degraded groundwater quality. • Sustainable groundwater yield unknown, requires further investigation to verify development goals.
	Quantity-based pricing	• Significant institutional issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
Tier 3	Canal lining	• Uneconomic unit cost of “conserved” water. Leakage is recoverable in toe drains, groundwater. No net benefits. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.

TABLE 12-2
PMWC Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply and drainwater reuse	• Base Supply is sufficient to meet TDR • Can continue Base Supply and drainwater reuse • Company may need to revise mix of these two sources in future. • Existing practices have no critical problems	Increase Base and reduce drainwater reuse proportionally	• Base is economical and reliable supply • Avoids potential salinity impacts from drainwater reuse	• Lose flexibility and efficiency benefits of drainwater reuse	• Findings of future salinity studies • Changes in Base transfer policy
Normal/Critical	Base Supply, Project Supply, and drainwater reuse	• Base and Project Supplies are NOT sufficient to meet TDR • Potential future issues are high reliance on drainwater and related impacts, possible reduction in drainwater supply if upstream field/management for drainwater reuse patterns change	Begin groundwater pumping, and reduce drainwater reuse and/or Project Supply use proportionally	• Reduces reliance on upstream drainwater supply • Mitigate impacts of future Project) supply cost increases • Potential for transfers	• Increased capital and O&M costs of groundwater pumping, impacts on regional groundwater levels	• Future practices in adjacent and upstream service areas (SMWC) • Future Project Supply Costs • Findings of future salinity and groundwater studies • State/federal transfer policies
Drought/Non-critical Year	Base Supply, drainwater reuse, groundwater pumping	• Base Supply is sufficient to meet TDR • Potential future issue is heavy reliance on drainwater and related salinity impacts	Increase Base use to full amount and reduce drainwater reuse and/or groundwater pumping proportionally	• Base is economical and reliable supply • Avoid potential salinity impacts of drainwater reuse and/or higher O&M costs of groundwater pumping	• Lose flexibility and efficiency benefits of drainwater use	• Findings of future salinity studies, overall operations costs of Base Supply versus drainwater and groundwater
			Increase groundwater pumping and reduce drainwater use and/or Base Supply proportionally	• Avoid potential salinity impacts of drainwater • Potential for transfer of Base Water	• Increased capital and O&M costs and impacts of groundwater pumping •	• Findings of future salinity and groundwater studies • State and federal transfer policies
Drought/Critical Year	Base Supply, Project Supply, drainwater reuse, and groundwater	• Base and Project Supplies are NOT sufficient to meet TDR • Potential future issues are future cost of Project Supply, heavy reliance on drainwater and related salinity impacts	Increase groundwater pumping and reduce drainwater use and/or Project Supply proportionally	• Avoid potential salinity impacts of drainwater • Potential for transfer of Project Water	• Increased capital and O&M costs of groundwater pumping, impacts on regional groundwater levels	• Future practices in adjacent and upstream service areas (SMWC) • Future Project Supply costs • Findings of future salinity and groundwater studies • State/federal transfer policies

SECTION 13

Natomas Central Mutual Water Company

Summary of Existing Water Supply and Management Practices

The historical water source use patterns for Natomas Central Mutual Water Company (NCMWC or Company) are shown on Figure 13-1, for the period 1985 through 1997, for normal and drought/critical years. Each of the four major analysis periods shown is discussed in detail below. In normal years, NCMWC has used Base Supply as its primary water source in non-critical months. In critical months, NCMWC has used Base Supply as its primary water source, with supplemental Project Supply, groundwater pumping and sub-irrigation from high groundwater levels, and drainwater reuse. In drought/critical years, the supply source mix has been similar to normal years. See TM 5 for more information on NCMWC's current water management practices such as system automation, water measurement, and drainwater reuse. See TM 3 for details on NCMWC's historical Sacramento River Base and Project diversions.

In the non-critical months of a normal year, NCMWC has supplied its TDR of approximately 82,900 ac-ft using Base Supply as the primary water source, and supplemental supply from drainwater and sub-irrigation. Approximately 48 percent (42,300 ac-ft) of the total average supply is Base Supply, 18 percent (16,000 ac-ft) is from groundwater and sub-irrigation, and the remaining 34 percent (30,000 ac-ft) is from drainwater reuse. The Company's Base Supply, along with drainwater reuse and sub-irrigation water, is adequate to meet TDR for non-critical months. Historically, NCMWC has used drainwater to offset a portion of its Base Supply use to improve farm-level efficiency, overall conveyance system efficiency, and operational flexibility.

In critical months of normal years, NCMWC has supplied its TDR of approximately 76,400 ac-ft using Base Supply as the primary water source and supplemental supply from Project Supply, sub-irrigation, and drainwater reuse. Approximately 37 percent (31,500 ac-ft) of the total average supply comes from Base Supply, 10 percent (8,600 ac-ft) comes from Project Supply, 17 percent (14,000 ac-ft) comes from groundwater and sub-irrigation, and 36 percent (30,000 ac-ft) comes from private drainwater reuse.

In the non-critical months of drought/critical years, NCMWC has supplied its TDR of approximately 86,800 ac-ft using Base Supply as its primary water source and supplemental supply from drainwater reuse and sub-irrigation. Approximately 50 percent (46,400 ac-ft) of the total average supply is Base Supply, 17 percent (16,000 ac-ft) is from groundwater and sub-irrigation and 33 percent (30,000 ac-ft) is from drainwater reuse.

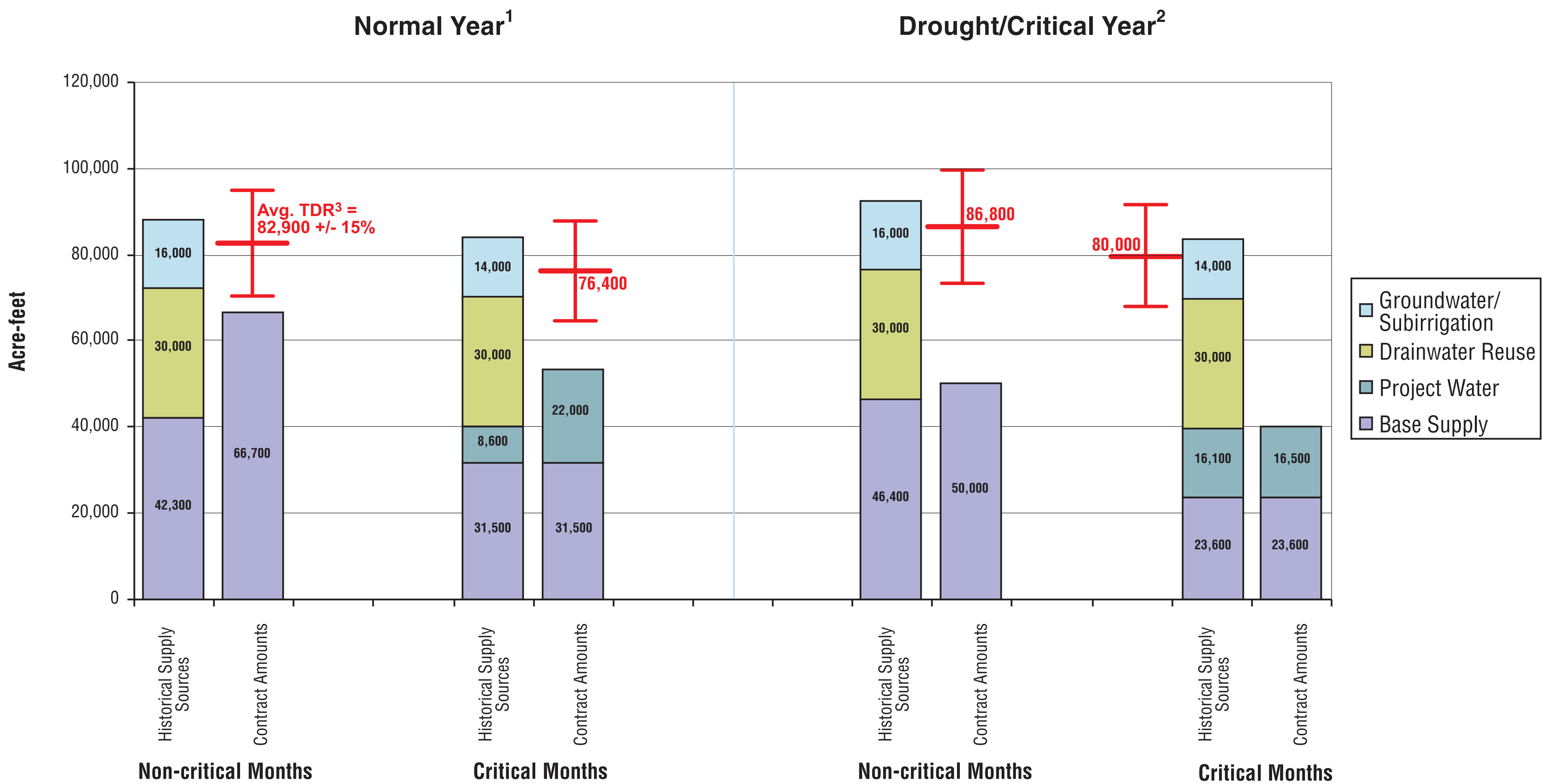
In the critical months of drought/critical years, NCMWC has supplied its TDR of approximately 80,000 ac-ft using Base Supply as the primary water source, with supplemental supply from Project Supply, sub-irrigation, and drainwater reuse. Approximately 28 percent (23,600 ac-ft) of the total average supply is Base Supply, 19 percent (16,100 ac-ft) is from Project Supply, 36 percent (30,000 ac-ft) is from drainwater reuse, and 17 percent (14,000 ac-ft) is from groundwater and sub-irrigation.

Analysis and Ranking of Water Management Options

The tier classification of management options for NCMWC is shown in Table 13-1, which summarizes ranking and factors that determine each option's ranking. Each of these options is discussed in detail in TM 5, including the current level of implementation and factors that may affect increased or new implementation. These individual options are the "building blocks" for future combined-actions water management alternatives discussed under Future Water Management Alternatives below.

TABLE 13-1
NCMWC Water Management Options – Tier Rankings

Option Priority Ranking	Options	Issues and Comments
Tier 1	Current groundwater use	• Source used now in both normal and drought/critical year. • Provides operational and supply flexibility.
	Current drainwater reuse	• Extensive reuse now, at practical limit of supply. Company topography and distribution system function as "bathtub," with almost 100 percent recapture of drainwater supplies. • Very minor increase possible with increased drainwater pumping capacity. See TM 5.
	Conveyance automation	• See potential improvements in TM 5. Minor conservation savings due to minimal existing operations spills.
	Water measurement	• See potential improvements in TM 5. Will improve water accounting, minor conservation savings.
	Water transfers	• Company has been both supplier and receiver in SRWCA pool.
	CVP purchases	• Important source for supply reliability and flexibility. • Increased costs may influence quantity of use.
Tier 2	Increase groundwater pumping	• Potential drought/critical-year supplemental supply. • May consider as part of regional conjunctive water management program. • Significant capital investment and O&M costs. • Sustainable groundwater yield unknown; requires further investigation to verify development goals.
	Farm-level measurement	• Use existing turnout gates, canal head measurement, and time of delivery to measure quantity. Install meters on drain pumps. • Consider measuring for blocks of users along single laterals. • Can use new measurement data to verify on-farm efficiency and target improvements as necessary.
	Quantity-based pricing	• Significant institutional issues in changing rate structure. • Remaining margin of conservation may be achievable with other methods.
	Canal lining	• Uneconomic unit cost of "conserved" water. Leakage is recoverable in toe drains, groundwater. No net benefits. • May help in long-term salinity management by reducing the total salt load in the drain flows. Varied management would be necessary to realize the potential benefits.
Tier 3	None identified	



[1] Based on records and normal practices for near-normal years from 1985 through 1997 (85, 86, 87, 88, 89, 90, 93, 95, 96, 97).

[2] The CVP amounts shown reflect years when water allocation would be reduced by 25 percent on the basis of Shasta inflow and represent a worst-case condition with respect to CVP water supplies.

[3] TDR based on revised 1995 acreages. See TM 2 for more informantion.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

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FIGURE 13-1
NATOMAS CENTRAL MUTUAL WATER COMPANY
CURRENT WATER USE AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

Future Water Management Alternatives

Table 13-2 summarizes future water management alternatives for NCMWC under each of the four major analysis periods: normal years – critical and non-critical months; and drought/critical years – critical and non-critical months. Alternatives are considered for each period because of the major differences in water demand and supply among these periods, which in turn, drive the Company's water management approaches. The alternatives are built up from combinations of options, the exact mix of which cannot be reasonably determined at this time given the uncertainty surrounding such basic issues as yield and cost of major supply options. The alternatives consider broad major options such as surface water, groundwater, drainwater use, and benefits of conservation options. The alternatives are presented in a qualitative manner for this reason, and are assessed based on readily identified benefits and drawbacks, and major issues for resolution or further study.

TABLE 13-2
NCMWC Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Normal/Non-critical	Base Supply, drainwater reuse, sub-irrigation, groundwater	• Contract Base Supply is NOT sufficient to meet TDR. Additional supply from mix of sub-irrigation and groundwater use required. • Potential issues that may influence water management include continued urban development within and adjacent to the NCMWC service area, regional conjunctive water management programs, and the recommendations from the ongoing Habitat Conservation Plan for the Natomas area.	Increase Base Supply to full contract amount, with corresponding reduction in drainwater and/or groundwater use.	• Base is economical and reliable supply • Minimizes potential drainwater quality impacts	• Lose flexibility and efficiency benefits of drainwater reuse • Some areas in Company would need new convey-ance facilities to replace current drainwater supply	• Findings of future water quality and soil salinity studies • Overall operations costs of drainwater versus Base Supply diversions
			Develop increased normal-year groundwater supply, with equivalent reduction in drainwater use and/or Base Supply.	• Reliable water supply • Minimizes potential drainwater reuse impacts • Provide surface water supplies for potential transfers	• Capital and O&M cost for new groundwater development; impacts to groundwater basin from increased pumping	• Findings of future salinity studies • Findings of groundwater investigations and conjunctive water management studies • Overall costs of groundwater supply • State/federal transfer policies • Ability to develop cooperative groundwater supply plan with private landowners, or increase Company involvement in groundwater pumping
Normal/Critical	Base Supply, Project Supply, drainwater reuse, sub-irrigation, groundwater	• Contract Base and Project Supply is NOT sufficient to meet TDR. • See above potential management issues.	Increase Project Supply to full contract amount, with corresponding reduction in drainwater or groundwater.	• Reliable normal-year supply • Minimizes potential drainwater reuse impacts • Possibly lower cost than groundwater pumping	• Lose flexibility and efficiency benefits of drainwater reuse • Water rights protection • Cost of Project Supply	• Findings of future salinity studies • Overall operations costs of drainwater and groundwater versus Project Supply diversions • State/federal transfer policies
			Develop increased normal-year groundwater supply, with equivalent reduction in either drainwater use, Base Supply, or Project Supply.	• Reliable supply • Minimizes potential drainwater reuse impacts • Potential transfers	• Cost and impacts to groundwater basin from increased pumping • Water rights protection • Cost of Project Supply	• Findings of future salinity studies • Findings of groundwater investigations and conjunctive water management studies • Overall operations costs of groundwater supply • Ability to develop cooperative groundwater supply plan with private landowners, or increase Company involvement in groundwater pumping. • State/federal policies in transfers

TABLE 13-2
NCMWC Future Water Management Alternatives

Water-year/Month Type	Current TDR Source(s)	Current Practices and Issues that May Affect Future Practices	Future Alternatives	Pros	Cons	Critical Factors
Drought/Non-critical	Base Supply, drainwater reuse, sub-irrigation, groundwater	• Contract Base Supply is NOT sufficient to meet TDR. • See above potential management issues.	Develop increased drought/critical-year groundwater supply, with equivalent reduction in drainwater use Base Supply.	• Reliable drought/critical-year water supply • Minimizes potential drainwater reuse impacts • Potential transfer	• Cost and impacts to groundwater basin from increased pumping	• Findings of future salinity studies • Findings of future groundwater investigations (yield, level impacts) • Overall operations costs of groundwater supply • State/federal transfer policies
						• Ability to develop cooperative groundwater supply plan with private landowners or revise District policy on groundwater development
Drought/Critical	Base Supply, Project Supply, drainwater reuse, sub-irrigation, groundwater	• Contract Base and Project Supplies are NOT sufficient to meet TDR. • See above potential management issues.	Develop increased drought/critical-year groundwater supply, with equivalent reduction in drainwater use Base Supply	• Reliable drought/critical-year water supply • Minimizes potential drainwater reuse impacts • Potential transfer	• Cost and impacts to groundwater basin from increased pumping	• Findings of future salinity studies • Findings of future groundwater investigations (yield, level impacts) • Overall operations costs of groundwater supply • State/federal transfer policies • Ability to develop cooperative groundwater supply plan with private landowners or revise Company policy on groundwater development

SECTION 14

Regional Water Management Options and Concepts

The following sections focus on the identification of those options considered to be potentially feasible at a basinwide level (Section 14), and review the potential for implementation within each of the sub-basins (Sections 15 through 19). The existing status of water management practices; water supplies; contract quantities for the agricultural (including participating SRSCs), municipal and industrial (M&I), and environmental sectors; necessary facilities; ongoing studies; and general political climate is summarized for each sub-basin in the context of the following options:

- New surface storage
- Conjunctive water management
- Water transfers
- Drainwater management

In addition, the anticipated need for some degree of cooperative regional management to implement any of the above options is also discussed, with environmental benefits derived from ongoing and future actions.

This section (Section 14) focuses on the issues associated with implementing the options listed above on a regional basis, and addresses issues common to any sub-basin. Recommendations are also made related to each of the options. Some options, such as new surface storage (including offstream storage), lend themselves primarily to a basinwide discussion given the associated large-scale capital investment, regulatory, and institutional issues. Other options allow for greater focus on sub-basin-specific recommendations. Thus, recommendations are provided within this section and the subsequent sub-basin-specific sections.

Scope and Purpose of Regional Options Analysis

As discussed in TM 5, a number of water management options require implementation at a basinwide or sub-basinwide level in order to maximize their effectiveness in meeting regional water management objectives. The following were determined to be key regional water management objectives:

- Maintain a reliable, adequate, and economic water supply to meet the existing and future needs of SRSCs and other major water needs in the Sacramento Basin.
- Identify and implement cooperative regional programs that provide environmental benefits.
- Seek opportunities for and foster implementation of coordinated water management actions at the sub-basin and basin level.

- Maximize the operational flexibility of CVP regional water supply systems in the Sacramento Basin.
- Build from common district-based options within each sub-basin via cooperative programs to maximize the benefits of these options within each sub-basin.

Sub-basin-specific Discussions (Sections 15 through 19)

SRSCs within each sub-basin share common features such as similar hydrologic, land, and water use characteristics. The relative geographic locations of the SRSCs also provide opportunities for collaborative efforts towards meeting regionwide goals across sub-basins. Implementation of any of the options identified above and further addressed below requires that potential cooperative arrangements be identified among SRSCs and with other local, state, and federal agencies and programs within a given sub-basin (as well as potentially the entire basin). Accordingly, the options are discussed specifically for each of the following sub-basins:

- Redding Sub-basin (Section 15)
- Colusa Sub-basin (Section 16)
- Butte Sub-basin (Section 17)
- Sutter Sub-basin (Section 18)
- American Sub-basin (Section 19)

Each of the sub-basin options has received considerable attention through ongoing forums, including, most recently, the CALFED program, implementation of the CVPIA, and numerous other assessments and studies that have been or are being conducted at the local, regional, and statewide level. The following discussion draws from these efforts and summarizes the status of each option within each sub-basin. It is anticipated that any of these options could be implemented individually, or in conjunction with other options, depending on the characteristics of a particular sub-basin.

Each sub-basin-specific section addresses implementation of the options in the following manner:

- **Summary of Water Supply Requirements and Sources** (overall sub-basin water requirements and supplies are presented; related needs identified).
- **Conjunctive Water Management** (current status of conjunctive water management study efforts within the specific sub-basin and infrastructure are identified; recommendations presented).
- **Water Transfers** (current status/historical water transfers within the specific sub-basin identified; recommendations presented).
- **Drainwater Management** (current drainwater use and study efforts within the specific sub-basin identified; recommendations presented).

In addition to the summary of water supply requirements and sources and option-by-option review, the following issues are also addressed in the context of each sub-basin.

Environmentally Beneficial Water Management

The anticipated environmental benefits associated with the implementation of these options are identified, as well as the status of key fish screen/passage and watershed/stream restoration projects within each sub-basin. In general, it is assumed that the implementation of the regional options can be conducted to maximize environmental benefits, or be structured to meet the needs of a particular user group while providing ancillary environmental benefits. This will likely require coordination with those resource agencies that have expertise and regulatory responsibility, either through existing forums or development of an action-specific coordination process.

Sub-basin Water Management Concepts

In addition to the identification of sub-basin-specific issues related to each of the options and related recommendations presented by the option and under the Environmentally Beneficial Water Management discussion in each section, water management "concepts" are also presented for each sub-basin. These concepts represent potential programs or options for each sub-basin in the context of that sub-basin's projected water supply and requirement in normal and drought conditions. The concepts are provided as a means of stimulating future discussion and advancing the most feasible options for more detailed future evaluation. It is fully recognized that implementation of almost any of the suggested concepts will require a substantial amount of public and agency involvement, as well as additional study.

New Surface Storage

Background

New surface water storage in the Sacramento Valley has been one of the most exhaustively considered regional water supply and management alternatives, based primarily on the significant potential benefits that new storage may offer. In TM 5, a summary assessment was presented for the various surface storage alternatives that have been evaluated to varying degrees of detail over the last 30 years. See TM 5 for information on the list of projects and information such as locations, basic concepts of operation, primary facilities, storage capacity, dry-year yield, and estimated costs.

The information presented in TM 5 was based in large part on the evaluations and "short-list" alternatives that resulted from CALFED's Integrated Storage Investigation (ISI). The CALFED ISI evaluated a wide range of surface and groundwater storage locations throughout central and northern California, including in-Delta, south-of-Delta, and north-of-Delta (Sacramento Valley) locations. In June 2000, CALFED released the document *California's Water Future: A Framework for Action*, which sets out actions anticipated to be included in a proposed preferred alternative and Record of Decision. This document strongly endorses the need for increased surface storage to achieve the management goals of the CALFED program, and presents a list of three recommended surface storage projects: In-Delta storage (250,000 ac-ft), an enlarged Shasta Dam and reservoir (300,000 ac-ft), and an expanded Los Vaqueros Reservoir (400,000 ac-ft), for a total of 950,000 ac-ft of new surface storage. Stage 1 of implementation of the CALFED preferred alternative will include the necessary steps to develop all three of these projects.

California's Water Future: A Framework for Action recommends that two additional projects, the Sites Reservoir option for offstream storage and an enlarged Friant Dam or functionally equivalent San Joaquin River watershed storage, be investigated further in partnership with local stakeholders. As summarized in the document, "…*These projects require extensive technical work, significant additional environmental review and development of cost-sharing agreements before a decision to implement the project as part of the CALFED Program*." Financing for all projects is to be on the basis of "beneficiaries pay."

The two projects evaluated by CALFED's ISI that are most relevant to the efforts of the BWMP are the Shasta Dam enlargement and the potential Sites Reservoir offstream storage project. In considering these two projects as part of an integrated Sacramento River Basin water supply and management program, the following key questions need to be answered:

- *Which projects are most likely to move forward, and what are the critical factors in determining their implementation?*
- *What is the framework, in terms of participating parties and institutional agreements, under which the projects will be financed, built, and operated?*
- *What will be the direct and secondary benefits and impacts on SRSCs and the Sacramento Basin as a whole?*
- *What are the costs of these benefits, and how do the unit benefit costs compare with other actions/alternatives?*
- *How do these projects tie in with or influence the effectiveness of other regional options under consideration?*

These two surface storage alternatives represent extremely complex undertakings that will require much more detailed evaluation efforts including regional water system (CVP and State Water Project [SWP]) operations studies, site investigations, cost/benefit studies, environmental studies, and determination of an institutional framework for execution. The following section presents a summary assessment of the Sites Reservoir offstream storage and the Shasta Lake Water Resource Investigation Alternatives, which include enlargement alternatives, and addresses briefly the above questions for each. Summary conclusions and recommendations for the next phase of the BWMP are presented in the last section.

Sites Reservoir Offstream Storage Alternative

Project Summary – The CALFED ISI has selected the "Large Sites Project" for further study in coordination with local stakeholders. The Large Sites Project refers to the larger of the two basic Sites Reservoir configurations, as discussed in TM 5, with a gross storage volume of approximately 1.8 million ac-ft. The project would be located about 10 miles west of Maxwell in Antelope Valley. The reservoir would be formed by two main dams on Stone Corral Creek and Funks Creek, with several smaller saddle dams. The reservoir would be filled using excess winter season flows in the Sacramento River. The water would be diverted and conveyed to the reservoir using either or both the Tehama-Colusa Canal and the GCID Canal, along with a series of new pump stations, pipelines, and regulating reservoirs. The stored water would be released back into either or both of the canals for distribution, or into the Colusa Basin Drain for conveyance to the Sacramento River. The estimated capital cost, in 1995 dollars, is $450 million. The average annual drought-year yield from the project has been estimated at 240,000 ac-ft per year, with a resultant unit cost of $1,875 per ac-ft of dry-period yield.

Potential Project Participants – The Sites Reservoir offstream storage project has been evaluated by various state, federal, and private parties. What the actual institutional mix of participating parties would be if the project moves forward is uncertain. However, CALFED has strongly emphasized the need for cooperative efforts involving local stakeholders in further evaluation of the project and in possible cost-sharing arrangements. The main participants in the next steps of evaluation and eventual implementation of the Sites Reservoir project will have a great deal of influence on the final project layout, how it is operated, the targeted benefits from use of Project Supply, and other key issues. Table 14-1 lists a conceptual-level summary of the main participants in the Sites Reservoir offstream storage project.

TABLE 14-1
Primary Participants and Roles in Sites Reservoir Offstream Storage Project

Participant	Role
Federal and state agencies – Reclamation, DWR, U.S. Fish and Wildlife Service (USFWS), others	Joint evaluation studies, funding, operations modeling and integration with CVP and SWP operations, support of facility design, regulatory and permitting issues.
SRSCs, other major Sacramento Valley water users such as Tehama-Colusa Canal Authority (TCCA)	Participation in and/or review of joint evaluation studies, input on facility layout, operations, objectives and benefits, cost-sharing programs.
Local governments (county, city)	Input to review and development process as local stakeholders.
Other Sacramento Valley water agencies	Review and comment at key stages of evaluation studies, input to development goals and objectives.
Environmental community representatives	Participation in and/or review of joint evaluation studies, operations concepts, objectives, and benefits.

Benefits and Impacts – The primary potential benefits to the Sacramento Basin in general, and the SRSCs in particular, are improved supply flexibility and reliability to meet all in-basin water needs in drought/critical-year conditions. Several SRSC service areas would be able to receive direct supplies from the outflow of the Sites Reservoir or the subsequent supply of flows into the Sacramento River. All other SRSC service areas could receive “in-lieu” improved supplies by the reduction in demands on the mainstem Sacramento River and Shasta Dam. The demands met by the Sites Reservoir yield would effectively reduce the overall deficit between supplies and demands, resulting in potentially less frequent and less severe cutbacks in CVP supplies.

Additionally, direct benefits in the form of releases for environmental purposes could also be realized so that operations either maximized environmental benefits or ensured that benefits occurred as a byproduct of operations. The secondary benefit of the Sites Reservoir project would be a general reduction in the constraints on existing Sacramento River diversions that result from the need to maintain in-stream flow targets of water temperature, flows, and water quality at key points, including net outflows to the Bay-Delta. By reducing direct diversions at critical times and possibly providing direct supplemental flows to the river, the operating range "cushion" between actual conditions and control targets is improved with the Sites Reservoir yield. Finally, the additional storage may directly contribute to more effective implementation of other regional water management alternatives such as transfers and conjunctive water management programs by improving the ability of the regional water systems to more closely manage the mix of supplies; store excess water for use in transfers or conjunctive water management programs; and match supplies and demands in term of timing, quantity, and water quality.

For comparison purposes, Table 14-2 summarizes the potential quantitative impacts of the Sites Reservoir dry-year yield in comparison to key water management quantities in the Sacramento Basin.

TABLE 14-2
Comparison of Drought-year Yield from Sites Offstream Storage to Key Basinwide Water Management Quantities

Management Quantity Description	Quantity (ac-ft)	Sites Yield (240 taf) as Percent of Management Quantity
Total SRSC Base Supply	1,843,118	13%
SRSC Critical Months' Base Supply	455,800	53%
Total SRSC Project Supply	383,821	63%
Critical-year Project Supply (75 percent of normal)	287,866	83%
Year 2020 Drought-year Sacramento Basin Deficit	1,109,000	22%

Shasta Dam and Reservoir Enlargement Project Summary

Project Summary – Various studies dating back more than 20 years have evaluated the alternatives for enlarging Shasta Dam and Shasta Reservoir's storage volume. The most recent study, which is included in ISI efforts, looked at three basic options for dam crest height increases; 6.5, 102.5, and 202.5 feet. The three options are generally referred to as the "low," "intermediate," and "high" options. The low-raise option of 6.5 feet has been recommended for implementation by ISI; therefore, it will be further considered in this evaluation. The three options (low, intermediate, and high) all have the same basic objective, which is to increase the available conservation storage in the reservoir to allow increased retention of flood flows for later release. The following project summary is based on information from the Reclamation's project web site.

The low-raise option would involve adding 6.5 feet to the crest height of the dam and the following related modifications: insert new spillway gates, replace outlet works valves, improve penstock supports, and make minor recreational facility relocations. The crest height increase would add approximately 290,000 ac-ft of conservation storage volume, while maintaining the current 1.3 million ac-ft of variable flood control storage. The 1.3 million ac-ft of variable flood storage is based on maintaining maximum target downstream flows and water surface elevations during a 100-year flood event. *It is important to note that the gross volume of storage added does NOT directly translate into an equal quantity of annual useful yield from the reservoir*.

The reservoir is operated under a complex set of operating rules and indices that dictate the variable quantity of flood volume to be maintained between October 1 and June 15, and provision of the extra storage simply increases the ability to efficiently manage the variable flood control volume. Based on extrapolations from results of a 1978 yield study, an upper limit estimate of the average annual yield increase is approximately 50,000 ac-ft (*estimated by BWMP staff using Reclamation data)*. Updated studies are required to account for changes in system demands and operating criteria since 1978.

Potential Project Participants – Project participants have not yet been identified. Reclamation has initiated a public outreach program to engage stakeholder participation in the study and to identify potential project participants.

Benefits and Impacts – Extensive modeling and analysis will be required to assess the net benefits and impacts of the project. Preliminary assessments indicate the following qualitative range of benefits:

- **Flood control –** Increased efficient management of Lake Shasta's flood control volume.
- **Water supply –** Approximately 50,000 ac-ft increase in average annual yield.
- **Power generation –** Increased power generation.
- **Environmental –** Improved ability to meet operational criteria related to Bay-Delta parameters, in-stream flows for ESA listing requirements, temperature control requirements, and dilution of acid mine drainage.

The overall benefits to the Sacramento River Basin and SRSCs generally are of a secondary nature. The increased yield and ability to meet the operational objectives will generally lessen the impacts of future shortages on existing water users. By essentially providing "carriage water" for the mainstem Sacramento River from Shasta Dam to the lower end of the basin, the project could substantially reduce restrictions placed on existing divertors which were made necessary by the limitations of the system to meet all of the operational criteria and objectives. For comparison purposes, Table 14-3 summarizes the potential impact of the Shasta Dam and Reservoir enlargement average annual yield in comparison to key water management quantities in the Sacramento Basin.

TABLE 14-3
Comparison of Drought-year Yield from Shasta Dam Raising to Key Basinwide Water Management Quantities

Management Quantity Description	Quantity (ac-ft)	Project Yield as Percent of Management Quantity
Total SRSC Base Supply	1,843,118	3%
SRSC Critical Months' Base Supply	455,800	11%
Total SRSC Project Supply	383,821	13%
Critical-year Project Supply (75 percent of normal)	287,866	17%
Year 2020 Drought-year Sacramento Basin Deficit	1,109,000	5%

Implementation of the Sites Reservoir offstream storage and Shasta Dam Raise projects would result in substantial direct and secondary benefits to Sacramento Basin water users and environmental resources, as well as south-of-Delta interests.

Ideally, both projects (and some mix of other storage projects such as the In-Delta and South-of-Delta projects) should be implemented, which would achieve a maximum practical increase in the supply and operations flexibility and reliability for the entire Sacramento Valley and Bay-Delta system.

Recommendations

The following actions are recommended with regard to the ongoing efforts related to the ISI study process and proposed Shasta Dam raise:

1. *Pursue a Memorandum of Understanding (MOU) with the CALFED ISI study effort to allow for more direct involvement on Sites Reservoir and other Offstream Storage project development, and pursue similar arrangement with Reclamation related to the Shasta Lake Water Resource Investigation.*
2. *Integrate both proposed projects into ongoing and future gaming exercises and operations modeling studies to better define the potential impacts, variations in operating objectives, and net benefits to the Sacramento Valley and south-of-Delta users.*
3. *Continue to monitor and participate in related technical studies and meetings related to both projects.*
4. *Continue to voice support of both projects or take leadership position in a basinwide manner as appropriate.*

Conjunctive Water Management

The objective of the conjunctive water management option is to facilitate development of opportunities and strategies for conjunctive water management in groundwater sub-basins in the study area. This section describes a fundamental approach to the development, design, evaluation, and ultimate implementation of regional conjunctive water management projects and programs.

Required Elements

In general, successful conjunctive water management projects have certain common elements including:

- A source of surface water supply and potential mechanisms for changing the timing of that supply (for example, re-regulation of surface water reservoirs).
- Identifiable usable storage capacity in an underlying groundwater aquifer.
- Groundwater recharge facilities (either direct, indirect, or in-lieu).
- Groundwater extraction facilities.
- Groundwater and surface water transmission/distribution (and treatment) facilities.

- A system for monitoring groundwater levels, groundwater quality, and recharge/ extraction volumes.
- An institutional framework for promulgating, modifying, and, in some cases, enforcing operational parameters.
- A financing mechanism for equitably distributing costs among project beneficiaries.

A critical aspect of developing conjunctive water management projects is the identification, development, and evaluation of these elements.

Evaluation Process

The flow chart (Figure 14-1) identifies critical tasks for the development, design, and evaluation of conjunctive water management projects. These tasks must be completed to the satisfaction of all stakeholders if the project is to proceed to the implementation phase. As indicated on the flow chart, the work tasks can generally be broken into three broad categories: physical requirements, legal and institutional issues, and political considerations. Once "candidate" basins have been identified, work can proceed in each of these areas simultaneously. Descriptions of each category are provided below.

Identify "Candidate" Basins. The initial task of any conjunctive water management investigation is to identify candidate groundwater basins that may be suitable for implementation of conjunctive water management. The physical characteristics of these basins are summarized in terms of proximity to major surface water streams, conveyance facilities from the nearest points of surface water diversion, hydrogeologic and aquifer properties, general groundwater conditions, surface water and groundwater quality recharge rates, groundwater extraction well densities and completion characteristics, and groundwater production. Comparison of these summaries facilitates prioritization of the candidate basins based on suitability (some basins can be eliminated from further evaluation at this step). This "early fail" approach saves significant time, effort, and cost. DWR assisted the BWMP Project Team in identifying candidate basins. These efforts were documented in a TM prepared by DWR under separate cover titled *Groundwater Hydrology Technical Memorandum* (January 2000). Information from this memorandum has been used to help characterize the groundwater sub-basins.

Develop Data. Detailed evaluation of specific groundwater sub-basins requires a significant data collection, compilation, and quality assurance effort. Available data has been collected as part of previous studies and investigations conducted by various districts in coordination with DWR. This information has been collected and discussed in DWR's *Groundwater Hydrology Technical Memorandum* (2000).

Develop Groundwater Model. Ultimately, a tool such as a groundwater model is needed to evaluate the groundwater impacts resulting from various conjunctive water management operations. This task would likely be implemented as part of subsequent phases of the BWMP. Sub-basin-level discussions are limited to identifying whether available models exist or not.

Formulate Facility and Operational Concepts. Once a groundwater basin has been characterized and sufficient data has been collected, various management concepts are formulated. These concepts incorporate variations in the timing and availability of surface water supplies, as well as the timing and pattern of water demands. Concepts that are typically investigated range from a low-capacity option that minimizes recharge and groundwater extraction capacity requirements, to a high-capacity option that maximizes those requirements. Alternate facility configurations are evaluated to explore the hydro-geologic potential of various portions of the underlying groundwater basin and to optimize the accessibility to surface water supplies. The responses of the groundwater basin to the various concepts can also be evaluated using groundwater models, if available. Concepts are discussed for each sub-basin below.

Evaluate "Local" Impacts. "Local" impacts include economic impacts, groundwater impacts, and environmental impacts. Economic impacts include the costs of implementing a particular scenario (such as capital costs, O&M costs, and mitigation and monitoring costs), as well as the benefits associated with the presumed increase in water supply availability and reliability. Third party impacts (such as the potential impact of changing groundwater levels on adjacent groundwater extraction operations) are evaluated as well. Environmental impacts include impacts on habitat and specific species. The response of the groundwater basin to the stresses applied under the various operations alternatives is of critical interest. For the current BWMP effort, this analysis is limited to a qualitative assessment.

Evaluate "System" Impacts. In some instances, an objective of a local groundwater conjunctive water management program is to provide an increment of dry-year yield and to make that increment available for transfer. In such cases, it is necessary to evaluate the impacts of an alternative on "system" water supplies and demands (that is, either of the state and/or federal projects) using DWRSIM, PROSIM, or CALSIM. Typically, both the average system yield over a long-term hydrologic period and the short-term yield through a constrained hydrologic period (that is, during a drought) are evaluated. For this TM, this assessment is qualitative, and draws from what we know from CALFED, CVPIA, and local efforts for which quantitative assessments were completed. More detailed assessment would be required in subsequent phases of the BWMP as specific programs or projects are identified.

Summarize Legal Setting. Analysis of conjunctive water management alternatives requires a thorough understanding of available surface water rights (including timing, point of diversion, place of use, type of use, quantity, and priority), as well as applicable ground-water rules, regulations, and ordinances. These aspects are briefly discussed for each sub-basin below. More detailed information regarding surface water rights, rules, regulations, and ordinances are available in TM 3 and DWR's *Groundwater Hydrology Technical Memorandum* (2000).

Identify/Evaluate Alternative Institutional Structures. Success of regional conjunctive water management projects is enhanced when an institutional framework is either in place or can be modified that provides for the promulgation and enforcement of operational parameters and the equitable distribution of costs and benefits. For example, the American River Basin Cooperating Agencies Regional Water Master Plan/Conjunctive Use Program has been instrumental in the formulation and development of the Sacramento North Area Groundwater Management Authority (SNAGMA), a joint powers authority (JPA) with statutory police powers to govern and regulate the groundwater basin underlying northern Sacramento County. Ongoing collaborative efforts and coalitions are discussed for each sub-basin.

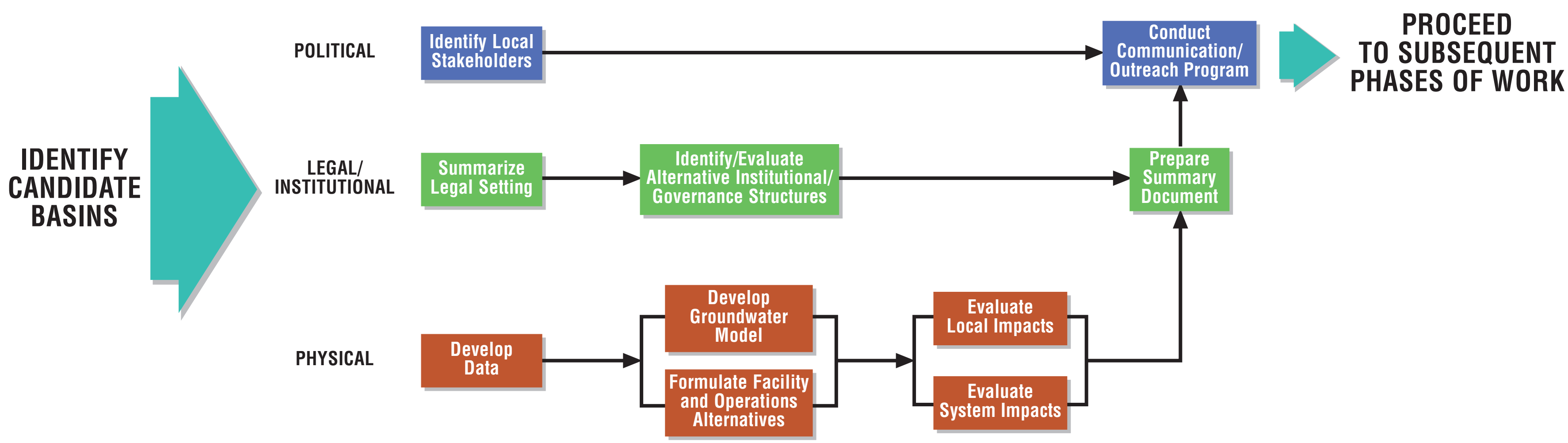


FIGURE 14-1
ASSESSMENT OF CONJUNCTIVE USE MANANGEMENT OPTIONS (EVALUATION PROCESS)
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

W032003010RDD_13 TM 6 (5/3/03)

Identify Local Stakeholders. If a project is to succeed, every voice must be heard, every legitimate concern must be addressed. Local stakeholder issues are discussed for each sub-basin.

Prepare a Summary Report and Conduct Communication/Outreach Program. Prepare a report of the information collected and the results of technical evaluations. This is typical of any project undertaking and a necessary step toward ultimate project implementation.

Recommendations

The following actions are recommended to position SRSCs for consideration of opportunities for regional conjunctive water management as a management option. This list is intended to be inclusive of all actions that could be pursued in the various sub-basins. Those recommendations that are deemed most applicable for a given sub-basin are discussed further in the following sections.

1. *Pursue opportunities for financial assistance. Funding opportunities exist at the state and federal level. These programs are designed to promote the evaluation of groundwater management and implementation of related projects. Depending on the program, support is provided for tasks ranging from initial feasibility studies to full project implementation. Several opportunities can be accessed by SRSCs, including:*

    Assembly Bill 303 (AB 303): The state legislature approved AB 303 (the Local Groundwater Management Assistance Act 2000) in September of this year. The bill would authorize money, upon appropriation by the legislature, to be used by DWR to assist local public agencies by awarding grants to those agencies to conduct groundwater studies, or to carry out groundwater monitoring and management activities, or both, as prescribed.

    Water Bond 2000 (Proposition 13): Grants for feasibility studies and construction projects should be available under Water Bond 2000 for programs that promote the conjunctive management of surface water and groundwater by increasing storage through direct recharge or in-lieu recharge. In total, $200 million in funds will potentially be available with a cap of $50 million per construction project. [Note – Proposition 204 also provides funding for groundwater management projects; however, funding requests far exceed available funds and DWR is no longer accepting additional applications for these types of projects].

    California DWR ISI Conjunctive Water Management Initiative: As part of the DWR ISI program, DWR is evaluating the potential opportunities for regional conjunctive water management projects in California. DWR intends to develop a better understanding of these programs and their potential impacts and net benefits. Their efforts will be conducted in three phases. Phase I involves evaluating the feasibility of conjunctive water management in different basins; Phase II involves monitoring, modeling, and demonstration projects; and Phase III is full-scale project implementation. The SRSCs should coordinate planning efforts with the ISI initiative and seek assistance in completing Phase I for their respective sub-basins, or possibly initiate Phase II.

    DWR Bulletin 118 – California's Groundwater: DWR has been conducting outreach efforts to encourage local participation. The bulletin will update the inventory of groundwater basins throughout California. Local water districts and other interested agencies should seek an active role in providing information on particular concerns or conditions existing in individual basins and management plans in place for individual basins.

2. *Because conjunctive water management projects provide greater potential benefits when configured on a sub-basin or basinwide level, a collaborative effort between water purveyors and other stakeholders would be required. SRSCs should consider an MOU or alternate organizational structure centered around conjunctive water management. Collaborative arrangements like this would more effectively address basin issues and basin management objectives, and would be required to implement regional programs that typically cross multiple jurisdictional boundaries.*
3. *Promote focused public information effort to educate concerned upper Northern California stakeholders as to the potential benefits or impacts of regional conjunctive water management programs.*
4. *Integrate proposed regional conjunctive water management projects into ongoing and future gaming exercises and modeling studies to better define the potential impacts and net benefits.*
5. *Continue to support CALFED-related efforts to provide incentives for reduced diversions (given TDRs can be met from other sources) and timing to promote mutually beneficial water transfers and water management improvements.*
6. *Promote cooperative SRSC, Reclamation, and SWRCB effort to identify appropriate level of documentation and key issues in support of future water transfers.*

Water Transfers

Water transfers are a potentially key management tool that allow for the movement of water to assist in meeting short- or long-term agricultural, M&I, and/or environmental needs. While water transfers alone do not produce "new" water in a basinwide sense, the receiving interest views the water as a new water supply that augments their respective supplies. Accordingly, water transfers are considered a method of matching users who have potentially available supplies with those users who are attempting to meet either existing or projected demands, including environmental needs. Additionally, transfers can be used to accomplish the movement of water made available through other regional options discussed in this TM such as conjunctive water management or offstream storage.

The importance of water transfers is underscored through its inclusion in the CALFED process as part of the preferred program alternative. As identified in the *Water Transfer Program Plan*, transfers can provide benefits such as the following:

- Helping to relieve mismatches between water supply and demand by moving water available in one area to satisfy a need in another area.
- Providing a mechanism to move water assets into and out of a proposed Environmental Water Account.
- Providing a short-term method to move existing supplies from one location to another while other facilities are being constructed (new conveyance, surface storage, or conjunctive use), during temporary reductions in water supply due to outages of conveyance facilities, or while new technologies are being developed (e.g., desalination).
- Moving water from storage facilities (surface or sub-surface) to various uses throughout the state, including in-basin needs, in-stream flows for the environment, and exports.
- Providing water quality benefits as a result of actions taken to make water available for transfer (e.g., reducing agricultural return flows).

Providing water for in-stream flow augmentation through actions such as fallowing, conservation, and conjunctive use.

The CVPIA also recognizes the potential for water transfers to play an integral role in improved water management. Section 3405(a) specifically authorizes the transfer of Project Water, provided such transfer can be shown not to adversely impact fish and wildlife, Project operations and Project contractors, and other legal users of water. The enactment of CVPIA served to further encourage the transfer of Project Water by authorizing Project contractors to transfer Project Water to any other California water user for any purpose recognized as beneficial under applicable state law. CVPIA allows the transfer of Project Water based on the quantity of water that would have been consumptively used or irretrievably lost, unless the transfer is between Project contractors within the same areas of origin as those terms are used under state law. Transfers of Project Water between Project contractors within the same areas of origin, such as those within the Sacramento River Basin between SRSCs and other users such as TCCA, are allowed under CVPIA without addressing whether the water is resulting from a reduction in consumptive use or irretrievable loss.

All water transfers are subject to the water transfer provisions of state law. One general provision applies to all water transfers: transfers cannot cause injury to any other legal user of the water involved. This condition applies to pre-1914 water rights through Section 1706 of the California Water Code, and to post-1914 water rights through Section 1702 of the California Water Code. Transfers involving post-1914 water rights are regulated by the State Water Resources Control Board. Water right holders are required to petition and receive approval from SWRCB to transfer water under post-1914 water rights. This includes transfers of water under the post-1914 water rights held by the SRSCs for Base Supply and water rights held by Reclamation for the CVP and DWR for the SWP. However, the water rights for both the CVP and SWP cover such a vast area and include so many water users that transfers of Project Water between water users within the CVP and transfers of water between water users within the SWP can take place without requiring Reclamation or DWR to petition the SWRCB for any change to the projects' respective water rights. For example, the place of use for Project Water delivered by Reclamation to Project contractors in the Sacramento Valley is covered under the same water rights used to deliver Project Water to Project contractors in the San Joaquin Valley. No water right change in place of use is required by SWRCB when Project Water is transferred between Project contractors within the CVP. Water transfers involving pre-1914 water rights are not under the authority of SWRCB. However, such transfers are subject to the "no injury" rule of state law and must evaluate potential impacts through the California Environmental Quality Act process.

Short-term transfers (less than 1 year) are exempt from California Environmental Quality Act requirements. State law and the SWRCB rules and guidelines protect against any adverse impacts from short-term transfers by allowing only the transfer of reduction in consumptive use. By limiting short-term transfers to reductions in consumptive use, possible impacts to other legal users are avoided. Long-term transfers must meet California Environmental Quality Act requirements; therefore, possible impacts from a transfer that is greater than a consumptive use reduction would be addressed.

Many entities within the Sacramento Valley support meeting in-basin needs first, and meeting environmental needs prior to providing supplies for transfer to out-of-basin uses. These issues, and proposed recommendations, are addressed further below.

Sacramento River Water Contractors' Association Project Water Pool

A total of 34 SRSCs (including the Colusa Drain Mutual Water Company) currently participate in the Pool, which was formed in 1974 to facilitate the exchange and purchase of supplemental Project Water. Since its inception, the Pool has been the forum to move Project Water supplies determined to be available within certain years to other SRSCs. Each year, members participating in the Pool have the option to identify a quantity of their respective Project supply that they wish to make available to the Pool. Contributions need to be identified by April 15 each year. The total quantity of water within the Pool that is committed and actually sold, which has varied greatly on an annual basis, is then available for use by other participating members. Additionally, SRWCA has acted collectively to transfer water to other Project Water users outside SRWCA. All of these transfers have been short term in nature, driven by individual user needs typically related to hydrologic conditions. Over the last decade, the Pool was used most extensively in 1994, in response to a dry year. Large volumes of water (approximately 138,000 ac-ft) were transferred to various entities, including Reclamation. In wetter years, the total amount of water sold through SRWCA has been less than 500 ac-ft because of limited demand. As currently structured, the SRWCA's agreement only allows for the exchange and sale of Project Water. The Pool could also be used to accommodate transfers of Base Supply, as well as out-of-basin transfers, if it were expanded in scope and if such transfers were accomplished in accordance with the water transfer provisions of state law. In turn, such transfers could be short or long term in nature.

Sacramento River Settlement Contractor Initiated Transfers

In addition to moving water through the Pool, direct transfers of Project Water have also occurred or been attempted directly between individual SRSCs and other users. Transfers to other SRSCs, water service contractors, non-CVP users, and users south of the Delta are discussed in each of the sub-basin discussions. Most recently, SMWC and RD 108 completed a successful temporary water transfer to the Contra Costa Water District related to weed abatement for a total of approximately 4,000 ac-ft. Future similar transfers are also being considered.

Natomas Central Mutual Water Company Transfer

Natomas Central Mutual Water Company, in conjunction with Western Water Company, attempted to conduct a short-term, out-of-basin transfer in late 1999 of up to 14,000 ac-ft to the SMWD, pursuant to Water Code 1725. The majority of the proposed transfer was denied, except for 1,995 ac-ft of conserved water associated with documented weed control efforts undertaken by NCMWC. The remaining proposal was denied by SWRCB based on the conclusion that NCMWC's reductions in diversions were not associated with reductions in consumptive use.

Potential for Transfers to Assist in Water Management

As discussed above and in TM 5, relatively small-scale, short-term transfers have been accomplished, primarily within the Sacramento River Basin. A listing of water transfers by SRSCs is available from records maintained by Reclamation's Willows office. The movement of Project Supplies via the Pool also represents a type of transfer arrangement, in that the movement of these supplies has allowed for some entities to augment their existing supplies on a temporary basis. However, if the potential for transfers is to be fully realized, even within the basin, the issues surrounding the transfer of Base Supplies must also be resolved to the mutual satisfaction of both SRSCs and Reclamation. Key among the issues is that many actions that are viewed as "conservation" do not result in a reduction of consumptive use.

In summary, the following issues currently constrain in-basin and out-of-basin transfers and require resolution to allow for transfers to play a meaningful role in Sacramento River Basin water management. Suggested potential actions are also identified:

- Resolution of Reclamation guidelines regarding transfer of Base Supplies (both in- and out-of-basin).
- Political and infrastructure concerns regarding out-of-basin transfers.
- Streamlining of long-term water transfer review process under Sections 1700 and 1735 of the Water Code.

Recommendations

The following recommendations were identified related to increasing the potential for transfers to play a meaningful role in basinwide management:

1. *Reclamation and SRSCs pursue cooperative approach to resolve issues on guidelines related to transfer on in- and out-of-basin Base Supplies.*
2. *Promote focused public information effort to educate concerned upper Northern California stakeholders as to benefits and limitations of transfers and accept/respond to concerns related to out-of-basin transfers.*
3. *The SRSCs should continue to support in-basin water transfers legislation (e.g., efforts patterned after AB 1741) to promote meeting in-basin water requirements between sub-basins. Note: It is Reclamation's policy to not become involved with the state legislative process.*
4. *Support CALFED-related efforts and increase involvement in developing solutions (related to regulatory and Tracy pumping capacity constraints) to increase the ability to provide Project Water to south-of-Delta users, which may incidentally aid in facilitating transfers.*
5. *Continue to support CALFED-related efforts to provide incentives for reduced diversions (given TDRs can be met from other sources) and timing to promote greater quantity of water available for transfer.*
6. *Promote cooperative SRSC and SWRCB effort to identify appropriate level of documentation and key issues of concern to allow for more substantial transfers.*

Drainwater Management

Background

Drainwater management in the form of controlling releases of drainwater from fields, reusing drainwater for on-field irrigation, and monitoring inflows to and out-flows from drains, is a common practice in many of SRSC service areas (see TM 5 for a summary of each SRSC's current drainwater management practices). On a sub-basin or larger scale, the management actions of the individual districts results in major cumulative influences on regional hydrology. These influences include changes in river diversions (reduced or increased diversions as drainwater supplies change relative to irrigation demand); changes in flow rates in the many natural sloughs, streams, and irrigation drains that convey both irrigation drainage and natural drainage; creation of many miles of habitat along the water courses; and water quality and temperature effects at return flow points where regional drainwater re-enters the Sacramento River and its major tributaries.

In addition to these influences on regional hydrology and habitat, drainwater management provides critical benefits at a regional scale by increasing the overall sub-basin efficiency through repeated use of field tailwater runoff. The reuse of drainwater provides greater operations and supply flexibility to irrigators by allowing them to draw on local supplies at or near the point of demand without conveying the needed supply through their entire conveyance system beginning at the river diversion headworks. Use of drainwater is a fundamental practice for all districts, with some deriving the majority of their supply from drainwater available internally or from upstream sources. Maximizing drainwater use while ensuring that crop yields are not affected due to increased salinity is a continuing challenge.

The net result of having these many local supply points is a dispersed "reservoir" of local supply that can be drawn on without direct changes in Sacramento River diversions. This dampening of the variations in demand on each irrigator's river diversions in turn results in reduced pressure on the regional river management (control of releases from Shasta Reservoir) to balance supply and demands on short-term time scales of several days or less. The use of drainwater is typically most prevalent in dry years or periods to allow users to stretch their supplies; however, the availability of drainwater in particularly dry years is generally low.

The influence of regional drainwater return flows on water quality in the Sacramento River and it tributaries has been and will continue to be a critical factor for regional water management. Irrigation operations in the Sacramento Basin are influenced at almost all levels by regulations and guidelines issued by state and federal agencies which relate to management of drainwater quality. Recently completed and ongoing water quality monitoring programs and studies have been undertaken by the California Regional Water Quality Control Board, U.S. Geological Survey, Environmental Protection Agency, and USFWS. Water quality parameters of concern in drainwater include pH, alkalinity, dissolved oxygen, metals, various common pesticide compounds, total dissolved solids, and others. There is generally increasing state and federal regulatory focus on non-point-source pollution controls, including agricultural source total maximum daily loads. All of these factors point to increasing pressure in the future to develop effective water quality management strategies that meet the necessary water quality objectives and minimize impacts on farm-level and district-level operations.

All of these impacts and benefits related to drainwater use occur from what are the largely non-coordinated actions of many irrigators acting independently on a daily basis to respond to changes in their local water supply and demand conditions. With some level of coordinated regional drainwater management, the water supply and management benefits of regional drainwater management can potentially be increased while at the same time allowing more effective actions to address return flow water quality and other regulatory issues. The most logical and effective geographic unit for regional drainwater management appears at this time to be the sub-basin. The following sections will present the objectives of a formal regional drainwater management program, summarize the infrastructure and institutional features of the program, list major impediments to such a program, and state what actions can be taken to support further development and evaluation of this action.

Objectives and Benefits of Regional Drainwater Management

The following are the key objectives and related benefits of regional drainwater management programs.

- **Improved measurement of drainwater flows –** Measure drainwater flows into and out of each service area at key points in major regional drains and at all major return flow points into the Sacramento River and its major tributaries. This will provide the flow-rate, quantity, and timing information needed to make basic management decisions and to track implementation of management actions. The data will also help refine estimates of sub-basin-level water use efficiency.
- **Improved water quality sampling and real-time monitoring –** Provide a regional network of drainwater sampling and water quality monitoring points to provide improved understanding of the seasonal trends, factors influencing drainwater quality, and monitoring of salinity loading on drainwater-irrigated fields.
- **Coordinate management of drainwater flow rates –** Provide improved control and coordination of flows in major regional drains to insure adequate supply to downstream users and help meet management targets related to timing of return flows into the Sacramento River and associated water quality and temperature criteria.
- **Maximize benefits from other regional actions**—Effectively integrate regional drainwater management with other regional actions such as conjunctive water management programs and water transfers to maximize regional efficiency in drought periods. For example, a targeted level of drought-year drainwater reuse could help ensure the availability of a related quantity of surface water for short-term transfers.

Infrastructure and Institutional Features

The following are basic features that may be needed to support potential regional drainwater management efforts. Each of these features would need to be carefully evaluated for a potential management area to determine the specific need for and limitations of each.

- Real-time flow measurement and water quality monitoring stations at key points in regional drains.
- Drainwater retention and storage basins.
- New diversion structures (gravity and pumped) and conveyance canals to tie into existing distribution systems.
- Supervisory control and data acquisition system network for collecting and transmitting real-time monitoring of drainwater flows and quality at key locations.
- Regional coordinating group(s)—Regional management body made up of representatives of major districts and state/federal agencies such as the California Regional Water Quality Control Board. The JPA may be responsible for some mix of the following basic tasks: coordinating the development of new facilities such as monitoring stations and SCADA networks; working with regulatory agencies to ensure management goals support applicable water quality objectives; formulating a regional operations program

for carrying out basic tasks such as data collection and dissemination; forecasting drainwater supply and demands; and coordinating required operations to manage drainwater flows such as timing of release from or diversion to new drainwater storage areas.

Implementation Issues

Regional drainwater is a critical part of the Sacramento Basin's regional hydrology and water management picture. Therefore, any proposals to undertake regional management approaches will need to carefully consider a wide range of implementation issues that may limit the practicality or effectiveness of potential programs. These include the following:

- Water rights and drain license issues related to modifying or impacting current drain use levels, both among irrigation districts and individual drain divertors.
- Impacts on existing regional drain management agreements such as the Colusa Basin "Five-Party Agreement."
- Coordination of regional operations such as Sacramento River reservoir releases and major diversion facilities on the river, to achieve target water quality objectives at key points in the Sacramento River downstream of major return flow points.
- There may be substantial capital and O&M costs for new drainwater management facilities. Issues related to ownership, operation, and maintenance responsibilities of these facilities will need to be considered.
- Environmental benefits or impacts from more intensive drainwater management.
- On-field soil salinity impacts.

Recommendations

The following recommendations were identified related to increasing the potential for regional drainwater management to play a meaningful role in basinwide management:

1. *Begin screening-level feasibility studies within each sub-basin to refine the more specific local objectives and benefits of a regional drainwater management program.*
2. *Open discussions and form working group among local stakeholders to identify and evaluate opportunities to build from existing drainwater management practices and formal agreements within each sub-basin. Process could also include discussion of regional and/or sub-basin approach to tracking and complying with emerging total maximum daily load regulations.*
3. *Review the progress related to ongoing efforts at coordinated regional drainwater management in the San Joaquin Valley area (as appropriate given differences in operations) such as coordinated system diversions and drainwater use. Identify the strengths and weaknesses of these programs as they may relate to Sacramento Valley drainwater management.*
4. *Secure applicable CALFED-related funding related to water quality and conservation programs for assistance in implementing regional drainwater management programs.*
5. *Refine current regional gaming model tools to include analysis of the impacts of major changes in regional drainwater use within each sub-basin. Monthly or weekly time-step analysis would be expected to reflect the significant impact of drainwater management on Sacramento River diversions, return flows, and net in-stream flows at critical downstream points.*

Regional Cooperative Management and Joint Power Authorities

Alternative Institutional Frameworks

In support of the BWMP effort, alternative regional partnerships and institutional frameworks are being considered that could support successful implementation of multi-agency or sub-basinwide management options. These arrangements could take on several forms with varied levels of management authority. For example, institutional frameworks could fall into one of the following categories:

- Existing water districts, water companies, cities, and counties, or some combination of these entities joined through an MOU type of agreement. For example, existing powers granted to current entities under the California Water Code could provide adequate management authority to enable a partnership arrangement to function effectively.
- Formation of a new overarching, umbrella-type water district (or "virtual district") that interfaces with existing entities and provides the authority to coordinate options involving multiple agencies.
- Formation of a JPA between entities.

The authority that might be required for implementing a regional management option largely dictates the type of entity that would be needed to carry out the program. For example, should the entity be responsible for the following:

- Oversight and project implementation?
- Monitoring project operations and performance?
- Monitoring surface water and groundwater conditions?
- Enforcing mitigation measures?

And should the entity:

- Have the ability to enter into contracts for water agreements?
- Have the authority to collect revenue through assessment or other revenue generating options?

Other questions also must be asked regarding the balancing of various physical, legal, and political considerations, for example:

- To what extent is the area of coverage based on physical attributes and political boundaries?
- How should the regional entity be governed, and how does it interface with other governing bodies, private parties, existing plans, and ordinances? Consideration must be given to:
  - AB 3030 plans in existence or under development
  - County ordinances
  - Special districts and water purveyors
  - Adjudicated basins (none present in the Sacramento Valley)

Fortunately, these and other questions have been addressed in other basins throughout the state. These experiences can be used to help guide the formation of regional partnerships and alternative institutional frameworks. For example, regional partnerships are currently guiding the development of regional solutions in the Sacramento area. These efforts are briefly described below.

Alternative Institutional Arrangement Being Applied in the Sacramento Area

In anticipation of the need for equitable, cost-effective water resources management strategies, water users in northern Sacramento and southern Placer counties formed the American River Basin Cooperating Agencies (Cooperating Agencies). Many of the agencies were initially reluctant to pursue such an arrangement; however, over time, the credibility of the concept, and the value of regional solutions became clear. Now these same agencies are the region's strongest supporters of the partnership. Working together, the Cooperating Agencies have developed a common set of goals and objectives, and are sponsoring several programs.

An important factor that initially eluded the Cooperating Agencies was the ability to monitor and protect the underlying groundwater basin (a key ingredient to implementing conjunctive water management options). In an effort to support the Cooperating Agencies, the Sacramento Metropolitan Water Authority undertook the initial steps to develop and adopt an AB 3030 plan. During the process however, the members of Sacramento Metropolitan Water Authority recognized the resultant plan would also have limited authority. Consequently, Sacramento Metropolitan Water Authority altered its process and ultimately formed a JPA for managing groundwater; namely the SNAGMA. The result is an organization, SNAGMA, with broad police powers, regional coverage, and regional consensus.

The combined efforts of the Cooperating Agencies and SNAGMA have resulted in significant progress toward implementing regional projects. The success of these arrangements and the corresponding authoritative power will soon be tested with the planned implementation of a pilot-scale groundwater banking and exchange program.

Recommendations

In all likelihood, regional conjunctive water management and potentially drainwater management options will need to be administered by a regional governing body, vested with broad powers and responsibilities. The actual institutional requirements will be reviewed in more detail upon selection of specific management options. In general, SRSCs should complete the following:

1. *Identify potentially affected parties.*
2. *Review the goals and objectives of the particular regional conjunctive water use management option.*
3. *Assess institutional mechanisms required to implement the regional conjunctive water management option.*
4. *Evaluate various institutional arrangements, using approaches currently being implemented in the American Sub-basin such as formation of and ongoing management provided by SNAGMA.*

Implementation of the regional options (either individually or in combination with one another) at a sub-basin level or basinwide level would be complex and is anticipated to potentially require a regional management authority (e.g., JPA).

Environmentally Beneficial Water Management Actions

All of the regional options being evaluated as part of the BWMP effort can serve to provide environmental benefits either directly or indirectly, depending on how they are implemented. In addition, current practices within districts also result in environmental benefits, typically in terms of habitat availability. The following identifies existing environmental benefits that are essentially byproducts of current operations, as well as the potential for additional benefits that could be derived from implementation of regional options.

Existing Operations and Associated Benefits

As discussed in TM 2, the movement and conveyance of water to serve agricultural uses provides environmental benefits primarily in terms of habitat. Habitat sustained by operations includes drainage ditches that typically support riparian vegetation including wetland species, and in some areas support elderberry shrubs that are the host plant for the listed valley elderberry longhorn beetle. Such ditches also provide habitat for the listed giant garter snake, as well as common species that serve as prey for raptors and waterfowl. Conveyance canals often also provide habitat including riparian tree species adjacent to the portion that is maintained and kept clear of vegetation. In addition to water conveyance facilities such as ditches and canals, rice fields themselves also provide valuable habitat for waterfowl. The prevalence of rice farming in the Sacramento Valley provides wetland habitat in the spring and summer months, as well as winter habitat for migrating birds in fields that are flooded to allow for rice decomposition.

With respect to aquatic habitat, a number of fish screen improvement projects have recently been completed, including major screen replacements at GCID, RD 108, ACID, PCGID, PID, and RD 1004. The potential for any of the regional options to change diversion timing and quantity could also potentially contribute to aquatic habitat benefits, given implementation was targeted to particular species and/or life stages.

Potential Conflicts between Water Conservation Efforts and ESA

Increased conservation efforts in the form of infrastructure improvements can result in locally adverse impacts to habitat. Many of the irrigation canals, ditches, and drains within the Sacramento Valley are unlined. Water seeps through such facilities and, as a result, a portion of the water conveyed is not available either to be applied directly to a field, or to a secondary conveyance lateral or canal. As described above, many unlined facilities accommodate vegetation either within the prism or directly adjacent to the facility. Lining of such facilities therefore can be at odds with maintenance of habitat – in essence, depending on the presence and value, such an action can be a trade-off between overall water conservation and habitat.

As identified above, some of the vegetation present along or within water conveyance and drain features can provide habitat for ESA-listed species. The presence of such habitat can be of concern to individual landowners, some of which view the issue as an encumbrance to the use of their land.

Implementation of Regional Options

Implementation of any of the potential regional options is anticipated to result in secondary and direct environmental benefits. Those options that allow for increased flexibility with respect to the timing and quantity of diversions (offstream storage, conjunctive water management, and potentially improved regional drainwater management) can be implemented to maximize benefits to all user groups and/or focus on environmental uses. Benefits can be realized on a district, sub-basin, or regional basis, depending on the particular benefit being targeted (e.g., terrestrial habitat versus in-river habitat and/or water quality). Implementation can also be conducted so that benefits to a particular user group, including environmental uses, can be maximized at a particular time of year or hydrologic condition (e.g., drought). Current operations of CVP and SWP attempt to strike just such a balance to the extent possible given limited supplies and growing demands. Water transfers have the potential to fill out the picture by improving the ability to match supplies with demands, thereby also increasing the ability to affect diversion timing and quantity on a district basis. The potential for increased regional drainwater management could also assist in providing greater district flexibility, given potential impacts related to salinity/crop yield and overall water quality can be addressed. Additionally, the implementation of any of the options could assist in addressing the concerns raised above related to potential adverse habitat impacts related to certain water conservation efforts and landowner concerns.

Recommendations

The following actions were identified to assist in promoting the maintenance and enhancement of environmental resources on a regional basis:

1. *Continue “gaming” effort to evaluate potential for in-stream fishery habitat maintenance and improvement as a result of modified system operation.*
2. *Continue to seek opportunities within the CALFED process and other funding sources to assist in supporting environmental benefits and habitat maintenance and enhancement where appropriate.*
3. *Promote joint SRSC and USFWS effort to support habitat maintenance and potential enhancement while maintaining existing agricultural land use and crop yields.*
4. *Evaluate potential for regional or sub-basin-level habitat evaluation (utilizing a Habitat Conservation Plan-like process as appropriate) and identification of areas suitable for maximizing habitat benefits while ensuring agricultural uses.*
5. *Continue to work with Reclamation, USFWS, and National Oceanic and Atmospheric Administration-Fisheries (formerly known as National Marine Fisheries Service) to obtain funding assistance to pursue screen improvements for districts/companies such as NCMWC and SMWC.*

Redding Sub-basin

- **Anderson-Cottonwood Irrigation District**

SECTION 15

Redding Sub-basin

Summary of Water Supply Requirements and Sources

The following section presents a summary of the water supply requirements and the historical use of the various water sources used to meet these supply requirements in the Redding Sub-basin. A "water balance" was presented for the Redding Sub-basin in TM 4 that provided a summary of the physical flows of water into the basin, consumptive use within the sub-basin, and outflows from the sub-basin to either groundwater or return surface flows. By definition, the water balance shows no "deficits" or "surpluses," only the flow of the physical quantity of water. For the purposes of proposing and evaluating potential regional water management actions, it is more helpful to summarize water supply requirements and historical sources at a more detailed level, specifically at the level of user type (agricultural/M&I/environmental) and water supply type (characterized both by source and contract category).

Figures 15-1 and 15-2 summarize the Redding Sub-basin's overall water supply requirement for all use types and historical source use under normal and drought/critical years under 1995 and 2020 conditions, respectively. SRSC quantities are presented next to the sub-basin totals to provide perspective on the significance of SRSC water management practices within the sub-basin. The following observations were made:

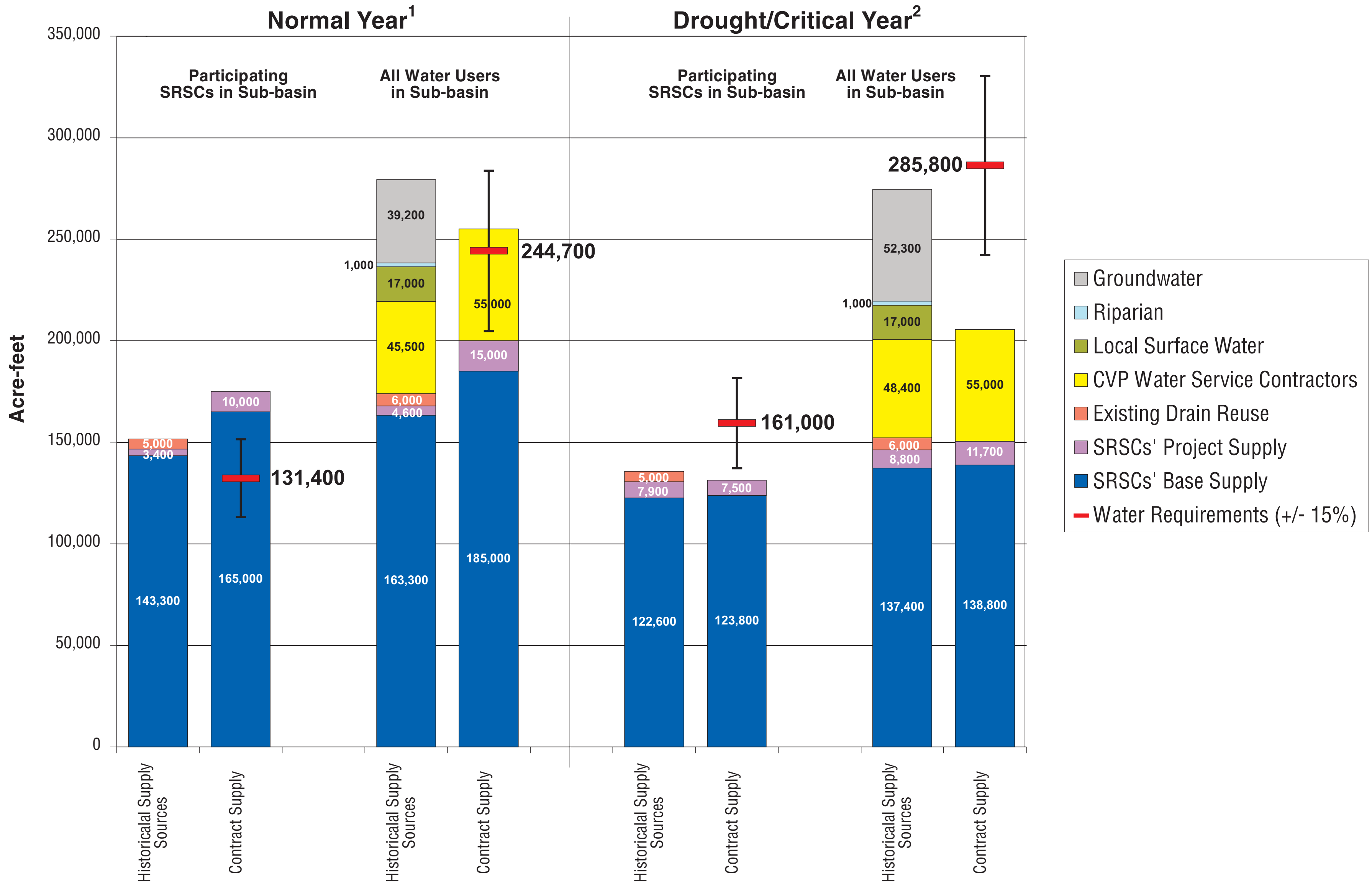
- The sub-basin demands are approximately two-thirds agricultural and one-third M&I. Managed environmental water supply requirements, other than those related to aquatic species within the Sacramento River, are exceeded by current demands relative to sub-basinwide agricultural and M&I demands.
- SRSCs account for approximately 55 to 60 percent of total supply in the sub-basin (170 thousand acre-feet per year [taf/yr] on average; 145 taf/yr in drought years).
- Water service contracts account for about 15 percent of total supply in the sub-basin (45 taf/yr on average; 48 taf/yr in drought years).
- Groundwater accounts for approximately 15 to 20 percent of total supply in the sub-basin (46 taf/yr on average; 57 taf/yr in drought years).
- Drainwater use is not significant in the Redding Sub-basin, accounting for less than 3 percent of typical supply. This is because of the absence of any rice acreage and associated flood irrigation.
- Total sub-basin M&I requirements, in both normal and drought years, will not be met with present contract supplies; and this condition could be exacerbated given uncertainty of CVP water service contract quantities. Groundwater is presently used to meet requirements not met with surface water.
- Total sub-basin SRSC requirements, in drought years, will not be met with present Base and Project contract supplies.

Tables 15-1, 15-2, 15-3, and 15-4 summarize water sources (characterized by source and contract type) and water supply requirements by user type for 1995 average and drought conditions and 2020 average and drought conditions, respectively. The numbers in these tables help to identify more specifically the discrete "blocks" of water users and sources, categorized by classifications that roughly match up with regional management "decision parameters" such as source type, volumes, institutional controls, and restrictions on source to help clarify potential management alternatives. This information also clearly shows supply and demand balances or imbalances within the sub-basin's major user categories. The following observations are noted for 2020 normal-year type conditions (Table 15-3):

- Possible availability of participating SRSC supplies for other in-basin needs (depending on timing).
- For the category of other agricultural users, existing CVP agricultural water service contracts could meet nearly one-half of their respective water requirements; however, delivery of full contract amount is unlikely under future conditions, increasing the likelihood of shortfalls.
- For the category of M&I users, existing CVP M&I water service contracts could meet nearly one-third of their respective water requirements; however, delivery of full contract amount is unlikely under future conditions, increasing the likelihood of shortfalls.
- On an aggregate basis, the sub-basin has adequate surface water supplies available in normal years to meet demands. The apparent future need resides in the ability to align these available supplies with future requirements of the different user types.

The following observations are noted for 2020 drought-year type conditions (Table 15-4):

- Future participating SRSC needs are not met with present surface water supplies alone.
- For the category of other agricultural users, existing CVP agricultural water service contracts could meet nearly one-half of their respective water requirements; however, delivery of full contract amount in drought years is very unlikely under future conditions, increasing the likelihood of shortfalls.
- For the category of M&I users, existing CVP M&I water service contracts could meet nearly one-third of their respective water requirements; however, delivery of full contract amount in drought years is very unlikely under future conditions, increasing the likelihood of shortfalls.
- On an aggregate basis, the sub-basin needs are not met, and large shortfalls are likely, given the uncertainty in future CVP water service contract deliveries in drought years.



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP water service contractors -- shown here as 100 percent; however, USBR has significantly reduced project deliveries during critcally dry periods.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

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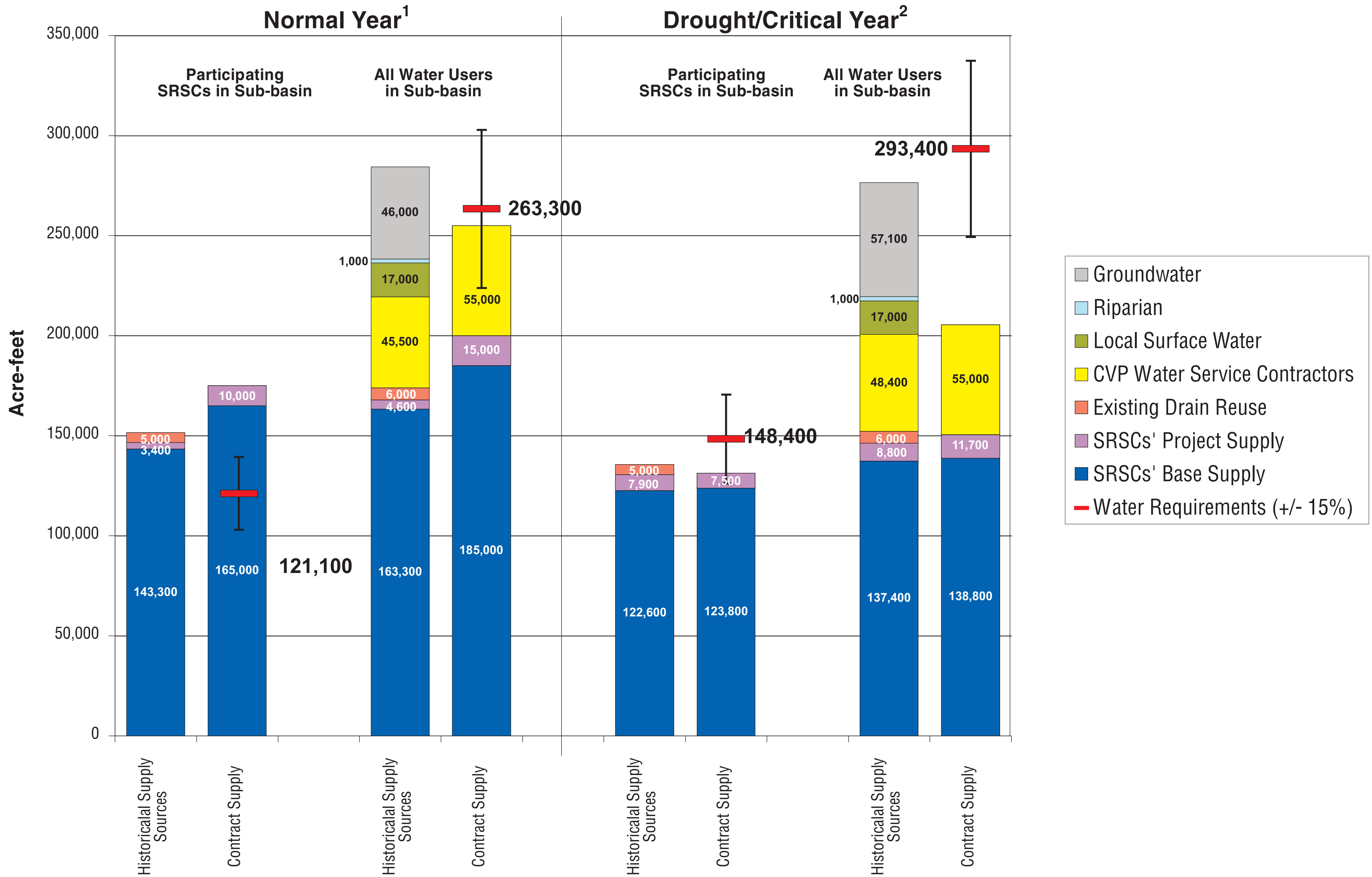
FIGURE 15-1
REDDING SUB-BASIN 1995
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP water service contractors -- shown here as 100 percent; however, USBR has significantly reduced project deliveries during critcally dry periods.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 15-2
REDDING SUB-BASIN 2020
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
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MBK

TABLE 15-1
Redding Sub-basin Potential Water Needs

	1995 Average Conditions				
	Participating SRSCs (ac-ft)	Other Agricultural Users (ac-ft)	M&I Users (ac-ft)	Managed[a] Environmental Uses (ac-ft)	TOTAL (ac-ft)
Annual Water Requirement	131,428	46,762	66,557	0	244,748
Annual Water Supplies					
CVP Water Supply[b]					
SRSC Base Supply	165,000	2,162	17,850		185,012
SRSC Project Supply	10,000	1,805	3,150		14,955
CVP Water Service Contracts	N/A	22,000	33,040		55,040
SUBTOTAL	175,000	25,967	54,040	0	255,007
Supply from Other Sources[c]					
Sacramento River Riparian	0	1,000	0		1,000
Local Surface Water	0	17,000	0		17,000
Groundwater	0	12,000	27,200		39,200
Reuse/Drainwater	5,000	*1,000*[d]	0	0	6,000
SUBTOTAL	5,000	31,000	27,200		63,200
TOTAL SUPPLIES	180,000	56,967	81,240	0	318,207

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Present contract amounts.
[c] Based on recent average historical use of these "other" supplies.
[d] Numbers in italics are preliminary approximations.

TABLE 15-2
Redding Sub-basin Potential Water Needs

	1995 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	160,968	57,272	67,574	0	285,815
Annual Water Supplies					
CVP Water Supply[b]					
SRSC Base Supply	123,750	1,622	13,388		138,759
SRSC Project Supply	7,500	1,805	2,363		11,668
CVP Water Service Contracts	N/A	7,700 to 22,000[c]	24,780 to 33,040		32,480 to 55,040
SUBTOTAL	131,250	11,127 to 25,427	40,531 to 48,790	0	182,908 to 205,467
Supply from Other Sources[d]					
Sacramento River Riparian	0	1,000	0		1,000
Local Surface Water	0	17,000	0		17,000
Groundwater	0	14,500	37,800		52,300
Reuse/Drainwater	5,000	*1,000*[e]	0		6,000
SUBTOTAL	5,000	33,500	37,800	0	76,300
TOTAL SUPPLIES	136,250	44,627 to 58,927	78,331 to 86,590	0	259,208 to 281,767

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Present contract amounts.
[c] Quantities are shown as ranges given water service contract supplies have historically been reduced by up to 65 percent in drought years for agricultural water service contractors, and up to 25 percent for M&I and environmental water service contractors.
[d] Based on recent average historical use of these "other" supplies.
[e] Numbers in italics are preliminary approximations.

TABLE 15-3
Redding Sub-basin Potential Water Needs

	2020 Average Conditions				
	Participating SRSCs (ac-ft)	Other Agricultural Users (ac-ft)	M&I Users (ac-ft)	Managed[a] Environmental Uses (ac-ft)	TOTAL (ac-ft)
Annual Water Requirement	121,132	42,200	100,000	0	263,332
Annual Water Supplies					
CVP Water Supply[b]					
SRSC Base Supply	165,000	2,162	17,850		185,012
SRSC Project Supply	10,000	1,805	3,150		14,955
CVP Water Service Contracts	N/A	22,000	33,040		55,040
SUBTOTAL	175,000	25,967	54,040	0	255,007
Supply from Other Sources[c]					
Sacramento River Riparian	0	1,000	0		1,000
Local Surface Water	0	17,000	0		17,000
Groundwater	0	10,700	35,300		46,000
Reuse/Drainwater	5,000	*1,000*[d]	0	0	6,000
SUBTOTAL	5,000	29,700	35,300		70,000
TOTAL SUPPLIES	180,000	55,667	89,340	0	325,007

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Present contract amounts.
[c] Based on recent average historical use of these "other" supplies.
[d] Numbers in italics are preliminary approximations.

TABLE 15-4
Redding Sub-basin Potential Water Needs

	2020 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	148,358	*45,000*[b]	*100,000*	0	293,358
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	123,750	1,622	13,388		138,760
SRSC Project Supply	7,500	1,805	2,363		11,668
CVP Water Service Contracts	N/A	7,700 to 22,000[d]	24,780 to 33,040		32,480 to 55,040
SUBTOTAL	131,250	11,127 to 25,427	40,531 to 48,790	0	182,908 to 205,467
Supply from Other Sources[e]					
Sacramento River Riparian	0	1,000	0		1,000
Local Surface Water	0	17,000	0		17,000
Groundwater	0	13,000	44,100		57,100
Reuse/Drainwater	5,000	*1,000*	0	0	6,000
SUBTOTAL	5,000	32,000	44,100		81,100
TOTAL SUPPLIES	136,250	43,127 to 57,427	84,631 to 92,890	0	264,008 to 286,567

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Numbers in italics are preliminary approximations.
[c] Present contract amounts.
[d] Quantities are shown as ranges given water service contract supplies have historically been reduced by up to 65 percent in drought years for agricultural water service contractors, and up to 25 percent for M&I and environmental water service contractors.
[e] Based on recent average historical use of these "other" supplies.

Conjunctive Water Management Program

Summary of Conjunctive Water Management Potential

Groundwater has been used historically in the Redding Sub-basin as a supplemental source for irrigation purposes, and also as a source of supply for domestic uses. However, opportunities may exist for coordinating groundwater and surface water supplies between ACID and other users in other areas of the sub-basin.

In general, successful conjunctive water management projects have certain common elements (see general discussion of conjunctive water management in Section 14). Table 15-5 summarizes the current status of these key elements within the Redding Sub-basin.

TABLE 15-5
Summary Status of Redding Sub-basin Conjunctive Water Management Elements

Element	Currently Present	Comments
Available surface supplies	Yes	ACID historically has had available supplies in many normal years.
Usable groundwater storage	Yes	
Groundwater recharge facilities	No	In-lieu would be more likely.
Groundwater extraction facilities	Some	Additional well fields required.
Transmission/distribution facilities	Some	Need facilities connecting well fields.
Monitoring facilities	Limited	
Institutional framework	AB 3030; Shasta County Ordinance	Could facilitate management; could possibly pursue JPAs or the like.
Financing mechanism	No	Funding could be pursued through DWR ISI and legislation.

Probably the most prohibitive physical elements for the Redding Sub-basin are the limited facilities. Because groundwater is not used extensively in the sub-basin, additional infrastructure needs would likely be high, particularly in the form of well fields and transmission facilities connecting them to existing surface water distribution systems. Another challenging area would be in the legal and institutional elements. Regional conjunctive water management programs have never been implemented in the area, and developing the institutional framework for carrying out such a program would likely be the most challenging task.

Assessment of Conjunctive Water Management Potential

A critical aspect of developing conjunctive water management projects is the identification, development, and evaluation of these elements. A process diagram was introduced earlier for carrying out this activity (see Conjunctive Water Management). This evaluation process is applied here in an effort to assess the opportunity for conjunctive water management in the Redding Sub-basin.

Identify Candidate Basins – The Redding Sub-basin is coincident with the Redding Groundwater Basin (for a description of the basin see *DWR's Groundwater Technical Memorandum*, 2000). Groundwater use varies from 15 to 20 percent of total water use, depending on hydrologic conditions, and ranges from 45 taf/yr to 55 taf/yr (DWR Bulletin 160 water use budgets). Within this groundwater basin, the ACID service area extends over several groundwater sub-basins, but primarily falls within the Anderson Sub-basin. Groundwater use in the district area is minimal relative to surface water, and very little groundwater development has occurred historically. Overall, DWR has reported that the Redding Groundwater Basin is stable, has good to excellent water quality, and has significant quantities of groundwater in storage(http://www.groundwater.water.ca.gov/bulletin118/basin_desc/basins_s.cfm#gwb45htm).

Develop Data and Groundwater Model – The ability to assess conjunctive water management potential in the Redding Sub-basin is limited largely by inadequate data. This inadequacy stems from the fact that groundwater is not extensively used throughout the sub-basin. What limited information does exist has been collected and reviewed. This limited information suggests that opportunities for conjunctive water management may exist; however, more detailed evaluation is required. A cooperative Redding Basin water supply and management plan is being done under the umbrella of Shasta County Water Agency and SCWUA. The plan includes an integrated ground-surface water model that will be used to evaluate conjunctive water management programs. A model of this type is required to address the potential yield of such a program and assist in evaluating the potential physical, social, and economic impacts of such a program.

Formulate Facility and Operational Concepts – A key factor for Redding Sub-basin conjunctive water management program is the geographic mismatch between the high-yield groundwater areas and the areas of high water use and expected future growth. The groundwater is in the central and southern end of the basin, and the potential users are primarily north and north/central. Accordingly, there are two potential major options. First is basically in-lieu “transfer” by having large users in the central and southern end of the sub-basin (ACID) pump groundwater and free up these same users’ surface water supplies for diversion by upstream M&I users such as Bella Vista Water District, City of Shasta Lake, and the City of Redding. Under this scenario, a series of extraction and monitoring wells would be located in the high-yield areas of the sub-basin and would most likely discharge into existing distribution facilities such as the ACID canal (or laterals off of the canal).

The second option is to have a “regional” pipeline network that ties together a series of regional extraction wells and conveys groundwater from the southern and south/central areas of the basin up to the north/central and northern areas. Potential parties for participation in a conjunctive water management program are ACID, City of Redding, Bella Vista Water District, and City of Shasta Lake. The cities are more likely to be able to afford cost of conjunctive water management development, but ACID overlays the high-yield groundwater areas and has the largest surface water supplies for in-basin exchanges. Transfers would be required to allow changes in surface water diversion from ACID to cities.

Evaluate Local and System Impacts – Implementation of a conjunctive water management program will result in some physical, social, and economic impacts to the Redding Sub-basin. These impacts, listed below, would ultimately need to be addressed through adoption of specific monitoring programs, as well as mitigation measures that would prevent or compensate for these impacts. Potential local impacts could include the following:

- Additional economic costs (such as capital costs, O&M costs, and mitigation and monitoring costs).
- Third party impacts (such as greater pumping lifts, well performance, dewatering of wells, impacts to other water rights holders in the basin).
- Physical impacts (affects on nearby streams, affects on wetland habitat, changes in crop yields for crops once irrigated by surface water and vice versa).

Potential system impacts could include the following:

- Adverse or beneficial changes in CVP operations.

Consider Legal, Institutional, and Stakeholder Needs – Groundwater management in California is an institutional challenge that has not yet been fully addressed. California landowners have a correlative right to extract as much groundwater as they can put to beneficial use on their overlying land. Two attempts to manage groundwater in the Redding Sub-basin include:

(1) The adoption of a groundwater management plan under the guise of AB 3030. The Redding Area Water Council is implementing this effort, with the Shasta County Flood Control and Water Conservation District serving as lead agency. The Redding Area Water Council consists of 13 members from both private and public entities.

(2) The adoption of a county ordinance by Shasta County. This ordinance requires a permit to extract groundwater underlying lands in Shasta County, either directly or indirectly. (A detailed discussion of this ordinance was provided in the DWR *Groundwater Hydrology Technical Memorandum, 2000*).

An institutional framework would be required of any regional conjunctive water management program. The framework would be responsible for promulgation and enforcement of operational elements and distribution of costs and benefits. This framework could possibly build upon the above groundwater management efforts, or a JPA could be formed. The managing body would focus on setting general annual targets (projections) of groundwater pumping, developing a monitoring program for levels-quantity-quality, and coordinating with outside water agencies (DWR and Reclamation). It could also possibly manage cooperative funding arrangements to help individual water agencies/users install major infrastructure (wells).

Outreach efforts would have to be launched early in the planning process to allow all stakeholders an opportunity to be heard, and to gather information needed to identify the parameters of a conjunctive water management program.

Recommendations

The following recommendations were identified related to advancing the potential to implement an appropriate conjunctive water management program within the Redding Sub-basin:

- *Begin CALFED-funded conjunctive water management study, per approved ACID CALFED grant. Phase 1 will focus on improved groundwater monitoring, canal leakage assessment, and groundwater modeling. Phase 2 will develop pilot program for 10,000 to 40,000 ac-ft per drought-year groundwater supply for Redding Sub-basin to facilitate beneficial in-sub-basin (or potentially out-of-sub-basin) transfers of surface water.*
- *Work with state and federal agencies to secure necessary funding for Phase 2 of ACID's conjunctive water management study.*
- *Incorporate Redding Sub-basin conjunctive water management operational concepts into subsequent regional gaming efforts.*
- *Form local working group composed of Redding Area Water Council members to coordinate with DWR's ISI-related conjunctive water management program and ensure local goals and objectives for conjunctive water management are reflected in larger planning efforts by DWR.*
- *Continue coordination, primarily through ACID, between SRSCs and Redding Area Water Council as the Shasta County Water Resources Master Plan's Phase 2 alternatives are developed. These will be long-term regional water management proposals for the Redding Sub-basin, scheduled for completion in summer 2001.*

Water Transfer Programs

Summary of Recent Water Transfer Activity

Water users in the Redding Sub-basin have engaged in water transfers in the past, and are expected to continue to use transfers as an effective water management option. Examples of recent transfers include the following.

- ACID regularly participates in the Pool, transferring a portion of the District's Project Supply to the Pool for use by other agricultural water users in the SRWCA.
- Reclamation and Townsend Flat Water Ditch Company's recent agreement represents a significant step forward for water transfers in the Redding Sub-basin. Under this agreement, Townsend Flat Water Ditch Company has transferred its pre-1914 water right on Clear Creek to Reclamation, in exchange for 6,000 ac-ft of settlement water from Reclamation. The transfer agreement is part of a larger agreement governing the removal of Saeltzer Dam to improve fish passage on Clear Creek. The transfer agreement allows Townsend Flat Water Ditch Company to transfer up to 3,360 ac-ft of the negotiated agreement supply for use outside of the Redding Sub-basin (Shasta County). These key elements of the agreement, relating to transfers of water rights, could have a major influence on the feasibility of future water transfers within the Sacramento Valley if applied to other pending or future water transfer efforts.

Potential for Future Water Transfers

The Redding Sub-basin, taken in total, typically has an overall balance between supplies and demands. However, individual water purveyors within the sub-basin face significant deficits in drought/critical years under their current CVP contracts. These same purveyors that face the most severe supply cutbacks do not typically have viable alternative supplies such as local groundwater. Within the Redding Sub-basin there are both surface and groundwater supplies that may have potential for use in future water transfers, and the area could likely benefit from intra-basin transfers to help balance the supplies and demands and alleviate the deficits caused by drought/critical year CVP supply cutbacks. Short-term transfers could be initiated during drought/critical years when some water purveyors have their surface water supplies reduced, or long-term transfers could be done to permanently reallocate supplies in a beneficial manner.

Given the sub-basin's significant groundwater and surface water resources, there may be potential for transfers with other Sacramento Valley water users downstream of the Redding Sub-basin. The Redding Sub-basin is in the unique position of being at the upstream end of the entire Sacramento Valley, allowing direct transfers to downstream water users, including other SRSCs and other agriculture and M&I users. Any transfers that used the Sacramento River as the conveyance route may also result in net increases in in-stream flows along the reach of the river between the Redding Sub-basin and the receiving entity's diversion.

Recommendations

In addition to the basinwide transfer-related recommendations made previously, the following recommendations are made specific to ACID and other entities within the Redding Sub-basin:

1. *Continue to pursue opportunities to transfer supplies within the Redding Sub-basin to assist in meeting sub-basin water requirements including recently approved ACID CALFED-funded conjunctive water management study.*

2. *Promote and participate in basinwide efforts to encourage transfer of Base and Project Supplies to assist in meeting in-sub-basin and basinwide water requirements.*

Sub-basin Drainwater Management

The Redding Sub-basin does not have significant levels of drainwater use. ACID is the only major irrigation district in the sub-basin, and has crop types and irrigation methods that do not result in the levels of drainwater generation and reuse typical of the other sub-basins in the Sacramento Basin. Therefore, regional agricultural drainwater management is not considered a significant potential future action for the Redding Sub-basin.

Potential does exist within the Redding Sub-basin to use treated wastewater for any number of uses including agricultural irrigation, landscape irrigation, and industrial processes such as cooling systems. Domestic potable use is also possible with proper treatment. The City of Shasta Lake, for example, has an M&I reuse program that uses treated wastewater for irrigation purposes such as freeway landscaping. The City's program may be expanded in the future to supply local industrial users also. Although M&I wastewater reuse is not addressed in detail in this BWMP, it is recognized that such reuse could result in numerous potential benefits, both in normal and dry periods. However, M&I wastewater reuse may require substantial infrastructure improvements such as new or upgraded water treatment facilities and separate non-potable distribution systems, and would require substantial public and agency involvement to ensure public acceptance.

Recommendations

The following recommendation is made related to the potential for reuse of treated M&I return water for the Redding Sub-basin:

1. *Use existing Redding Area Water Council forum to investigate potential for appropriate treated M&I wastewater reuse for supplemental or routine agricultural use, landscape irrigation, or industrial cooling purposes. Potential uses include cooling and process water supply to several large paper mills near the City of Anderson, the City of Redding's electrical power generation facilities, and large outdoor irrigation users such as golf courses, parks, cemeteries, and freeway landscape irrigation.*

Environmentally Beneficial Water Management Actions

Summary of Current Activities

There are several significant actions and programs underway in the Redding Sub-basin, related to water management, that are driven primarily by environmental improvement objectives, as well as potential for improved management. The following provides a summary of each.

Fish Screen Improvements – ACID's Lake Redding fish screen and ladder project is currently under construction and will provide a state-of-art fish screen and fish passage facility at the District's main canal intake on the Sacramento River. The project is being funded by CALFED and Reclamation, and is a cooperative undertaking between ACID, CALFED, Reclamation, and USFWS. ACID is also evaluating options to replace its South Bonnyview pump station on the Sacramento River to eliminate this diversion. The City of Redding has recently received funding to replace the fish screens on its main pump station diversion, just upstream from ACID's new facility, and is beginning the process to replace the old screen structure.

Watershed Management and Restoration – Three major watershed programs are in progress associated with Clear Creek, Battle Creek, and Cottonwood Creek. The Battle Creek project is a cooperative program to remove several hydropower dams and restore the watershed fishery along 45 miles for salmon and steelhead. The program involves several state and federal agencies and private organizations. Removal of Saeltzer Dam on Clear Creek was completed in summer 2000, and ongoing stream restoration programs are proposed to continue. The Cottonwood Creek watershed study program is currently in an early stage of formulation.

Recommendations

The following recommendations were identified to assist in promoting the maintenance and enhancement of environmental resources within the Redding Sub-basin:

1. *Evaluate presence of habitat related to water deliveries in relation to potential conservation options including canal lining and or additional drain maintenance with appropriate agencies.*
2. *Support and seek funding opportunities for additional fish passage enhancement projects including identifying most beneficial screen replacements and conveyance system improvements.*
3. *Support additional sub-basinwide watershed planning and enhancement efforts.*
4. *Support system gaming efforts to evaluate potential for maximizing environmental benefits while ensuring adequate water supplies to meet in-basin user water requirements.*

Redding Sub-basin Water Management Concepts

In addition to the identification of basinwide, sub-basin, and district-specific water management options, it was determined useful to identify water management concepts that could potentially be implemented at a sub-basin level. Concepts are potential actions based upon grouping identified options that appear to be reasonable and appropriate given the existing and projected water requirements and supplies within a particular sub-basin. It is recognized that the implementation of any of the identified concepts would likely require extensive coordination among stakeholders within a given sub-basin, as well as additional study, and would represent long-term actions. Primary issues associated with implementation of any of the options are discussed under the sub-basin and district-specific option sections. It is also recognized that implementing any concept would provide for optimizing normal- and dry-year supplies; the grouping of concepts within normal and drought years below is simply to allow for convenient discussion.

As described above, the identification of sub-basin-specific concepts is driven by the projected water requirement and available water supply. The projected water requirements and supplies for the year 2020 are identified for both the normal and drought condition per data developed in the BWMP in large part obtained from DWR. Supply is identified in terms of current contract supplies and provisions, and is shown as a range for some sub-basins given reductions in dry years and even normal years would vary depending on contract type and the severity of a given year of period. In general, it is assumed that CVP agricultural water service contract (WSC) deliveries could be reduced to zero and M&I WSC amounts reduced by 25 percent in drought years. Where appropriate, concepts that would involve other sub-basins are presented, as well as concepts that would generally be driven only by in-sub-basin users and facilities. It is the intent of these sections to provide for increased discussion, awareness, and analysis as determined appropriate by stakeholders across each sub-basin and the region in general.

Projected year 2020 supply (contracted amount, groundwater, and reuse/drainwater) versus water requirements is as follows:

Normal Year:

- Total water supplies and total contract amounts exceed requirements *(approximately 60,000 ac-ft).*
- M&I requirements exceed supply *(approximately 10,000 ac-ft).*

Drought Year:

- Total requirements exceed contract amount/supply *(approximately 10,000 to 40,000 ac-ft).*
- All sectors show deficit – assumed (based on historical use) to be made up by additional groundwater pumping.

Potential Concepts

Normal Years

- **Transfer –** ACID could transfer water available beyond its TDR to meet in-basin M&I users requirements (assumed to be approximately 10,000 ac-ft) and reduce the need to pump groundwater. Available water could also be transferred out-of-sub-basin to a variety of potential users.
- **Banking –** ACID could bank available supply in excess of TDR in groundwater basins (Redding, Colusa, and American assuming storage available) or future offstream storage location (e.g., Sites Reservoir in the Colusa Sub-basin). In-basin storage would require sufficient pumping to occur so as to allow for storage (currently, Redding and Colusa Sub-basins have minimal storage available given natural recharge typically exceeds pumping). Water could be credited either through Shasta release, water exchange, or direct monetary compensation.
- **Treated wastewater reuse** (normal and drought) **–** M&I discharge to the Sacramento River from local wastewater treatments plants (which is typically in the range of approximately 25,000 ac-ft per year) could be supplied to ACID and/or large industrial users or for landscape uses.

Drought Years

- **Transfer –** ACID could transfer available water in non-critical (those years when SRSCs have not had their contract amounts reduced) years and could be particularly valuable in dry years when SRSC entitlements are not reduced, assuming ACID TDR can be met. Transfers could be in- or out-of-sub-basin.
- **Groundwater/surface water exchange –** ACID could develop groundwater pumping capability–pumps 40,000 ac-ft (*unless surface water available*) and transfers 40,000 ac-ft of negotiated agreement surface water to M&I users. Program would necessitate water be recharged in normal and wet years.
- **Direct groundwater supply –** Regional transmission pipeline could be constructed for direct conveyance of 50,000 ac-ft of groundwater from south/central basin to meet in-sub-basin M&I northern/central area uses.
- **Conservation –** Could pursue potential for increased M&I and agricultural conservation where sub-basin benefits can be achieved.

Colusa Sub-basin

- **Glenn-Colusa Irrigation District**
- **Provident Irrigation District**
- **Princeton-Codora-Glenn Irrigation District**
- **Maxwell Irrigation District**
- **Reclamation District No. 108**

SECTION 16

Colusa Sub-basin

Summary of Water Supply Requirements and Sources

The following section presents a summary of the water supply requirements and the historical use of the various water sources used to meet these supply requirements in the Colusa Sub-basin. A water balance was presented for the Colusa Sub-basin in TM 4 that provided a summary of the physical flows of water into the basin, consumptive use within the sub-basin, and outflows from the sub-basin to either groundwater or return surface flows. By definition, the water balance shows no deficits or surpluses, only the flow of the physical quantity of water. For the purposes of proposing and evaluating potential regional water management actions, it is helpful to summarize water supply requirements and historical sources at a more detailed level, specifically at the level of user type (agricultural/M&I/ environmental) and water supply type (characterized both by source and contract category).

Figures 16-1 and 16-2 summarize the Colusa Sub-basin's overall water supply requirement for all use types and historical source use under normal and drought/critical years under 1995 and 2020 conditions, respectively. The SRSC quantities are presented next to the sub-basin totals to provide perspective on the significance of SRSC water management practices within the sub-basin. The following observations were made:

- Agricultural needs account for approximately 95 percent of the demand in the sub-basin (over 2 million ac-ft per year). Managed environmental water supply requirements (i.e., wildlife refuge demands) make up the other 5 percent of demand in the sub-basin, and M&I demands are relatively insignificant at less than 1 percent.
- SRSCs account for approximately 40 to 45 percent of total water use in the sub-basin (over 1 million ac-ft per year on average; over 850 taf/yr in drought years).
- Deliveries associated with CVP water service contracts range between 5 and 10 percent of total supply in the sub-basin (235 taf/yr on average; 135 taf/yr in drought years).
- Groundwater accounts for approximately 15 to 25 percent of total supply in the sub-basin (363 taf/yr on average; 477 taf/yr drought years).
- Drainwater use is an important water supply component to the sub-basin. Drainwater use is highly variable and not measured regionally; however, estimates suggest that approximately 400 to 450 taf/yr is reused. This accounts for approximately 15 to 20 percent of the total supply.

Tables 16-1, 16-2, 16-3, and 16-4 summarize water sources (characterized by source and contract type) and water supply requirements by user type for 1995 average and drought conditions and 2020 average and drought conditions, respectively. The numbers in these tables help to identify more specifically the discrete "blocks" of water users and sources, categorized by classifications that roughly match up with regional management "decision parameters" such as source type, volumes, institutional controls, and restrictions on source to help clarify potential management alternatives. This information also clearly shows supply and demand balances or imbalances within the sub-basin's major user categories. The following observations are noted for 2020 normal-year type conditions (Table 16-3):

- Possible availability of participating SRSC supplies for other in-basin needs (depending on timing).
- For the category of other agricultural users, existing CVP agricultural water service contracts could meet nearly one-third of their respective water requirements; however, delivery of full contract amount is unlikely under future conditions, increasing the likelihood of shortfalls (specifically in the TCCA area).
- On an aggregate basis, the sub-basin has adequate surface water supplies available in normal years to meet demands. The apparent future need resides in the ability to align these available supplies with future requirements of the different user types, particularly for TCCA.

The following observations are noted for 2020 drought-year type conditions (Table 16-4):

- Possible availability of participating SRSC supplies for other in-basin needs (depending on timing).
- For the category of other agricultural users, existing CVP agricultural water service contracts could meet nearly one-third of their respective water requirements; however, delivery of full contract amount in drought years is very unlikely under future conditions, increasing the likelihood of shortfalls.

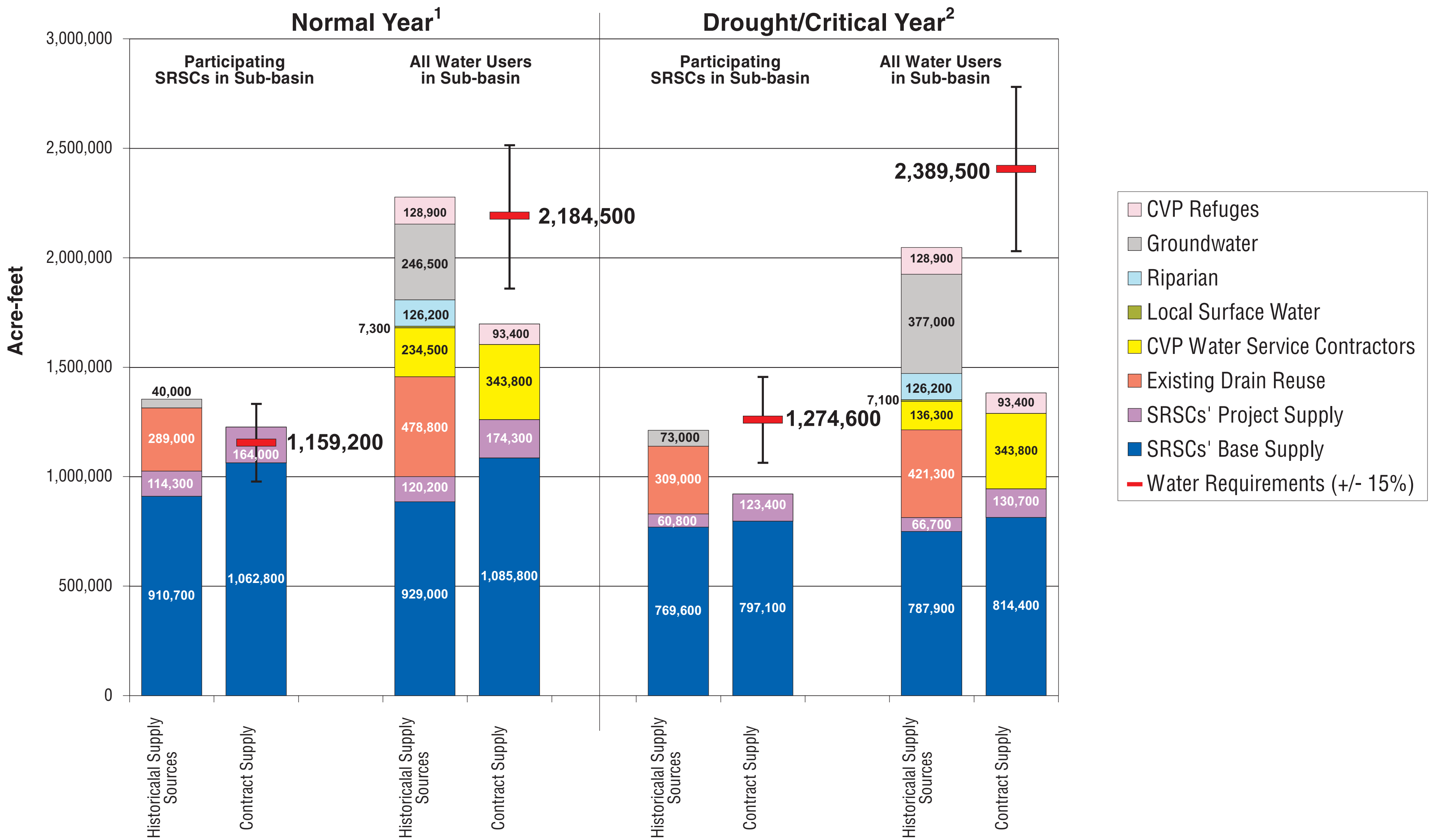
On an aggregate basis, the sub-basin falls short of having adequate surface water supplies available in drought years to meet demands. Often alternative supplies are used, including more reuse, more groundwater pumping, and transfer water. The CVP water service contractors (namely TCCA) are at greatest risk under drought conditions.

Conjunctive Water Management Program

Summary of Conjunctive Water Management Potential

Colusa Sub-basin has characteristics suitable for further developing conjunctive water management options. There is significant benefit to be gained from conjunctively managing surface and groundwater supplies, ranging from helping to meet water needs for in-basin users such as TCCA and Colusa Basin drain users to providing greater systemwide flexibility for CVP operations.

In addition to conjunctive water management actions that have already been implemented, there are several conjunctive water management program concepts being considered by districts in coordination with DWR, some of which involve SRSCs participating in the BWMP.



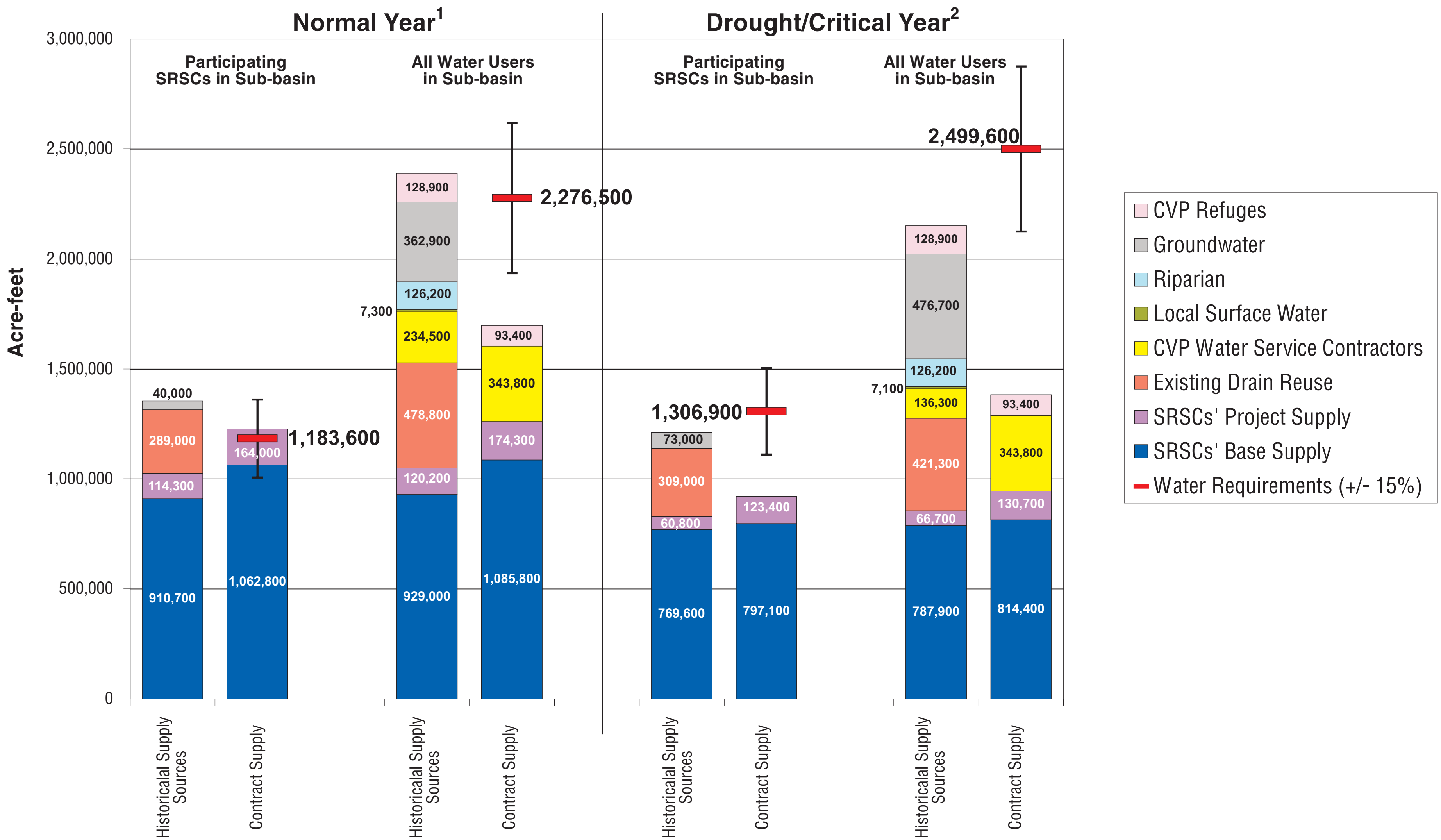
[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP water service contractors -- shown here as 100 percent; however, USBR has significantly reduced project deliveries during critcally dry periods.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 16-1
COLUSA SUB-BASIN 1995
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP water service contractors -- shown here as 100 percent; however, USBR has significantly reduced project deliveries during critcally dry periods.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 16-2
COLUSA SUB-BASIN 2020
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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TABLE 16-1
Colusa Sub-basin Potential Water Needs

	1995 Average Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	*1,159,173*[b]	*899,665*	10,700	*115,000*	2,184,538
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	1,062,820	23,011	0	0	1,085,831
SRSC Project Supply	164,000	10,314	0	0	174,314
CVP Water Service Contracts	N/A	343,836	0	93,350	437,186
SUBTOTAL	1,226,820	377,161	0	93,350	1,697,331
Supply from Other Sources[d]					
Sacramento River Riparian	0	104,513	0	21,700	126,213
Local Surface Water	0	7,300	0	0	7,300
Groundwater	*40,000*	194,400	12,100	0	246,500
Reuse/Drainwater	289,000	189,800	0	0	478,800
SUBTOTAL	329,000	496,013	12,100	21,700	858,813
TOTAL SUPPLIES	1,555,820	873,174	12,100	115,050	2,556,144

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Numbers in italics are preliminary approximations.
[c] Present contract amounts.
[d] Based on recent average historical use of these "other" supplies.

TABLE 16-2
Colusa Sub-basin Potential Water Needs

	1995 Drought Conditions				
	Participating SRSCs (ac-ft)	Other Agricultural Users (ac-ft)	M&I Users (ac-ft)	Managed[a] Environmental Uses (ac-ft)	TOTAL (ac-ft)
Annual Water Requirement	*1,274,573*[b]	*989,230*	*10,700*	*115,000*	2,389,503
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	797,115	17,258	0	0	814,373
SRSC Project Supply	123,375	7,361	0	0	130,736
CVP Water Service Contracts	N/A	120,343 to 343,836[d]	0	70,012 to 93,350	190,355 to 437,186
SUBTOTAL	920,490	144,962 to 368,455	0	70,012 to 93,350	1,135,464 to 1,382,295
Supply from Other Sources[e]					
Sacramento River Riparian	0	104,513	0	21,700	126,213
Local Surface Water	0	7,100	0	0	7,100
Groundwater	73,000	291,800	12,200	0	377,000
Reuse/Drainwater	309,000	112,316	0	0	421,316
SUBTOTAL	382,000	515,729	12,200	21,700	931,629
TOTAL SUPPLIES	1,302,490	660,691 to 884,184	12,200	91,712 to 115,050	2,067,093 to 2,313,924

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Numbers in italics are preliminary approximations.
[c] Present contract amounts.
[d] Quantities are shown as ranges given water service contract supplies have historically been reduced by up to 65 percent in drought years for agricultural water service contractors, and up to 25 percent for M&I and environmental water service contractors.
[d] Based on recent average historical use of these "other" supplies.

TABLE 16-3
Colusa Sub-basin Potential Water Needs

	2020 Average Conditions				
	Participating SRSCs (ac-ft)	**Other Agriculture Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	1,183,577	958,128	19,800	*115,000*[b]	2,276,505
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	1,062,820	23,011	0	0	1,085,831
SRSC Project Supply	164,000	10,314	0	0	174,314
CVP Water Service Contracts	N/A	343,836	0	93,350	437,186
SUBTOTAL	1,226,820	377,161	0	93,350	1,697,331
Supply from Other Sources[d]					
Sacramento River Riparian	0	104,513	0	21,700	126,213
Local Surface Water	0	7,300	0	0	7,300
Groundwater	*40,000*	304,700	18,200	0	362,900
Reuse/Drainwater	289,000	189,800	0	0	478,800
SUBTOTAL	329,000	606,313	18,200	21,700	975,213
TOTAL SUPPLIES	1,555,820	983,474	18,200	115,050	2,672,544

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Numbers in italics are preliminary approximations.
[c] Present contract amounts.
[d] Based on recent average historical use of these "other" supplies.

TABLE 16-4
Colusa Sub-basin Potential Water Needs

	2020 Drought Conditions				
	Participating SRSCs (ac-ft)	Other Agriculture Users (ac-ft)	M&I Users (ac-ft)	Managed[a] Environmental Uses (ac-ft)	TOTAL (ac-ft)
Annual Water Requirement	1,306,891	*1,057,953*[b]	*19,800*	*115,000*	2,499,644
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	797,115	17,258	0	0	814,373
SRSC Project Supply	123,375	7,361	0	0	130,736
CVP Water Service Contracts	N/A	120,343 to 343,836[d]	0	70,012 to 93,350	190,355 to 437,186
SUBTOTAL	920,490	144,962 to 368,455	0	70,012 to 93,350	1,135,464 to 1,382,295
Supply from Other Sources[e]					
Sacramento River Riparian	0	104,513	0	21,700	126,213
Local Surface Water	0	7,100	0	0	7,100
Groundwater	73,000	385,400	18,300	0	476,700
Reuse/Drainwater	309,000	112,316	0	0	421,316
SUBTOTAL	382,000	609,329	18,300	21,700	1,031,329
TOTAL SUPPLIES	1,302,490	754,291 to 977,784	18,300	91,712 to 115,050	2,166,793 to 2,413,624

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Number in italics are preliminary approximations.
[c] Present contract amounts.
[d] Quantities are shown as ranges given water service contract supplies have historically been reduced by up to 65 percent in drought years for agricultural water service contractors, and up to 25 percent for M&I and environmental water service contractors.
[e] Based on recent average historical use of these "other" supplies.

In general, successful conjunctive water management projects have certain common elements (see general discussion of conjunctive water management in Section 14). Table 16-5 summarizes the current status of these key elements within the Colusa Sub-basin.

Probably the most prohibitive physical elements for the Colusa Sub-basin are the limited facilities. Because groundwater is not used extensively in some parts of the sub-basin, additional infrastructure needs would likely be high, particularly in the form of well fields and transmission facilities connecting them to existing surface water distribution systems. Another challenging area would be in the legal and institutional elements. This is discussed further under the heading Consider Legal, Institutional, and Stakeholder Needs.

TABLE 16-5
Summary Status of Colusa Sub-basin Conjunctive Water Management Elements

Element	Currently Present	Comments
Available surface supplies	Possibly	Depends on timing and expected future regional needs.
Usable groundwater storage	Yes	(See the DWR *Groundwater Hydrology Technical Memorandum,* 2000).
Groundwater recharge facilities	No	No regional facilities, however, areas conducive to recharge are prevalent, especially in the Stony Creek fan area.
Groundwater extraction facilities	Limited	Private pumpers exist (such as those used on GCID conjunctive water management efforts in recent drought years during the 1990s).
Transmission/distribution facilities	Limited	Some facilities already exist. Depends on type of conjunctive water management program and the participants.
Monitoring facilities	Limited	Additional monitoring wells required (or identified).
Institutional framework	AB 3030; County Ordinances (Glenn, Colusa, Yolo)	Could facilitate management; could possibly pursue JPAs or similar management arrangement.
Financing mechanism	None in place	Funding could be pursued through DWR ISI, Reclamation, and legislation.

Assessment of Conjunctive Water Management Potential

A critical aspect of developing conjunctive water management projects is the identification, development, and evaluation of these elements. A process diagram was introduced earlier for carrying out this activity (see Conjunctive Water Management). This evaluation process is applied here in an effort to assess the opportunity for conjunctive water management in the Colusa Sub-basin.

Identify Candidate Basins – DWR (see the DWR *Groundwater Hydrology Technical Memorandum*, 2000) has identified Colusa Sub-basin as having groundwater characteristics suitable for further developing conjunctive water management options.

Estimates of perennial yield are limited by availability of data and modeling. However, DWR indicated that Colusa Sub-basin has some of the greatest potential for conjunctive water management in the Sacramento Basin.

Develop Data and Groundwater Model – Districts in coordination with DWR have been collecting important data to allow further evaluation of groundwater management options in the Sacramento Valley. Presently, DWR is developing an integrated surface-groundwater model for the lower Colusa Basin. This tool will allow further evaluation of conjunctive water management scenarios.

Formulate Facility and Operational Concepts – Dry-year supplies could be developed through various options or some combination of options including the following: carry forward ongoing conjunctive water management investigations (efforts involving RD 108, GCID, PID, MID, and other districts). Initial estimates of potential dry-year yield range from 35,000 to 100,000 ac-ft per year (according to regional conjunctive water management feasibility studies completed by districts in coordination with DWR). These studies involve in-lieu type recharge components and direct recharge components. For example, the northern third of the sub-basin is conducive to both types of recharge (in the vicinity of the Stony Creek Fan area); however, the southern two-thirds of the sub-basin are more conducive to in-lieu because of soil conditions (i.e., permeability limits efficient recharge through direct means). Continue to pursue outside funding through government programs such as CALFED Conjunctive Use Grant program (i.e., possibly use MID's Conjunctive Use Project grant application as a model for securing future available funds).

It is imperative that efforts to coordinate with other programs, such as the DWR ISI Conjunctive Use Program and the DWR Bulletin 118 update, continue. Information from these efforts could help further shape regional conjunctive water management programs in the sub-basin. Outside funding assistance through government programs such as the California Water Bond (Proposition 13) and AB 303 should also be considered to help finance future programs.

Evaluate Local and System Impacts – Implementation of a conjunctive water management program will result in some physical, social, and economic impacts to the Colusa Sub-basin. These impacts, listed below, would ultimately be addressed through adoption of specific monitoring programs, and with mitigation measures that would prevent or compensate for these impacts. Potential local impacts could include the following:

- Additional economic costs (such as capital costs, O&M costs, and mitigation and monitoring costs).
- Third party impacts (such as greater pumping lifts, well performance, dewatering of wells, impacts to other water rights holders in the basin).
- Physical impacts (affects on nearby streams, affects on wetland habitat, changes in crop yields for crops once irrigated by surface water and vice versa).

Potential system impacts could include the following:

- Adverse or beneficial changes in CVP operations.

Consider Legal, Institutional, and Stakeholder Needs – Groundwater management in California is an institutional challenge that has not yet been fully addressed. California landowners have a correlative right to extract as much groundwater as they can put to beneficial use on their overlying land. Attempts to manage groundwater in the Colusa Sub-basin include the following:

- AB 3030 efforts
- County ordinance efforts (Glenn, Colusa, and Yolo)

Many stakeholders are concerned that sub-basin or basinwide water management options would result in inequities among water users within a large sub-basin like Colusa. These inequities are due in part to the wide variation in physical characteristics, infrastructure, and supply sources, which can limit the benefit to some water users, or even negatively impact them. Greater flexibility in managing water throughout a basin is required to overcome these differences (i.e., regional conjunctive water management programs can benefit greatly from a transfer element that would provide greater flexibility to move water between participants). However, institutional/legal impediments exist that prevent this needed flexibility. First, while limited transfers of Project Water provide some relief toward this need, additional flexibility to move surface and groundwater among users within a basin is required. Secondly, some regional oversight of these supplies is needed to establish the operational criteria for regional water management. This oversight could be provided by an umbrella-type agency formed under the auspices of a JPA, or possibly an MOU among the project participants. Only through these types of cooperative arrangements can basin management objectives, operational criteria, financing, and other requirements of a regional management option be formulated and implemented.

Recommendations

In addition to the overall regional conjunctive water management recommendations made previously (see Section 14), the following recommendations are made specific to SRSCs and other entities within the Colusa Sub-basin:

1. *Continue to assess ongoing regional conjunctive water management studies, such as those previously evaluated by districts (in coordination with DWR) and others.*

2. *Continue to coordinate with DWR, counties, and other stakeholders towards regional conjunctive water management programs in a cooperative fashion. This may require forming MOUs and possibly JPAs that, as an initial purpose, would address basin management objectives, transfer issues, and generally define what steps need to be taken to work around barriers that normally hinder regional conjunctive water management programs.*

3. *Consider potential funding opportunities, either through direct means or through in-kind services from programs such as:*

   – *The California Water Bond (Proposition 13).*
   – *AB 303 (The Local Groundwater Management Assistance Act 2000).*
   – *The Integrated Storage and Investigation Conjunctive Use Initiative.*
   – *Future CALFED Grant Application programs.*

4. *Integrate proposed regional conjunctive water management projects into ongoing and future gaming exercises and modeling studies to better define the potential impacts and net benefits.*

Water Transfer Programs

Summary of Recent Water Transfer Activity

Water users in the Colusa Sub-basin have engaged in water transfers in the past, and are expected to continue to use transfers to the extent possible. Each SRSC within the sub-basin (GCID, PID, PCGID, and MID) participates in the Pool, transferring a portion of Project Supply to the Pool for use by other agricultural water users in the SRWCA. As described previously, and consistent with districts within other sub-basins, the greatest amount of transfer activity occurred in 1994 in response to dry conditions and Reclamation's allowance of additional transfers. Additionally, each SRSC in the Colusa Sub-basin transfers water directly to the Colusa Basin Mutual Water Company via a "sub-pool" administered by the SRWCA as follows:

- **GCID –** Operating agreement (in place annually since 1998) to ensure up to 15,000 ac-ft of water is available within the Colusa Drain for Colusa Basin Mutual Water Company use. Amount of annual transfer limited by agreement with Reclamation based on agreed upon total GCID irrigated acreage (127,000 acre "cap").
- **RD 108 –** Participated in the State Drought Water Bank and met requirements during that year with groundwater. Currently pumping approximately 10,000 ac-ft of drainwater into drains rather than Sacramento River as done previously to facilitate greater drainwater reuse. The District and SMWC recently completed a water transfer related to weed abatement to Contra Costa Water District.
- **PID –** Transferred 2,000 ac-ft over last 2 years (1999 and 2000).
- **PCGID –** 4,000 ac-ft transferred over last 2 years (1999 and 2000).

Other notable transfers within the basin have been primarily conducted by GCID, including the transfer of 11,000 ac-ft in 1998 to Sacramento Area Flood Control Association. The District's formal policy on transfers is that priority is first given to in-basin uses, environmental uses, and then out-of-basin uses. GCID also is continuing their in-basin transfer program to adjacent landowners which was begun in 1997 and will likely continue. The District anticipates that future transfers under this program will likely total approximately 5,500 ac-ft in most years except critically dry years when supplies are reduced by 25 percent. In addition to GCID's programs, PID and PCGID have transferred water when available to the state during dry periods.

Potential for Future Water Transfers

The Colusa Sub-basin, taken in total, typically has an overall balance between supplies and demands. Reuse of water is extensive within District boundaries, and drainwater from upstream districts is a substantial source of water for many agricultural districts. GCID has historically had some water available for transfer in non-critical months during normal years, a trend that is likely to continue. However, like the Redding Sub-basin, individual water purveyors within the sub-basin face significant deficits in drought/critical years under their current CVP contracts. Key entities that fall within this category are the members of TCCA given their status as CVP water service contractors, as well as the Colusa Drain Mutual Water Company. In dry years, these purveyors face the most severe supply cutbacks and do not typically have viable alternative supplies such as local groundwater. Additionally, those districts that rely heavily on drainwater from other districts such as Colusa Drain Mutual Water Company are heavily impacted in dry years, given less drainwater is typically available because of increased reuse upstream. As described above, agreements are in place with Colusa Drain Mutual Water Company to assist in meeting water requirements. Transfers to TCCA have not occurred within the basin, in large part because of the costs associated with wheeling the water.

Short-term or temporary transfers could be initiated during drought/critical years when some water purveyors have their surface water supplies reduced sharply, or long-term transfers could be made to permanently reallocate supplies in a beneficial manner. As discussed earlier, the potential to accomplish substantial transfers of water is constrained by existing regulations and policy. Given in-basin needs can be met, the potential for transfers with other Sacramento Valley water users downstream, as well as out-of-basin users, is also a possibility. Such transfers may also result in net increases in in-stream flows along the reach of the river between the Colusa Sub-basin and the receiving entity's diversion.

Recommendations

In addition to the basinwide transfer-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the Colusa Sub-basin:

1. *Continue to pursue opportunities to transfer supplies within the Colusa Sub-basin to assist in meeting in-sub-basin water requirements.*
2. *Promote and participate in basinwide efforts to encourage transfer of Base and Project Supplies to assist in meeting in-sub-basin and basinwide water requirements.*

Sub-basin Drainwater Management

Existing Development

As shown in Table 16-2, drainwater reuse accounts for over 420,000 ac-ft per year of supply within the Colusa Sub-basin. Major entities that use drainwater or are involved in its management within the sub-basin include the TCCA member districts, GCID, PID, PCGID, MID, RD 108, the Colusa Basin Drain Users Association members, the Sacramento National Wildlife Refuge complex, and several reclamation districts. Given the high level of drain-water reuse, existing drainwater management agreements, and drain reuse infrastructure, the Colusa Sub-basin may have the strongest potential of any area in the Sacramento Valley for effective regional drainwater management.

Potential Program Objectives and Benefits

Potential regional drainwater management program objectives and benefits could include some or all of the following: modification of Sacramento River diversion patterns in support of short-term in-stream flow targets; drought-year increase in drainwater reuse together with other supplies such as groundwater to support beneficial intra-basin or out-of-basin transfers of other supplies; improved monitoring of drainwater quality and soil salinity impacts, both by location and season, with increased ability to track soil salinity accumulation and set soil leaching targets; improved management of return flow water quality impacts to meet in-stream water quality targets at key downstream points in the Sacramento River; and increased supply reliability to drainwater users with few or no alternative supplies.

Recommendations

In addition to the basinwide drainwater management-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the Colusa Sub-basin:

1. *Convene a local working group with representatives of the major drainwater users in the Colusa Sub-basin. Begin an initial screening-level evaluation of the feasibility of regional drainwater management and possible opportunities, objectives, and benefits. The following steps would support the initial evaluation.*
2. *Collect and review existing reports, agreements, project proposals, and operations data related to drainwater use and management in the Colusa Sub-basin. Compile this information into a summary report that presents key information such as annual drainwater use, seasonal outflow and diversion patterns, major drains and control facilities such as weirs and pump stations, and all major discharge and diversion points.*
3. *Identify major information and/or data gaps from above, and produce a list of recommended flow monitoring stations or other data collection steps to fill in critical gaps. These could include new flow and water quality monitoring stations at key points along the Colusa Drain and at major drain weirs and outfalls from district service areas, meters on drain pumps, and regular quality sampling of drainwater supplies to fields in areas of heavy drainwater use.*
4. *Apply for available CALFED funding to install regional monitoring stations and provide support for the data collection program and applicable next steps.*
5. *Evaluate the potential role of regional drainwater management as it might relate to other regional programs in the Colusa Sub-basin, such as conjunctive water management and transfers.*
6. *As applicable, build from these steps and carry out a detailed feasibility study of a regional drainwater management program for the Colusa Sub-basin.*

Environmentally Beneficial Water Management Actions

Summary of Current Activities

There are several significant actions and programs underway in the Colusa Sub-basin, related to water management, that are driven primarily by environmental improvement objectives. The following provides a summary of each.

Fish Screen Improvements – Fish screen improvements are either underway or have been recently completed for all SRSCs within the sub-basin. PID and PCGID’s joint screen and pump facility at Sidds Landing is now operational, as well as MID’s improved screen facility. RD 108’s fish screen facility, which is one of the larger screens on the river, is now also fully operational. GCID’s Hamilton City screen site, which will be among the largest fish screens in the world, is scheduled for completion in 2001. All of these efforts were undertaken jointly with state and federal agencies in response to fishery concerns and received significant funding assistance from the CALFED program.

Watershed Management and Restoration – Aside from the Sacramento River, the potential for restoration of key tributaries continues to be assessed. The installation of a siphon under Stony Creek allowed GCID to permanently remove their seasonal dam across the creek and as a result improve fish access. The installation of the siphon was a result of Reclamation reaching agreement with GCID to improve District facilities to allow for increased supplies to the Sacramento Complex that includes the Sacramento, Delevan, and Colusa National Wildlife refuges. Reclamation continues to sponsor a stakeholder process focused on appropriate use of Stony Creek, given the multiple uses that occur within and directly adjacent to the creek. Progress continues on developing a solution at TCCA's Red Bluff Diversion Dam (located north of the Colusa Sub-basin near Red Bluff) to provide improved fish passage while ensuring reliable supplies for TCCA member districts. The Colusa Basin Drainage District recently released a draft environmental impact statement/report evaluating the proposed construction of a series of flood detention dams and basins on west-side ephemeral stream, restoration measures, and a developed water supply.

As described in TM 2, rice lands provide habitat for waterfowl during spring and summer months, as well as during winter in fields that are flooded to promote rice stubble decomposition. Such fields add substantially to the amount of habitat available within the basin in addition to the refuges identified above and private wetland areas.

Recommendations

The following recommendations were identified to assist in promoting the maintenance and enhancement of environmental resources within the Colusa Sub-basin:

1. *Continue to seek opportunities to provide habitat for waterfowl through encouraging rice flooding practices, including rice stubble decomposition.*
2. *Promote increased water supply reliability for private wetland areas and development of additional wetland areas where practical.*
3. *Work with USFWS and California Department of Fish and Game to promote maintenance of habitat associated with agricultural drains (and canals where feasible) while encouraging existing agricultural uses.*
4. *Evaluate presence of habitat related to water deliveries in relation to potential conservation options including canal lining and or additional drain maintenance with appropriate agencies.*
5. *Support and seek funding opportunities for additional fish passage enhancement projects including identifying most beneficial screen replacements and conveyance system improvements*
6. *Support additional sub-basinwide watershed planning and enhancement efforts.*
7. *Support system gaming efforts to evaluate potential for maximizing environmental benefits while ensuring adequate water supplies to meet in-basin user water requirements.*

Colusa Sub-basin Water Management Concepts

In addition to the identification of basinwide, sub-basin, and district-specific water management options, it was determined useful to identify water management concepts that could potentially be implemented at a sub-basin level. Concepts are potential actions based upon grouping identified options that appear to be reasonable and appropriate given the existing and projected water requirements and supplies within a particular sub-basin. It is recognized that the implementation of any of the identified concepts would likely require extensive coordination among stakeholders within a given sub-basin, as well as additional study, and would represent long-term actions. Primary issues associated with implementation of any of the options are discussed under the sub-basin and district-specific option sections. It is also recognized that implementing any concept would provide for optimizing normal and dry year supplies; the grouping of concepts within normal and drought years below is simply to allow for convenient discussion.

As described above, the identification of sub-basin-specific concepts is driven by the projected water requirement and available water supply. The projected water requirements and supplies for the year 2020 are identified for both the normal and drought condition per data developed in the BWMP in large part obtained from DWR. Supply is identified in terms of current contract supplies and provisions, and is shown as a range for some sub-basins given reductions in dry years and even normal years would vary depending on contract type and the severity of a given year of period. In general, it is assumed that CVP agricultural WSC deliveries could be reduced to zero and M&I WSC amounts reduced by 25 percent in drought years. Where appropriate, concepts that would involve other sub-basins are presented, as well as concepts that would generally be driven only by in-sub-basin users and facilities. It is the intent of these sections to provide for increased discussion, awareness, and analysis as determined appropriate by stakeholders across each sub-basin and the region in general.

Projected year 2020 supply (contracted amount, groundwater, and reuse/drainwater) versus water requirements are as follows:

Normal Year:

- Total supply exceeds requirements *(approximately 400,000 ac-ft).*
- Some WSCs deficient (districts within TCCA) – M&I requirements are insignificant.

Drought Year:

- Total requirements exceed contract amount/supply *(approximately 100,000 to 400,000 ac-ft).*
- Majority of deficiency associated with agricultural WSCs (TCCA).

Potential Concepts/Actions

Normal Years

- **Transfer –** SRSCs (GCID, PID, PCGID, RD 108, and MID; GCID most likely to potentially have available supplies) could transfer water available in excess of their respective TDRs to meet in-basin WSC user requirements (assumed to be approximately

350,000 ac-ft). Surface water could also be made available to substitute for current groundwater pumping *(current in-sub-basin pumping is approximately 350,000 ac-ft; however, such pumping would likely be encouraged under the conjunctive water management concept identified below to "free up" space for groundwater storage)*. Available water could also be transferred out-of-sub-basin to a variety of potential users.

- **Drainwater Reuse Management –** SRSCs could reduce reuse/drainwater use by increasing river diversions to full contract to allow for flushing of salts related to salinity concerns. Increased use of drainwater and general reuse in drought years (see below under drought years).
- **Banking/Conjunctive Water Management –** SRSCs could bank available supply in excess of individual TDRs in groundwater basins (Redding, Colusa, and American assuming storage available) or future offstream storage location (e.g., Sites Reservoir in the Colusa Sub-Basin). In-basin banking would require infrastructure improvements and numerous agreements with M&I entities to manage the groundwater supplies. Water could be credited either through Shasta release, water exchange, direct monetary compensation.
- **Offstream Storage –** (normal and drought conditions) – Multiple in- and out-of-sub-basin management possibilities with potential to assist in meeting water requirements of agricultural, environmental, or M&I users; bank supplies/drought-year protection.

Drought Years

- **Drainwater Reuse Management (increase reuse/drainwater use) –** SRSCs could increase reuse/drainwater use – to assist in meeting increased TDR requirements in drought conditions (river diversions would be increased in normal and wet conditions to decrease salt loads as described above). River diversions could be reduced to assist other users if respective TDRs can be met (potential to do so in dry years when SRSC entitlements are not reduced; surface water potentially transferred in- or out-of-sub-basin if available).
- **Banking/Conjunctive Water Management –** SRSCs could develop additional groundwater pumping capability and/or coordinate with private pumpers – pump water banked during normal periods (potentially more if requirements necessitate). See above under normal years.
- **Transfers –** SRSCs could transfer available water in non-critical (years when SRSC contract supplies are not reduced) years; could be particularly valuable in dry years when SRSC entitlements are not reduced, assuming respective SRSC TDRs can be met). Transfers could be in- or out-of-sub-basin. Water could also be transferred into the sub-basin in particularly dry years from willing sellers including ACID, or other willing sellers to assist in meeting sub-basin drought-year requirements (including potential SRSC requirements).
- **Offstream Storage –** (normal and drought conditions) – Multiple in- and out-of-sub-basin management possibilities with potential to assist in meeting water requirements of agricultural, environmental, or M&I users; bank supplies/drought-year protection.
- **Conservation –** Could pursue potential for increased agricultural conservation (M&I requirements limited within the sub-basin) where sub-basin benefits can be achieved.

Butte Sub-basin

- Reclamation District No. 1004

SECTION 17

Butte Sub-basin

Summary of Water Supply Requirements and Sources

The following section presents a summary of the water supply requirements and the historical use of the various water sources used to meet these supply requirements in the Butte Sub-basin. A water balance was presented for the Butte Sub-basin in TM 4 that provided a summary of the physical flows of water into the basin, consumptive use within the sub-basin, and outflows from the sub-basin to either groundwater or return surface flows. By definition, the water balance shows no deficits or surpluses, only the flow of the physical quantity of water. For the purposes of proposing and evaluating potential regional water management actions, it is more helpful to summarize water supply requirements and historical sources at a more detailed level, specifically at the level of user type (agricultural/ M&I/environmental) and water supply type (characterized both by source and contract category).

Figures 17-1 and 17-2 summarizes the Butte Sub-basin's overall water supply requirement for all use types and historical sources used under normal and drought/critical years under 1995 and 2020 conditions, respectively. The SRSC quantities are presented next to the sub-basin totals to provide perspective on the significance of SRSC water management practices within the sub-basin. The following observations were made:

- Agricultural needs account for approximately 98 percent of the demand in the sub-basin (over 725 taf/yr, depending on hydrologic and other factors). Managed environmental water supply requirements (i.e., wildlife refuge demands) are not a significant demand on the sub-basin, and M&I demands are relatively insignificant at less than 2 percent.
- SRSCs account for less than 15 percent of total water use in the sub-basin, ranging from 70 to 85 taf/yr, depending on hydrologic conditions and other factors.
- There are no CVP water service contractors in the sub-basins.
- Groundwater accounts for approximately 30 to 40 percent of total supply in the sub-basin (228 taf/yr on average; 255 taf/yr drought years).
- Drainwater use is an important water supply component to the sub-basin. Drainwater use is highly variable and not measured regionally; however, estimates suggest that approximately 80 to 100 taf/yr is reused. This accounts for approximately 10 to 15 percent of the total supply.

Tables 17-1, 17-2, 17-3, and 17-4 summarize water sources (characterized by source and contract type) and water supply requirements by user type for 1995 average and drought conditions and 2020 average and drought conditions, respectively. The numbers in these tables help to identify more specifically the discrete "blocks" of water users and sources categorized by classifications that roughly match up with regional management "decision parameters" such as source type, volumes, institutional controls, and restrictions on source to help clarify potential management alternatives. This information also clearly shows supply and demand balances or imbalances within the sub-basin's major user categories. The following observations are noted for 2020 normal-year type conditions (Table 17-3):

- On an aggregate basis, the sub-basin has adequate surface water supplies available in normal years to meet demands. However, drainwater reuse ranges from 10 to 15 percent of total use, and if this supply were to diminish under future conditions, shortages could develop.

The following observations are noted for 2020 drought-year type conditions (Table 17-4):

- For the both the participating SRSCs and other agricultural user categories, the supply mix does not appear adequate to meet the estimated annual water requirements. Under drought conditions, greater reliance on other sources, specifically groundwater and drainwater, would be required to meet unmet demands.

Conjunctive Water Management Program

Summary of Conjunctive Water Management Potential

Butte Sub-basin has many characteristics suitable for further developing conjunctive water management options. In general, successful conjunctive water management projects have certain common elements (see general discussion of conjunctive water management in Section 14). Table 17-5 summarizes the current status of these key elements within the Butte Sub-basin.

Assessment of Conjunctive Water Management Potential

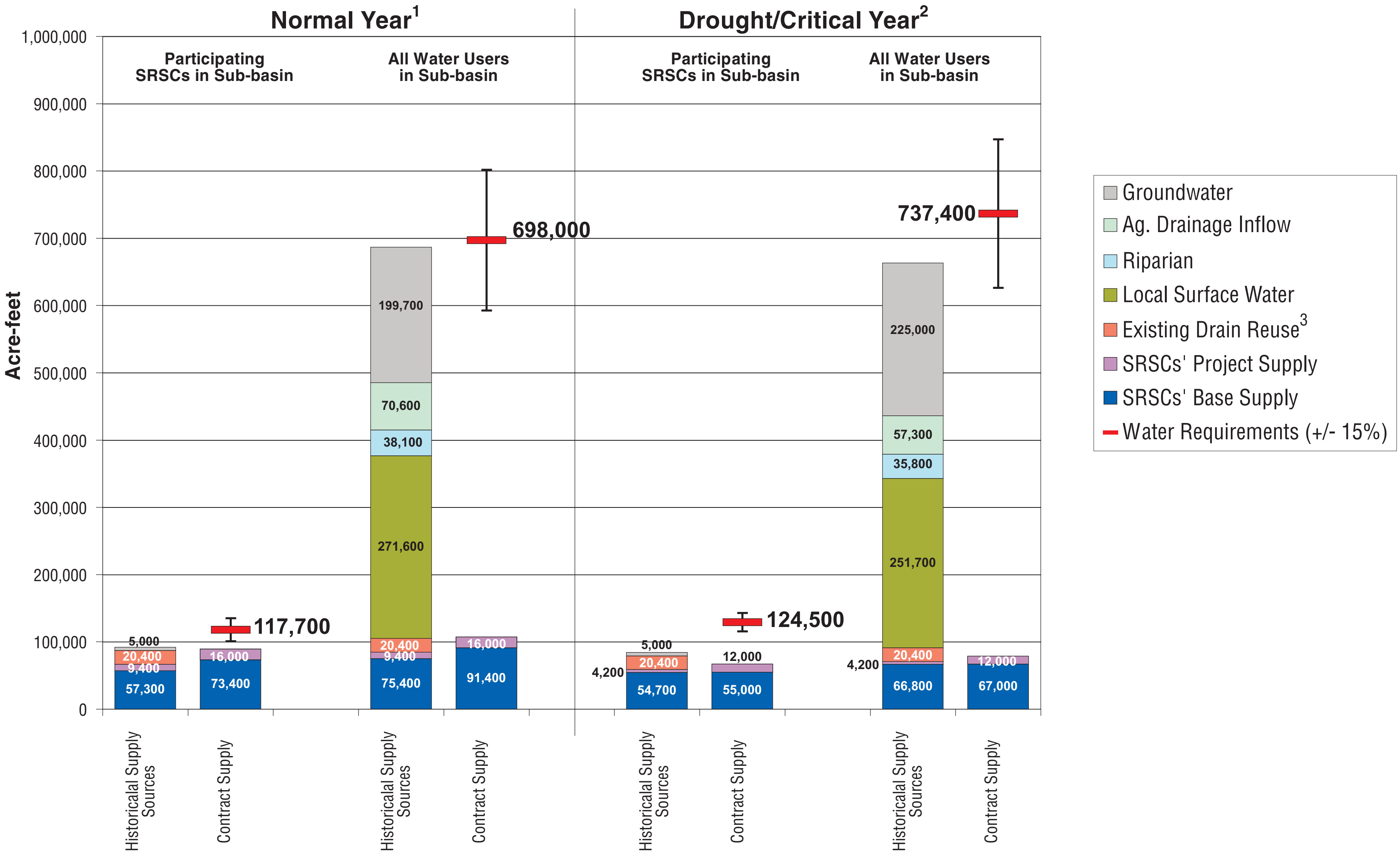
A critical aspect of developing conjunctive water management projects is the identification, development, and evaluation of these elements. A process diagram was introduced earlier for carrying out this activity (see Regional Conjunctive Water Management Options). This evaluation process is applied here in an effort to assess the opportunity for conjunctive water management in the Butte Sub-basin.

Identify Candidate Basins – DWR (see the DWR *Groundwater Hydrology Technical Memorandum,* 2000) has identified Butte Sub-basin as having some potential conjunctive water management opportunities. Estimates of perennial yield are limited by availability of data and modeling.

Develop Data and Groundwater Model – Districts in coordination with DWR (namely Butte Water User's Association) have been collecting important data to allow further evaluation of groundwater management options.

Formulate Facility and Operational Concepts

Because of Butte Sub-basin's unique qualities, in terms of surface and groundwater supplies, opportunities appear to exist for enhancing in-basin management of these supplies. It is imperative that efforts to coordinate with other programs, such as the DWR ISI Conjunctive Use Program and the DWR Bulletin 118 update, continue. Information from these efforts could help further shape regional conjunctive water management programs in the sub-basin. Outside funding assistance through government programs such as the California Water Bond (Proposition 13) and AB 303 should also be considered to help finance future programs.



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100%.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP Water Service Contractors -- shown here as 100 percent, however, USBR has significantly reduced project deliveries during critcally dry periods.

[3]Reuse for participating SRSCs only. It does not include reuse by others.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

W062004006RDD_21 TM 6 (7/21/04)

FIGURE 17-1
BUTTE SUB-BASIN 1995
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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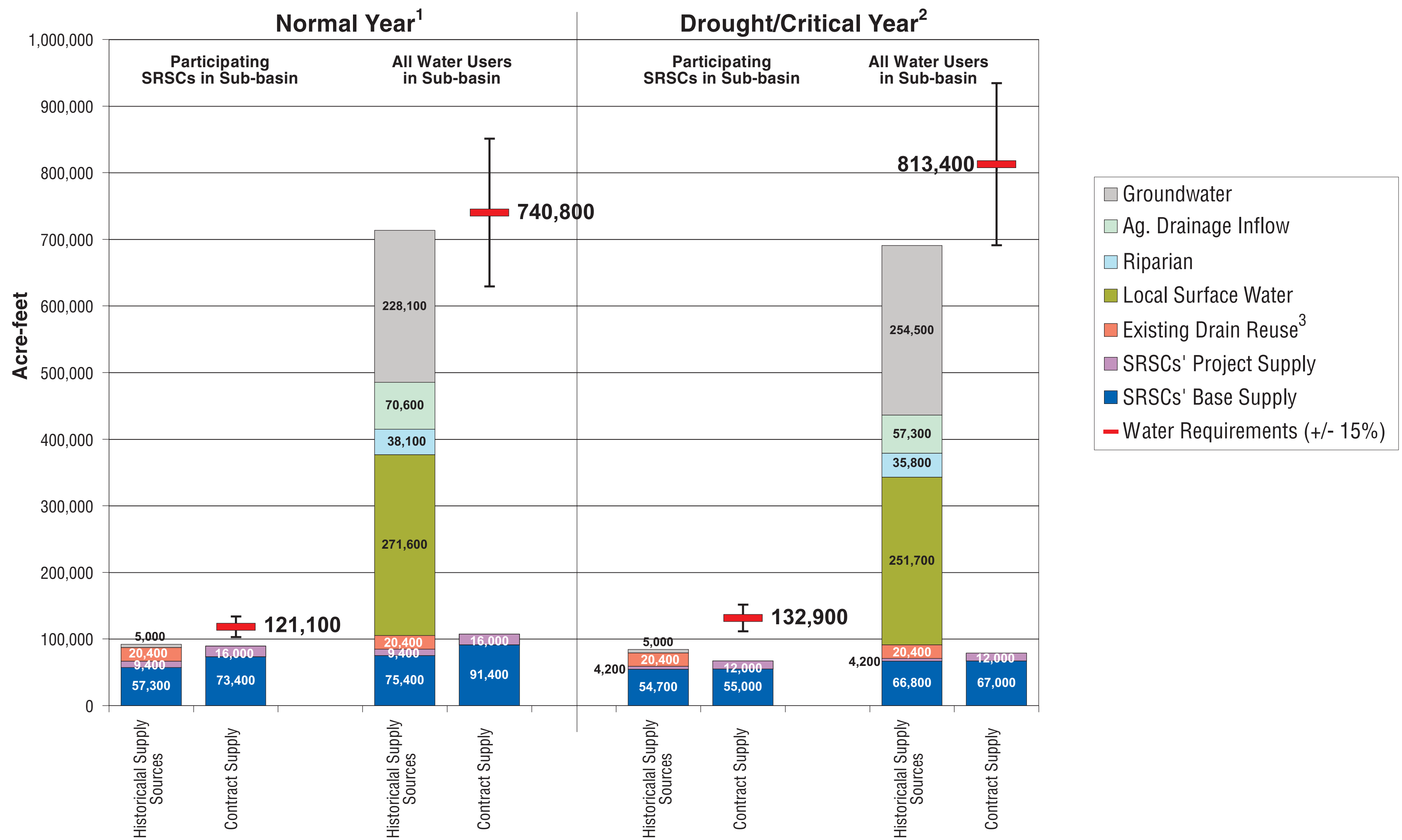
in association with
MONTGOMERY WATSON HARZA
MBK



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100%.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP Water Service Contractors -- shown here as 100 percent, however, USBR has significantly reduced project deliveries during critcally dry periods.

[3]Reuse for participating SRSCs only. It does not include reuse by others.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

W062004006RDD_19 TM 6 (7/21/04)

FIGURE 17-2
BUTTE SUB-BASIN 2020
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 –SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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TABLE 17-1
Butte Sub-basin Potential Water Needs

	1995 Average Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	117,745	570,180	10,100	0	698,025
Annual Water Supplies					
CVP Water Supply[b]					
SRSC Base Supply	73,380	18,045	0	0	91,425
SRSC Project Supply	15,976	0	0	0	15,976
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	89,356	18,045	0	0	107,401
Supply from Other Sources[c]					
Sacramento River Riparian	0	38,061	0	0	38,061
Local Surface Water	0	271,600	0	0	271,600
Groundwater	*5,000*[d]	184,600	10,100	0	199,700
Reuse/Drainwater	20,400	70,600	0	0	91,000
SUBTOTAL	25,400	564,861	10,100	0	600,361
TOTAL SUPPLIES	114,756	582,906	10,100	0	707,762

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Present contract amounts.
[c] Based on recent average historical use of these "other" supplies.
[d] Numbers in italics are preliminary approximations.

TABLE 17-2
Butte Sub-basin Potential Water Needs

	1995 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	*124,484*[b]	*602,843*	*10,100*	0	737,427
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	55,035	12,012	0	0	67,047
SRSC Project Supply	11,982	0	0	0	11,982
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	67,017	12,012	0	0	79,029
Supply from Other Sources[d]					
Sacramento River Riparian	0	35,802	0	0	35,802
Local Surface Water	0	251,700	0	0	251,700
Groundwater	*5,000*	203,500	16,500	0	225,000
Reuse/Drainwater	20,400	57,300	0	0	77,700
SUBTOTAL	25,400	548,302	16,500	0	590,202
TOTAL SUPPLIES	92,417	560,314	16,500	0	669,231

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Numbers in italics are preliminary approximations.
[c] Present contract amounts.
[d] Based on recent average historical use of these "other" supplies.

TABLE 17-3
Butte Sub-basin Potential Water Needs

	2020 Average Conditions				
	Participating SRSCs (ac-ft)	**Other Agriculture Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	121,000	604,945	14,800	0	740,845
Annual Water Supplies					
CVP Water Supply[b]					
SRSC Base Supply	73,380	18,045	0	0	91,425
SRSC Project Supply	15,976	0	0	0	15,976
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	89,356	18,045	0	0	107,401
Supply from Other Sources[c]					
Sacramento River Riparian	0	38,061	0	0	38,061
Local Surface Water	0	271,600	0	0	271,600
Groundwater	*5,000*[d]	207,800	15,300	0	228,100
Reuse/Drainwater	20,400	70,600	0	0	91,000
SUBTOTAL	25,400	588,061	15,300	0	628,761
TOTAL SUPPLIES	114,756	606,106	15,300	0	736,162

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Present contract amounts.
[c] Based on recent average historical use of these "other" supplies.
[d] Numbers in italics are preliminary approximations.

TABLE 17-4
Butte Sub-basin Potential Water Needs

	2020 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agriculture Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	132,916	*663,971*[b]	*16,500*	0	813,387
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	55,035	12,012	0	0	67,047
SRSC Project Supply	11,982	0	0	0	11,982
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	67,017	12,012	0	0	79,029
Supply from Other Sources[d]					
Sacramento River Riparian	0	35,802	0	0	35,802
Local Surface Water	0	251,700	0	0	251,700
Groundwater	*5,000*	233,000	16,500	0	254,500
Reuse/Drainwater	20,400	57,300	0	0	77,700
SUBTOTAL	25,400	577,802	16,500	0	619,702
TOTAL SUPPLIES	92,417	589,814	16,500	0	698,731

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Numbers in italics are preliminary approximations.
[c] Present contract amounts.
[d] Based on recent average historical use of these "other" supplies.

TABLE 17-5
Summary Status of Butte Sub-basin Conjunctive Water Management Elements

Element	Currently Present	Comments
Available surface supplies	Possibly	Depends on timing and expected future regional needs.
Usable groundwater storage	Yes	(see DWR *Groundwater Hydrology Technical Memorandum*, 2000).
Groundwater recharge facilities	No	No regional facilities. No information on direct recharge potential.
Groundwater extraction facilities	Yes	Private pumpers exist and meet approximately one-third of requirement.
Transmission/distribution facilities	Limited	
Monitoring facilities	Limited	Additional monitoring wells required (or identified).
Institutional framework	AB 3030; Butte County Ordinance	Could facilitate management. JPA or similar management arrangement could be considered.
Financing mechanism	None in place	Funding could be pursued through DWR ISI, Reclamation, and legislation.

Evaluate Local and System Impacts – Implementation of a conjunctive water management program will result in some physical, social, and economic impacts to the Butte Sub-basin. These impacts, listed below, would ultimately be addressed through adoption of specific monitoring programs, and with mitigation measures that would prevent or compensate for these impacts. Potential local impacts could include the following:

- Additional economic costs (such as capital costs, O&M costs, and mitigation and monitoring costs).
- Third party impacts (such as greater pumping lifts, well performance, dewatering of wells, impacts to other water rights holders in the basin).
- Physical impacts (affects on nearby streams, affects on wetland habitat, changes in crop yields for crops once irrigated by surface water and vice versa).

Potential system impacts could include the following:

- Adverse or beneficial changes in CVP operations.

Consider Legal, Institutional, and Stakeholder Needs – Groundwater management in California is an institutional challenge that has not yet been fully addressed. California landowners have a correlative right to extract as much groundwater as they can put to beneficial use on their overlying land. Attempts to manage groundwater in the Butte Sub-basin include the following:

- Ongoing local water management planning efforts
- AB 3030 efforts
- County ordinance (Butte County)

Stakeholders are concerned that sub-basin or basinwide water management options would result in inequities among water users within a large sub-basin like Butte. These inequities are due in part to the wide variation in physical characteristics, infrastructure, and supply sources, which can limit the benefit to some water users, or even negatively impact them. Greater flexibility in managing water throughout a basin is required to overcome these differences (i.e., regional conjunctive water management programs can benefit greatly from a transfer element that would provide greater flexibility to move water between participants). However, institutional/legal impediments exist that prevent this needed flexibility. First, while limited transfers of Project Water provide some relief towards this need, additional flexibility to move surface and groundwater among users within a basin is required. Secondly, some regional oversight of these supplies is needed to establish the operational criteria for regional water management. This oversight could be provided by an umbrella-type agency formed under the auspices of a JPA, or possibly an MOU among the project participants. Only through these types of cooperative arrangements can basin management objectives, operational criteria, financing, and other requirements of a regional management option be formulated and implemented.

Recommendations

In addition to the overall regional conjunctive water management recommendations made previously (see Section 14), the following recommendations are made specific to SRSCs and other entities within the Butte Sub-basin:

1. *Continue to coordinate with DWR, counties, and other stakeholders toward regional conjunctive water management programs in a cooperative fashion. This may require forming MOUs and possibly JPAs that, as an initial purpose, would address basin management objectives, transfer issues, and generally define what steps need to be taken to work around barriers that normally hinder regional conjunctive water management programs.*
2. *Consider potential funding opportunities, either through direct means or through in-kind services from programs such as:*
   - *The California Water Bond (Proposition 13).*
   - *AB 303 (The Local Groundwater Management Assistance Act 2000).*
   - *The Integrated Storage and Investigation Conjunctive Use Initiative.*
3. *Promote focused public information effort to educate concerned upper Northern California stakeholders as to the potential benefits or impacts of regional conjunctive water management programs.*
4. *Integrate proposed regional conjunctive water management projects into ongoing and future gaming exercises and modeling studies to better define the potential impacts and net benefits.*

Water Transfer Programs

Summary of Recent Water Transfer Activity

Water users in the Butte Sub-basin have engaged in water transfers in the past, and are expected to continue to use transfers to the extent possible. Both M&T Chico Ranch (MTCR) and RD 1004 have participated in the Pool, but have not committed to or purchased water from the Pool since 1994 and 1990, respectively. In addition, a portion of the Western Canal Water District, which is a state water contractor, is also included in the sub-basin. Western Canal Water District has not transferred water to other SRSCs in the sub-basin, but did make water available for sale during the State Drought Water Bank in 1994.

Potential for Future Water Transfers

The Butte Sub-basin typically has an overall balance between supplies and demands. Reuse of water occurs within district boundaries, and drainwater from upstream districts is a source of water for agricultural districts. Groundwater is also a significant portion of total water supplies used within the sub-basin. Butte Creek also is used as a source of supply for RD 1004 to the extent water is available; supplies are generally very limited in dry years. Given the use of drainwater and reliance on drainwater from upstream users, neither MTCR nor RD 1004 would typically have large supplies of water available for transfer, particularly in dry years. As is of true of other sub-basins, districts that rely on drainwater from other districts are impacted in dry years because less drainwater is typically available because of increased reuse upstream. Accordingly, the sub-basin should be viewed as one that would likely be seeking to transfer water in rather than having supplies available for transfer out (assuming current cropping patterns).

Short-term or temporary transfers into the sub-basin could be initiated during drought/ critical years when some water purveyors have their surface water supplies reduced sharply, or long-term transfers could be done to permanently reallocate supplies in a beneficial manner. As discussed earlier, the potential to accomplish substantial transfers of water is constrained by existing regulations and policy. Given in-basin needs can be met, the potential for transfers with other Sacramento Valley water users downstream, as well as out-of-basin users, is also a possibility. Such transfers may also result in net increases in in-stream flows along the reach of the river between the Butte Sub-basin and the receiving entity's diversion.

Recommendations

In addition to the basinwide transfer-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the Butte Sub-basin:

1. *Continue to pursue opportunities to transfer supplies within the Butte Sub-basin to assist in meeting in-sub-basin water requirements.*

2. *Promote and participate in basinwide efforts to encourage transfer of Base and Project Supplies to assist in meeting in-sub-basin and basinwide water requirements.*

Sub-basin Drainwater Management

Existing Development

As shown in Table 17-2, drainwater reuse accounts for approximately 78,000 ac-ft per year of supply within the Butte Sub-basin. Major entities that use drainwater or are involved in its management within the sub-basin include RD 1004, MTCR, Western Canal Water District, Richvale Irrigation District, several reclamation districts, numerous individual riparian and drain users along Butte Creek and the Butte Sink area, and USFWS and California Department of Fish and Game through their holdings in several wildlife management areas. Drainwater return flows and diversions are an integral part of the lower Butte Creek and Butte Slough hydrology during much of the year, and play a critical role in both irrigation supply and in-stream flow management. The Lower Butte Creek Project, which was began in 1997, is a major effort by local stakeholders to develop regional alternatives for improved fish passage, agricultural water supply, and seasonal wetlands and other habitat management. The project has evaluated a wide range of structural and institutional alternatives to meet these objectives, and is currently implementing several capital projects along lower Butte Creek to improve flow control and fish passage. There have also been important water transfer and in-stream flow management agreements worked out among the parties to help meet in-stream flow objectives.

Based on the high level of drainwater reuse, existing efforts at regional management practices, and the extensive drain reuse infrastructure, the Butte Sub-basin may have strong potential for effective regional drainwater management.

Potential Program Objectives and Benefits

Potential regional drainwater management program objectives and benefits could include some or all of the following: modification of Sacramento River and/or Butte Creek diversion patterns in support of short-term in-stream flow targets; drought year-increase in drainwater reuse together with other supplies such as groundwater to support beneficial intra-basin or out-of-basin transfers to other water users; improved monitoring of drainwater quality and soil salinity impacts, both by location and season, with increased ability to track soil salinity accumulation and set soil leaching targets; improved management of return flow water quality impacts to meet in-stream water quality targets at key downstream points such as the Butte Slough Outfall gates and the East-West Diversion Weir at the head of the Sutter Bypass; and increased supply reliability to drainwater users with few or no alternative supplies.

Recommendations

In addition to the basinwide drainwater management-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the Butte Sub-basin:

1. *Convene a local working group with representatives of the major drainwater users in the Butte Sub-basin. The existing Lower Butte Creek Project participants would be a potential starting point for such a group. Begin an initial screening-level evaluation of the feasibility of regional drainwater management and possible opportunities, objectives, and benefits. The following steps would support the initial evaluation.*

2. *Collect and review existing reports, agreements, project proposals, and operations data related to drainwater use and management in the Butte Sub-basin. Compile this information into a summary report that presents key information such as annual drainwater use, seasonal inflow and diversion patterns, major drains and control facilities such as weirs and pump stations, and all major discharge and diversion points.*

3. *Identify major information and/or data gaps from above, and produce a list of recommended flow monitoring stations or other data collection steps to fill in critical gaps. These could include incorporating flow and quality measurement at the new control structures proposed under the Lower Butte Creek Project and other points such as the Butte Slough Outfall Gates and the East-West Diversion Weir.*
4. *Apply for available CALFED funding to install regional monitoring stations and provide support for the data collection program and applicable next steps.*
5. *Evaluate the potential role of regional drainwater management as it might relate to other regional programs such as conjunctive water management and transfers.*
6. *As applicable, build from these steps and carry out a detailed feasibility study of a regional drainwater management program for the Butte Sub-basin.*

Environmentally Beneficial Water Management Actions

Summary of Current Activities

Several significant actions and programs have been completed or are underway in the Butte Sub-basin, related to water management, that are driven primarily by environmental improvement objectives. The following provides a summary of each.

Fish Screen/Passage Improvements – Fish screen improvements have been recently completed for both RD 1004 and MTCR. In addition to the improved MTCR pump and screen facility, an agreement was reached with Reclamation so that MTCR decreased their diversion on Butte Creek by 40 cubic feet per second from October 1 through June 30, thereby enhancing Butte Creek flows. The Western Canal Water District recently completed installation of a siphon across Butte Creek and the subsequent removal of four dams to improve fish passage on the creek. Each of these projects were undertaken jointly with state and federal agencies in response to fishery concerns and received significant funding assistance from the CALFED program.

Watershed Management and Restoration – Butte Creek remains a focus of restoration efforts given its importance in providing valuable salmonid habitat, particularly to spring-run salmon. The Lower Butte Creek Project is a stakeholder- and agency-driven program begun in 1997 to evaluate and implement fish passage improvements while maintaining water deliveries. Projects associated with the Lower Butte Creek Project currently under development within the sub-basin include improvements at the Butte Creek/Sanborn Slough Bifurcation Structure, White Mallard Dam, White Mallard Outfall, and Drumheller Slough Outfall. These projects are all directly adjacent to RD 1004. Other related fish passage improvement facilities are being investigated in the area. Aside from the state and federal resource agencies, key organizations involved in restoration efforts include Ducks Unlimited, Nature Conservancy, and California Waterfowl Association. These and other restoration efforts along the creek south of the Butte Sub-basin are expected to continue and be supported by resource agencies.

As described in TM 2, rice lands provide habitat for waterfowl during spring and summer months, as well as during winter in fields that are flooded to promote rice stubble decomposition. Such fields add substantially to the amount of habitat available within the basin in addition to the refuges identified above and private wetland areas.

Recommendations

The following recommendations were identified to assist in promoting the maintenance and enhancement of environmental resources within the Butte Sub-basin:

1. *Continue to seek opportunities to provide habitat for waterfowl through encouraging rice flooding practices, including rice stubble decomposition.*
2. *Promote increased water supply reliability for private wetland areas and development of additional wetland areas where practical.*
3. *Work with USFWS and California Department of Fish and Game to promote maintenance of habitat associated with agricultural drains (and canals where feasible) while encouraging existing agricultural uses.*
4. *Evaluate presence of habitat related to water deliveries in relation to potential conservation options including canal lining and/or additional drain maintenance with appropriate agencies.*
5. *Support and seek funding opportunities for additional fish passage enhancement projects including identifying most beneficial screen replacements and conveyance system improvements.*
6. *Support additional sub-basinwide watershed planning and enhancement efforts.*
7. *Support system gaming efforts to evaluate potential for maximizing environmental benefits while ensuring adequate water supplies to meet in-basin user water requirements.*

Butte Sub-basin Water Management Concepts

In addition to the identification of basinwide, sub-basin, and district-specific water management options, it was determined useful to identify water management concepts that could potentially be implemented at a sub-basin level. Concepts are potential actions based upon grouping identified options that appear to be reasonable and appropriate given the existing and projected water requirements and supplies within a particular sub-basin. It is recognized that the implementation of any of the identified concepts would likely require extensive coordination among stakeholders within a given sub-basin, as well as additional study, and would represent long-term actions. Primary issues associated with implementation of any of the options are discussed under the sub-basin and district-specific option sections. It is also recognized that implementing any concept would provide for optimizing normal and dry-year supplies; the grouping of concepts within normal and drought years below is simply to allow for convenient discussion.

As described above, the identification of sub-basin-specific concepts is driven by the projected water requirement and available water supply. The projected water requirements and supplies for the year 2020 are identified for both the normal and drought condition per data developed in the BWMP in large part obtained from DWR. Supply is identified in terms of current contract supplies and provisions, and is shown as a range for some sub-basins given reductions in dry years and even normal years would vary depending on contract type and the severity of a given year of period. In general, it is assumed that CVP agricultural WSC deliveries could be reduced to zero and M&I WSC amounts reduced by 25 percent in drought years. Where appropriate, concepts that would involve other sub-basins are presented, as well as concepts that would generally be driven only by in-sub-basin users and facilities. These sections provide increased discussion, awareness and analysis, as determined appropriate by stakeholders across each sub-basin and the region in general.

Normal Year:

- Total supply generally equals requirements
- SRSCs about 15 percent of total sub-basin requirement/supply, majority of other agricultural users' supplies from the SWP

Drought Year:

- Total requirements exceed contract amount/supply *(approximately 100,000 ac-ft)*
- Deficiency generally split between SRSCs and other agricultural users

Potential Concepts/Actions

Normal Years

- **Transfer –** SRSCs (RD 1004 and MTCR) could transfer water available in excess of their respective TDRs out-of-sub-basin to a variety of potential users or to in-sub-basin users to reduce the need to pump groundwater within the sub-basin if determined to be beneficial *(current in-sub-basin pumping is approximately 225,000 ac-ft)*.
- **Drainwater Reuse Management –** SRSCs could reduce reuse/drainwater use by increasing river diversions to full contract to allow for flushing of salts related to salinity concerns. Increased use of drainwater and general reuse in drought years (see below under drought years).
- **Banking/Conjunctive Water Management –** SRSCs could bank available supply in excess of individual TDRs in in-sub-basin groundwater basin or out-of-sub-basin locations (Redding, Colusa, and American assuming storage available) or future offstream storage location (e.g., Sites Reservoir in the Colusa Sub-basin). In-basin storage would require sufficient pumping to allow for storage (currently, Redding and Colusa Sub-basins have minimal storage available given natural recharge typically exceeds pumping). Water could be credited either through Shasta release, water exchange, or through direct monetary compensation.
- **Offstream Storage –** (normal and drought conditions) – Multiple in- and out-of-sub-basin management possibilities with potential to assist in meeting water requirements of agricultural, environmental, or M&I users; bank supplies/drought-year protection.

Drought Years

- **Drainwater Reuse Management (increase reuse/drainwater use) –** SRSCs could increase reuse/drainwater use – to assist in meeting increased TDR requirements in drought conditions. Could reduce river diversions to assist other users if respective

TDRs can be met (potential to do so in dry years when SRSC entitlements are not reduced; surface water potentially transferred in- or out-of-sub-basin if available).

- **Banking/Conjunctive Water Management –** SRSCs could develop additional ground-water pumping capability and/or coordinate with private pumpers–pump water banked during normal periods (potentially more if requirements necessitate) as well as coordinate with other agricultural users, including those receiving SWP supplies. See above under normal years.
- **Transfers –** SRSCs could transfer available water in non-critical years and could be particularly valuable in dry years when SRSC entitlements are not reduced, assuming respective SRSC TDRs can be met. Transfers could be in- or out-of-sub-basin. Water could also be transferred into the sub-basin in particularly dry years from willing sellers including ACID, or other willing sellers to assist in meeting sub-basin drought-year requirements (including potential SRSC requirements).
- **Offstream Storage –** (normal and drought conditions) – Multiple in- and out-of-sub-basin management possibilities with potential to assist in meeting water requirements of agricultural, environmental, or M&I users; bank supplies/drought-year protection.
- **Conservation –** Pursue potential for increased agricultural conservation (M&I requirements limited within the sub-basin) where sub-basin benefits can be achieved.

Sutter Sub-basin

- **Meridian Farms Water Company**
- **Sutter Mutual Water Company**
- **Pelger Mutual Water Company**

SECTION 18
Sutter Sub-basin

Summary of Water Supply Requirements and Sources

The following section presents a summary of the water supply requirements and the historical use of the various water sources used to meet these supply requirements in the Sutter Sub-basin. Note that in TM 4, a water balance was presented for the Sutter Sub-basin that provided a summary of the physical flows of water into the basin, consumptive use within the sub-basin, and outflows from the sub-basin to either groundwater or return surface flows. By definition, the water balance shows no deficits or surpluses, only the flow of the physical quantity of water. For the purposes of proposing and evaluating potential regional water management actions, it is more helpful to summarize water supply requirements and historical sources at a more detailed level, specifically at the level of user type (agricultural/M&I/environmental) and water supply type (characterized both by source and contract category).

Figures 18-1 and 18-2 summarize the Sutter Sub-basin's overall water supply requirement for all use types and historical source use under normal and drought/critical years under 1995 and 2020 conditions, respectively. The SRSC quantities are presented next to the sub-basin totals to provide perspective on the significance of SRSC water management practices within the sub-basin. The following observations were made:

- Agricultural needs account for approximately 99 percent of the demand in the sub-basin (over 350 taf/yr, depending on hydrologic and other factors). Managed environmental water supply requirements (i.e., wildlife refuge demands) are not a significant demand on the sub-basin, and M&I demands are relatively insignificant at less than 1 percent.
- SRSCs account for about 85 percent of total water use in the sub-basin, ranging from 250 taf/yr to nearly 300 taf/yr, depending on hydrologic conditions and other factors.
- There are no CVP water service contractors in the sub-basins.
- Groundwater is used very sparingly because of poor quality.
- Drainwater use is an important water supply component to the sub-basin. Drainwater use is highly variable and not measured regionally; however, estimates suggest that approximately 65 to 75 taf/yr is reused. This accounts for approximately 15 to 20 percent of the total supply.

Tables 18-1, 18-2, 18-3, and 18-4 summarize water sources (characterized by source and contract type) and water supply requirements by user type for 1995 average and drought conditions and 2020 average and drought conditions, respectively. The numbers in these tables help to identify more specifically the discrete "blocks" of water users and sources categorized by classifications that roughly match up with regional management "decision parameters" such source type, volumes, institutional controls, and restrictions on source to help clarify potential management alternatives. This information also clearly shows supply and demand balances or imbalances within the sub-basin's major user categories. The following observations are noted for 2020 normal-year type conditions (Table 18-3):

- Possible availability of participating SRSC supplies for other in-basin needs (depending on timing).
- Limited groundwater availability, from a regional perspective, due in large part to the poor quality of groundwater in the southern half of the sub-basin. However, on a local scale, groundwater has been used to help meet demands; for example, PMWC relies on groundwater as a normal part of its resource mix.

The following observations are noted for 2020 drought-year type conditions (Table 18-4):

- For participating SRSC and other agricultural users, there is a greater reliance on drainwater reuse due to reductions in Sacramento River supplies and limited availability of groundwater supplies. Therefore, shortages are possible under future drought conditions.

Conjunctive Water Management Program

Summary of Conjunctive Water Management Potential

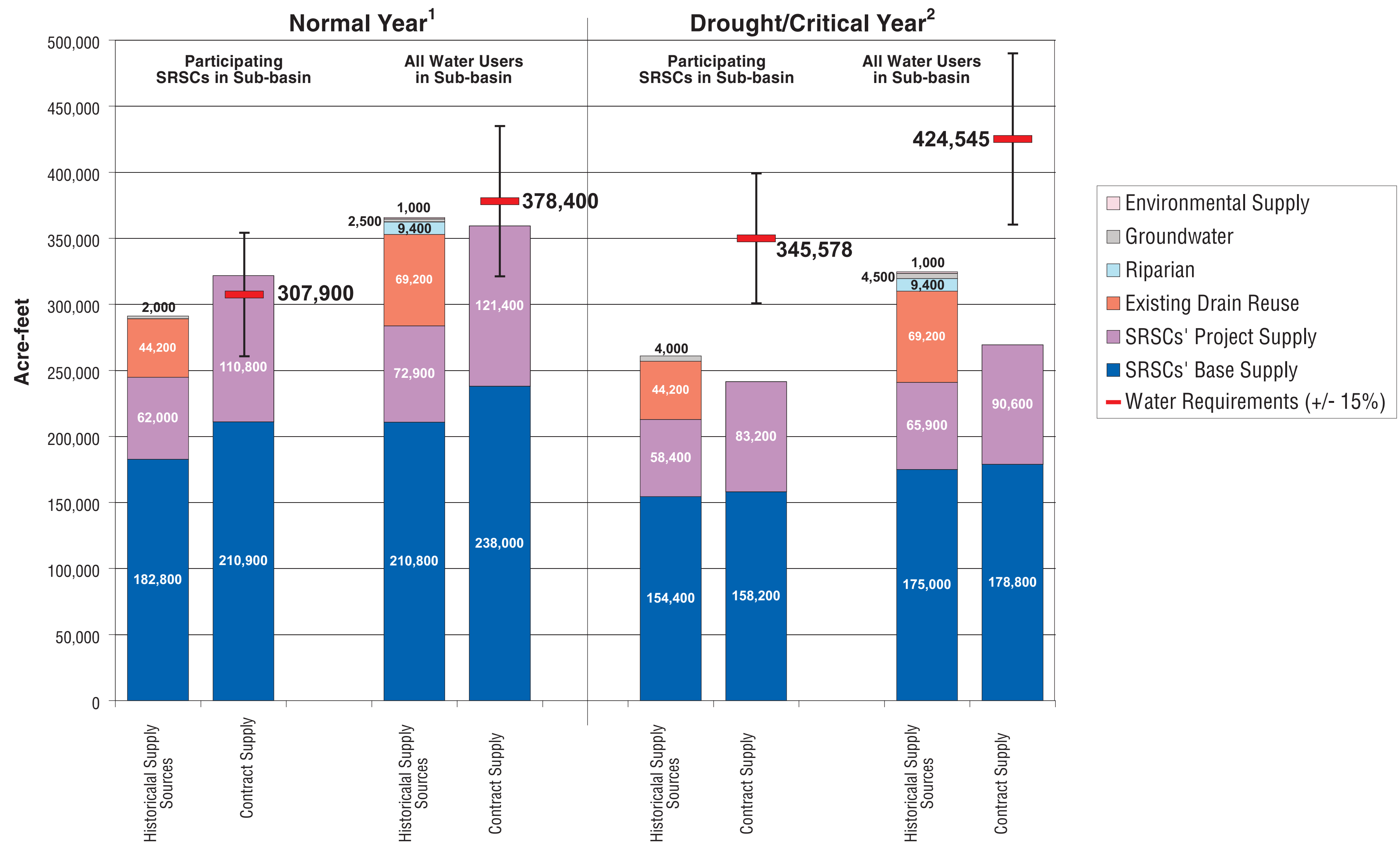
For the southern portion of Sutter Sub-basin (those areas occupied primarily by SMWC and PMWC), groundwater is limited because of widespread shallow saline water. As a result, developing conjunctive water management projects with extraction facilities in these areas would likely be problematic (extraction would cause these areas of poor-quality water to expand into areas that are currently useable). However, areas in the southern half of the sub-basin could conceivably participate in a regional program that encompassed the entire sub-basin (MFWC and Tisdale Irrigation and Drainage Company [TIDC] are situated in the northern half of the sub-basin). The northern half of the sub-basin does not suffer the same regional water quality concerns, and is likely more conducive to conjunctive water management.

In general, successful conjunctive water management projects have certain common elements (see general discussion of conjunctive water management in Section 14). Table 18-5 summarizes the current status of these key elements within the Sutter Sub-basin.

Assessment of Conjunctive Water Management Potential

A critical aspect of developing conjunctive water management projects is the identification, development, and evaluation of these elements. A process diagram was introduced earlier for carrying out this activity (see Regional Conjunctive Water Management Options). This evaluation process is applied here in an effort to assess the opportunity for conjunctive water management in the Sutter Sub-basin.

Identify Candidate Basins – The DWR (see the DWR *Groundwater Hydrology Technical Memorandum*, 2000) has identified Sutter Sub-basin as having very limited characteristics conducive to groundwater recharge and banking programs.



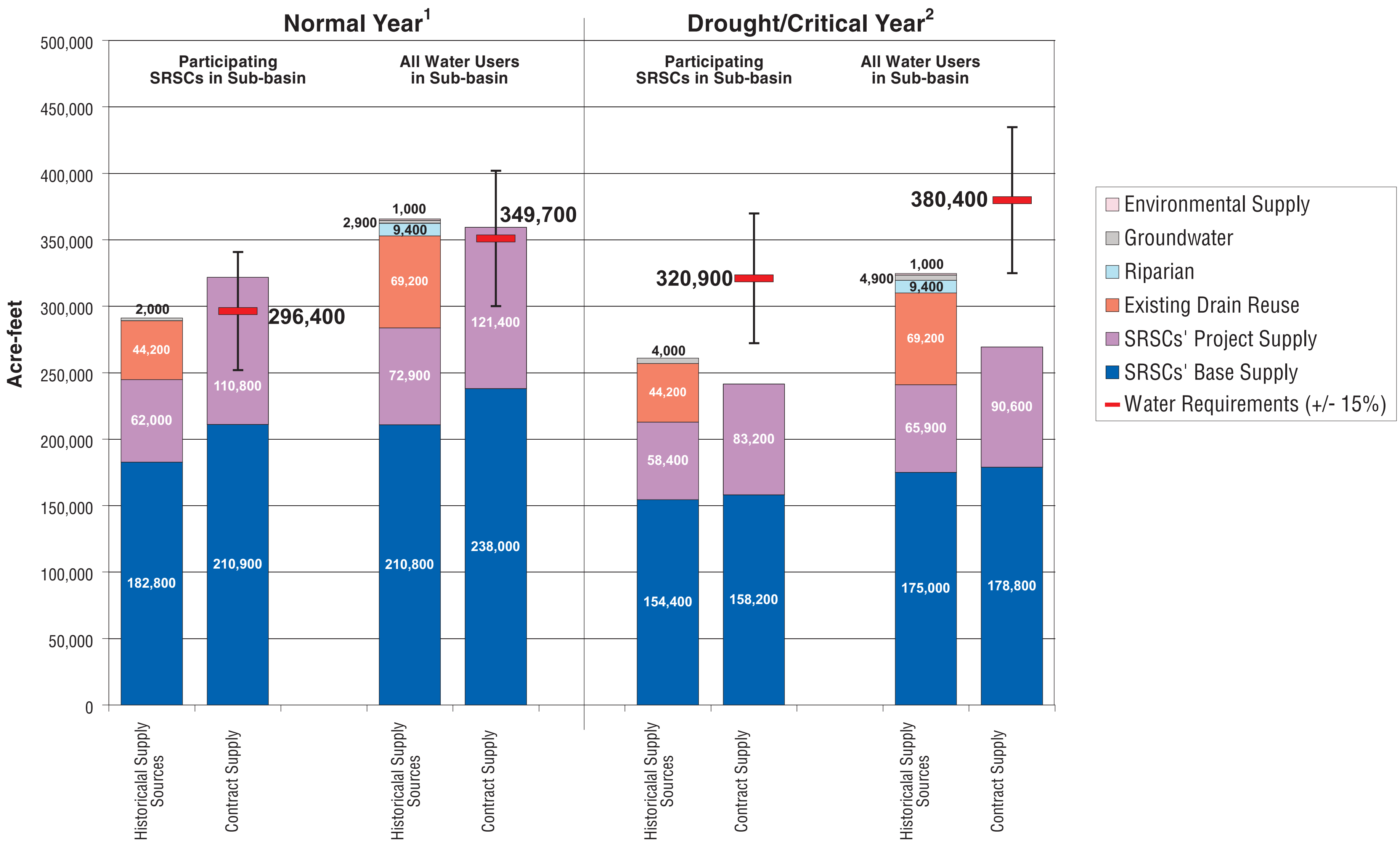
[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount shown at 100 percent.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 18-1
SUTTER SUB-BASIN 1995
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount shown at 100 percent.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 18-2
SUTTER SUB-BASIN 2020
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

TABLE 18-1
Sutter Sub-basin Potential Water Needs

	1995 Average Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses[b] (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	307,900	69,020	500	1,000	378,420
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	210,910	27,090	0	0	238,000
SRSC Project Supply	110,750	10,667	0	0	121,417
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	321,660	37,757	0	0	359,417
Supply from Other Sources[d]					
Sacramento River Riparian	0	9,400	0	0	9,400
Local Surface Water	0	0	0	1,000	1,000
Groundwater	2,000	0	500	0	2,500
Reuse/Drainwater	44,200	25,000	0	0	69,200
SUBTOTAL	46,200	34,400	500	1,000	82,100
TOTAL SUPPLIES	367,860	72,157	500	1,000	441,517

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Use is for wildlife refuge.
[c] Present contract amounts.
[d] Based on recent average historical use of these "other" supplies.

TABLE 18-2
Sutter Sub-basin Potential Water Needs

	1995 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses[b] (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	*345,578*[c]	*77,467*	*500*	*1,000*	*424,545*
Annual Water Supplies					
CVP Water Supply [d]					
SRSC Base Supply	158,182	20,601	0	0	178,783
SRSC Project Supply	83,212	7,351	0	0	90,563
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	241,394	27,952	0	0	269,346
Supply from Other Sources[e]					
Sacramento River Riparian	0	9,400	0	0	9,400
Local Surface Water	0	0	0	1,000	1,000
Groundwater	4,000	0	500	0	4,500
Reuse/Drainwater	44,200	25,000	0	0	69,200
SUBTOTAL	48,200	34,400	500	1,000	84,100
TOTAL SUPPLIES	289,594	62,352	500	1,000	353,446

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Use is for wildlife refuge.
[c] Numbers in italics are preliminary approximations.
[d] Present contract amounts.
[e] Based on recent average historical use of these "other" supplies.

TABLE 18-3
Sutter Sub-basin Potential Water Needs

	2020 Average Conditions				
	Participating SRSCs (ac-ft)	Other Agriculture Users (ac-ft)	M&I Users (ac-ft)	Managed[a] Environmental Uses[b] (ac-ft)	TOTAL (ac-ft)
Annual Water Requirement	296,433	51,327	900	1,000	349,660
Annual Water Supplies					
CVP Water Supply[c]					
SRSC Base Supply	210,910	27,090	0	0	238,000
SRSC Project Supply	110,750	10,667	0	0	121,417
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	321,660	37,757	0	0	359,417
Supply from Other Sources[d]					
Sacramento River Riparian	0	9,400	0	0	9,400
Local Surface Water	0	0	0	1,000	1,000
Groundwater	2,000	0	900	0	2,900
Reuse/Drainwater	44,200	25,000	0	0	69,200
SUBTOTAL	46,200	34,400	900	1,000	82,500
TOTAL SUPPLIES	367,860	72,157	900	1,000	441,917

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Use is for wildlife refuge.
[c] Present contract amounts.
[d] Based on recent average historical use of these "other" supplies.

TABLE 18-4
Sutter Sub-basin Potential Water Needs

	2020 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agriculture Users (ac-ft)**	**M&I Users (ac-ft)**	**Managed[a] Environmental Uses[b] (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	320,871	*57,615*[c]	900	1,000	380,386
Annual Water Supplies					
CVP Water Supply[d]					
SRSC Base Supply	158,182	20,601	0	0	178,783
SRSC Project Supply	83,212	7,351	0	0	90,563
CVP Water Service Contracts	N/A	0	0	0	0
SUBTOTAL	241,394	27,952	0	0	269,346
Supply from Other Sources[e]					
Sacramento River Riparian	0	9,400	0	0	9,400
Local Surface Water	0	0	0	1,000	1,000
Groundwater	4,000	0	900	0	4,900
Reuse/Drainwater	44,200	25,000	0	0	69,200
SUBTOTAL	48,200	34,400	900	1,000	83,500
TOTAL SUPPLIES	289,594	62,352	900	1,000	353,846

[a] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[b] Use is for wildlife refuge.
[c] Numbers in italics are preliminary approximations.
[d] Present contract amounts.
[e] Based on recent average historical use of these "other" supplies.

TABLE 18-5
Summary Status of Sutter Sub-basin Conjunctive Water Management Elements

Element	Currently Present	Comments
Available surface supplies	Limited	Depends on timing and expected future regional needs.
Usable groundwater storage	Limited	(see the DWR *Groundwater Hydrology Technical Memorandum*, 2000) – high salinity hazard exists in much of the sub-basin.
Groundwater recharge facilities	No	No regional facilities.
Groundwater extraction facilities	Very Limited	Some private pumpers exist, though a large numbers of additional wells would have to be studied.
Transmission/distribution facilities	Limited	
Monitoring facilities	Limited	Additional monitoring wells required (or identified).
Institutional framework	AB 3030	Could facilitate management; could possibly pursue JPAs or similar management arrangement.
Financing mechanism	None in place	Funding could be pursued through DWR ISI, Reclamation, and legislation.

Estimates of perennial yield are limited by availability of data and modeling. However, DWR has indicated (see the DWR *Groundwater Hydrology Technical Memorandum*, 2000) that Sutter Sub-basin groundwater suffers from high salinity hazards.

Develop Data and Groundwater Model – Because of the limited potential for groundwater development in this sub-basin, little has been done in the area of model development and application. There are no ongoing models being developed for this sub-basin.

Formulate Facility and Operational Concepts – Regional conjunctive water management programs require the ability to store and recover large volumes of surface water supplies; however, the potential for in-basin storage is minimal in Sutter Sub-basin given the presence of poor quality groundwater in the southern half of the sub-basin. The SRSCs within the sub-basin could consider the possibility of banking available supplies in neighboring sub-basins. Water stored could somehow be credited through either Shasta releases or possibly direct monetary compensation. Also, as previously mentioned, the northern half of the sub-basin does not suffer from the same widespread groundwater quality problem, and a regional program encompassing the entire sub-basin could be conceived. This would require overcoming some legal/institutional barriers that could limit the movement of surface water and groundwater throughout the sub-basin, and also possibly some physical constraints associated with transmitting the water throughout the sub-basin.

Evaluate Local and System Impacts – Implementation of a conjunctive water management program will result in some physical, social, and economic impacts to the Sutter Sub-basin. These impacts, listed below, would ultimately be addressed through adoption of specific monitoring programs, and with mitigation measures that would prevent or compensate for these impacts. Potential local impacts could include the following:

- Additional economic costs (such as capital costs, O&M costs, and mitigation and monitoring costs).
- Third party impacts (such as greater pumping lifts, well performance, dewatering of wells, impacts to other water rights holders in the basin).
- Physical impacts (affects on nearby streams, affects on wetland habitat, changes in crop yields for crops once irrigated by surface water and vice versa).

Potential system impacts could include the following:

- Adverse or beneficial changes in CVP operations.

Consider Legal, Institutional, and Stakeholder Needs – Groundwater management in California is an institutional challenge that has not yet been fully addressed. California landowners have a correlative right to extract as much groundwater as they can put to beneficial use on their overlying land. Attempts to manage groundwater in the Sutter Sub-basin include the following:

- AB 3030 efforts
- County Ordinance (Butte County)

Similar to discussions in previous sub-basins (see Colusa Sub-basin under Consider Legal, Institutional, and Stakeholder Needs) consideration must be given to the institutional/legal hindrances that could deter regional conjunctive water management.

Recommendations

In addition to the overall regional conjunctive water management recommendations made previously (see Section 14), the following recommendations are made specific to SRSCs and other entities within the Sutter Sub-basin. Such efforts would likely need to be focused on areas within the northern portion of the sub-basin, given the presence of poor-quality groundwater in much of the remainder of the sub-basin:

1. *Continue to coordinate with DWR, Sutter County, and other water users toward regional conjunctive water management programs in a cooperative fashion. This may require forming MOUs and possibly JPAs that, as an initial purpose, would address basin management objectives, transfer issues, and generally define what steps need to be taken to work around barriers that normally hinder regional conjunctive water management programs. Consider collaborative efforts among SRSCs within the sub-basin, and/or with other water users within the sub-basin, or with SRSCs in neighboring sub-basins.*

2. *Consider potential funding opportunities, either through direct means or through in-kind services from programs such as:*

   - *The California Water Bond (Proposition 13).*
   - *AB 303 (The Local Groundwater Management Assistance Act 2000).*
   - *The Integrated Storage and Investigation Conjunctive Use Initiative.*
   - *Future CALFED Grant Application programs.*

Water Transfer Programs

Summary of Recent Water Transfer Activity

Water users in the Sutter Sub-basin have engaged in water transfers in the past, and are expected to continue to use transfers to the extent possible. All SRSCs within the sub-basin participate in the Pool, SMWC being the most active. Among the other SRSCs participating in the BWMP located within the Sutter Sub-basin, MFWC and PMWC have also contributed water in the past. As described previously, and consistent with districts within other sub-basins, the greatest amount of transfer activity occurred in 1994 in response to dry conditions and Reclamation's allowance for additional transfers.

Sutter Mutual Water Company completed a water transfer of 5,000 ac-ft to TCCA in 1995, and has, in the past, transferred water to Contra Costa Water District in conjunction with RD 108. The Company has historically had some water available for transfer in non-critical months during normal years, a trend that is likely to continue.

Potential for Future Water Transfers

The Sutter Sub-basin typically has an overall balance between supplies and demands. SRSC Base and Project Supplies make up the vast majority of supplies within the sub-basin. Reuse of water occurs within District boundaries, and drainwater from upstream districts is a source of water for agricultural districts, with some districts meeting the majority of their TDR with drainwater. As described above, SMWC will likely continue to transfer Project Supplies within non-critical months in normal years. The presence of poor-quality groundwater within much of the sub-basin is particularly problematic in dry years given groundwater cannot be counted on as a reliable source. Additionally, those districts that rely heavily on drainwater from other districts are heavily impacted in dry years, given less drainwater is typically available because of increased reuse upstream. Accordingly, the sub-basin should be viewed as one that would likely be seeking to transfer water in rather than having supplies available for transfer out (assuming current cropping patterns). Individual water purveyors within the sub-basin face significant deficits in drought/critical years under their current CVP contracts. Such districts typically meet their total district requirement using available drainwater to supplement their CVP supplies.

Short-term or temporary transfers of water could be initiated during drought/critical years when some water purveyors have their surface water supplies reduced sharply, or long-term transfers could be done to permanently reallocate supplies in a beneficial manner. As discussed earlier, the potential to accomplish substantial transfers of water is constrained by existing regulations and policy. Given in-basin needs can be met, the potential for transfers with other Sacramento Valley water users downstream, as well as out-of-basin users, is also a possibility. Such transfers may also result in net increases in in-stream flows along the reach of the river between the Sutter Sub-basin and the receiving entity's diversion.

Recommendations

In addition to the basinwide transfer-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the Sutter Sub-basin:

1. *Continue to pursue opportunities to transfer supplies within the Sutter Sub-basin to assist in meeting in-sub-basin water requirements.*
2. *Promote and participate in basinwide efforts to encourage transfer of Base and Project Supplies to assist in meeting in-sub-basin and basinwide water requirements.*

Sub-basin Drainwater Management

Existing Development

As shown in Table 18-2, drainwater reuse accounts for approximately 69,000 ac-ft per year of supply within the Sutter Sub-basin. Major entities that use drainwater or are involved in its management within the sub-basin include MFWC, Butte Slough Irrigation Company, TIDC, SMWC, and PMWC. Reclamation district in the area include RD 70, RD 1660, and RD 1500. The Sutter Sub-basin is effectively split into north and south portions by the Tisdale Bypass, which separates the surface hydrology of the two portions and makes it more practical to consider the north and south portions of the sub-basin separately in terms of regional drainwater management. Drainwater reuse plays a major role in both areas of the sub-basin, increasing the supply flexibility and reliability, as well as the overall water use efficiency of the sub-basin.

Based on the current high level of drainwater reuse, existing informal efforts at regional management practices, and the extensive drain reuse infrastructure in place, the Sutter Sub-basin may have potential for effective regional drainwater management in both the northern and southern areas. Given the geographic extent of RD 1500 and SMWC over the southern portion of the sub-basin, and just three irrigation districts in the northern portion, the institutional challenges of regional drainwater management in the Sutter Sub-basin may be less complicated compared to sub-basins with a larger number of local parties to coordinate among.

Potential Program Objectives and Benefits

Potential regional drainwater management program objectives and benefits could include some or all of the following: modification of Sacramento River diversion patterns in support of short-term in-stream flow targets; drought-year increase in drainwater reuse together with other supplies such as groundwater to support beneficial intra-basin or out-of-basin transfers to other water users; improved monitoring of drainwater quality and soil salinity impacts, both by location and season, with increased ability to track soil salinity accumulation and set soil leaching targets; improved management of return flow water quality impacts to meet in-stream water quality targets at key downstream points such as various reclamation district outfall locations; and increased supply reliability to drainwater users with few or no alternative supplies.

Recommendations

In addition to the basinwide drainwater management-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the Sutter Sub-basin:

1. *Convene a local working group with representatives of the major drainwater users in the Sutter Sub-basin. There may be two such groups, one for the northern area and one for the southern area. Begin an initial screening-level evaluation of the feasibility of regional drainwater management and possible opportunities, objectives, and benefits within both parts of the sub-basin.*
2. *Collect and review existing reports, agreements, project proposals, and operations data related to drainwater use and management in the Sutter Sub-basin. Compile this information into a summary report that presents key information such as annual drainwater use, seasonal inflow and diversion patterns, major drains and control facilities such as weirs and pump stations, and all major discharge and diversion points.*
3. *Identify major information and/or data gaps from above, and produce a list of recommended flow monitoring stations or other data collection steps to fill in critical gaps. These could include incorporating flow and quality measurement at RD 70 and RD 1500 pump stations, and at regular intervals along the Reclamation Main Drain through SMWC service area.*
4. *Apply for available CALFED funding to install regional monitoring stations and provide support for the data collection program and applicable next steps.*
5. *Evaluate the potential role of regional drainwater management as it might relate to other regional programs such as conjunctive water management and transfers.*
6. *As applicable, build from these steps and carry out a detailed feasibility study of a regional drainwater management program for the Sutter Sub-basin.*

Environmentally Beneficial Water Management Actions

Summary of Current Activities

The following actions and programs have been completed or are underway in the Sutter Sub-basin, all of which are driven primarily by environmental improvement objectives. The following provides a summary of each.

Fish Screen/Passage Improvements – SMWC is currently working with the National Oceanic and Atmospheric Administration Fisheries, USFWS, and Reclamation to evaluate the potential to replace the Company's existing fish screen. Pelger Mutual Water Company was one of the first districts to install an improved screen under the CVPIA Anadromous Fisheries Restoration Program, and recently completed an operations-related retro-fit. Meridian Farms Water Company is currently in the early screen design process.

Watershed Management and Restoration – PMWC continues to maintain an agreement with USFWS to provide winter water for waterfowl. A number of projects are proposed along the Sutter Bypass associated with the Lower Butte Creek Project, including a number of weir enhancements to promote fish passage and exclude salmon from agricultural conveyance facilities through use of barriers. Other related fish passage improvement facilities are also being investigated in the area. Most of these projects are located within the Sutter Bypass adjacent to and east of SMWC. Aside from the state and federal resource agencies, key organizations involved in restoration efforts include Ducks Unlimited, Nature Conservancy, and California Waterfowl Association. These and other restoration efforts along the creek and bypass are expected to continue and be supported by resource agencies.

As described in TM 2, rice lands provide habitat for waterfowl during spring and summer months, as well as during winter in fields that are flooded to promote rice stubble decomposition. Such fields add substantially to the amount of habitat available within the basin in addition to the refuges identified above and private wetland areas.

Recommendations

The following recommendations were identified to assist in promoting the maintenance and enhancement of environmental resources within the Sutter Sub-basin:

1. *Continue to seek opportunities to provide habitat for waterfowl through encouraging rice flooding practices, including rice stubble decomposition.*
2. *Promote increased water supply reliability for private wetland areas and development of additional wetland areas where practical.*
3. *Work with USFWS and California Department of Fish and Game to promote maintenance of habitat associated with agricultural drains (and canals where feasible) while encouraging existing agricultural uses.*
4. *Evaluate presence of habitat related to water deliveries in relation to potential conservation options including canal lining and or additional drain maintenance with appropriate agencies.*
5. *Support and seek funding opportunities for additional fish passage enhancement projects including identifying most beneficial screen replacements and conveyance system improvements.*
6. *Support additional sub-basinwide watershed planning and enhancement efforts.*
7. *Support system gaming efforts to evaluate potential for maximizing environmental benefits while ensuring adequate water supplies to meet in-basin user water requirements.*

Sutter Sub-basin Water Management Concepts

In addition to the identification of basinwide, sub-basin, and district-specific water management options, it was determined useful to identify water management concepts that could potentially be implemented at a sub-basin level. Concepts are potential actions based upon grouping identified options that appear to be reasonable and appropriate given the existing and projected water requirements and supplies within a particular sub-basin. It is recognized that the implementation of any of the identified concepts would likely require extensive coordination among stakeholders within a given sub-basin, as well as additional study, and would represent long-term actions. Primary issues associated with implementing any of the options are discussed under the sub-basin and district-specific option sections. It is also recognized that implementation of any concept would provide for optimizing normal and dry-year supplies; the grouping of concepts within normal and drought years below is simply to allow for convenient discussion.

As described above, the identification of sub-basin-specific concepts is driven by the projected water requirement and available water supply. The projected water requirements and supplies for the year 2020 are identified for both the normal and drought condition per data developed in the BWMP in large part obtained from DWR. Supply is identified in terms of current contract supplies and provisions, and is shown as a range for some sub-basins given reductions in dry years and even normal years would vary depending on contract type and the severity of a given year of period. In general, it is assumed that CVP agricultural WSC deliveries could be reduced to zero and M&I WSC amounts reduced by 25 percent in drought years. Where appropriate, concepts that would involve other sub-basins are presented, as well as concepts that would generally be driven only by in-sub-basin users and facilities. It is the intent of these sections to provide for increased discussion, awareness, and analysis as determined appropriate by stakeholders across each sub-basin and the region in general.

Projected year 2020 supply (contracted amount, groundwater, and reuse/drainwater) versus water requirements is as follows:

Normal Year:

- Total supply exceeds requirements *(approximately 90,000 ac-ft)*
- M&I requirements are insignificant

Drought Year:

- Total requirements exceed contract amount/supply *(approximately 25,000 ac-ft)*
- SRSCs are impacted but can likely accommodate water requirements unless multi-year drought; others either pump (M&I and other agriculture) or have riparian rights

Potential Actions/Concepts

Normal Years

- **Transfer –** SRSCs (SMWC and PMWC) could transfer water available in excess of their respective TDRs to meet out-of-basin user requirements of a variety of potential users. Minimal groundwater pumping occurs within most of the sub-basin due to poor water quality.

- **Banking/Conjunctive Water Management –** SRSCs could bank available supply in excess of individual TDRs in groundwater basins (Redding, Colusa, Butte, or American assuming storage available) or future offstream storage location (e.g., Sites Reservoir in the Colusa Sub-Basin). Potential for in-basin-storage minimal given presence of poor quality groundwater. Out-of-basin storage would require sufficient pumping to occur so as to allow for storage (current condition in Redding and Colusa Sub-basins is minimal storage is available given natural recharge typically exceeds pumping). Water could be credited either through Shasta release, water exchange or through direct monetary compensation.

- **Drainwater Reuse Management –** SRSCs could reduce reuse/drainwater use by increasing river diversions to full contract to allow for flushing of salts related to salinity concerns. Increased use of drainwater and general reuse in drought years (see below under drought years).

Drought Years

- **Drainwater Reuse Management (increase reuse/drainwater use) –** SRSCs increase reuse/drainwater use to assist in meeting increased TDR requirements in drought conditions. Reduce river diversions to assist other users if respective TDRs can be met (potential to do so in dry years when SRSC entitlements are not reduced; surface water potentially transferred in- or out-of-sub-basin if available).
- **Transfers –** SRSCs could transfer available water in non-critical years; could be particularly valuable in dry years when SRSC entitlements are not reduced, assuming respective SRSC TDRs can be met). Transfers could be in- or out-of-sub-basin. Water could also be transferred into the sub-basin in particularly dry years from willing sellers including ACID or GCID, or other willing sellers to assist in meeting sub-basin drought-year requirements (including potential SRSC requirements).
- **Banking/Conjunctive Water Management –** SRSCs could call upon water banked out-of-sub-basin (including offstream storage site). Sutter Sub-basin is unique in that in-sub-basin storage is not a viable solution given presence of poor-quality groundwater within much of the sub-basin. See above under normal years.
- **Offstream Storage –** normal and drought conditions) – Multiple in- and out-of-sub-basin management possibilities with potential to assist in meeting water requirements of agricultural, environmental, or M&I users; bank supplies/drought-year protection.
- **Conservation –** Pursue potential for increased agricultural conservation (M&I requirements limited within the sub-basin) where sub-basin benefits can be achieved; needs to be evaluated in terms of potential environmental impacts.

American Sub-basin

- Natomas Central Mutual Water Company

SECTION 19

American Sub-basin

Summary of Water Supply Requirements and Sources

The following section presents a summary of the water supply requirements and the historical use of the various water sources used to meet these supply requirements in the American Sub-basin. A water balance was presented for the American Sub-basin in TM 4 that provided a summary of the physical flows of water into the basin, consumptive use within the sub-basin, and outflows from the sub-basin to either groundwater or return surface flows. By definition, the water balance shows no deficits or surpluses, only the flow of the physical quantity of water. For the purposes of proposing and evaluating potential regional water management actions, it is more helpful to summarize water supply requirements and historical sources at a more detailed level, specifically at the level of user type (agricultural/M&I/environmental) and water supply type (characterized both by source and contract category).

Figures 19-1 and 19-2 summarize the American Sub-basin's overall water supply requirement for all use types and historical source use under normal and drought/critical years under 1995 and 2020 conditions, respectively. The SRSC quantities are presented next to the sub-basin totals to provide perspective on the significance of SRSC water management practices within the sub-basin. The following observations were made:

- The sub-basin demands are expected to be approximately 55 percent agricultural and 45 percent M&I under average 2020 conditions. Managed environmental water supply requirements (i.e., wildlife refuge demands) make up less than 5 percent of demand in the sub-basin.
- SRSCs account for about 15 to 20 percent of total water use in the sub-basin (ranging from approximately 135 to 165 taf/yr).
- Deliveries associated with CVP water service contracts represent less than 10 percent of the total supply in the sub-basin (approximately 45 to 55 taf/yr).
- Groundwater is a significant source of supply and accounts for approximately 40 percent of total supply in the sub-basin (approximately 300 to 350 taf/yr).
- Drainwater use is highly variable and not measured regionally; however, estimates suggest that approximately 50 to 75 taf/yr is reused sub-basinwide. This accounts for less than 10 percent of the total supply.

Tables 19-1, 19-2, 19-3, and 19-4 summarize water sources (characterized by source and contract type) and water supply requirements by user type for 1995 average and drought conditions and 2020 average and drought conditions, respectively. The numbers in these tables help to identify more specifically the discrete "blocks" of water users and sources, categorized by classifications that roughly match up with regional management "decision parameters" such as source type, volumes, institutional controls, and restrictions on source to help clarify potential management alternatives. This information also clearly shows supply and demand balances or imbalances within the sub-basin's major user categories. The following observations are noted for 2020 normal-year type conditions (Table 19-3):

- For the category of M&I users, demands can continue to be met by the existing supply mix only at the expense of groundwater overdraft.
- Given the multiple supplies available to the sub-basin as a whole, opportunities exist for conjunctively managing surface and groundwater supplies through cooperative programs between different water users throughout the sub-basin. Without cooperative programs, the likelihood for continued groundwater overdraft is greater.

The following observations are noted for 2020 drought-year type conditions (Table 19-4):

- For the category of M&I users, demands can continue to be met by the existing supply mix only at the expense of groundwater overdraft. In addition, other agricultural users are more heavily dependent on groundwater under drought conditions, increasing the likely severity of groundwater overdraft.
- Development of programs that better manage the existing mix of supplies is critically important to drought-year conditions where dependence on water resources in the region will be stretched to the limit. This is evident by the large shortage exhibited for the sub-basin as a whole in Table 19-4.

Conjunctive Water Management Program

Summary of Conjunctive Water Management Potential

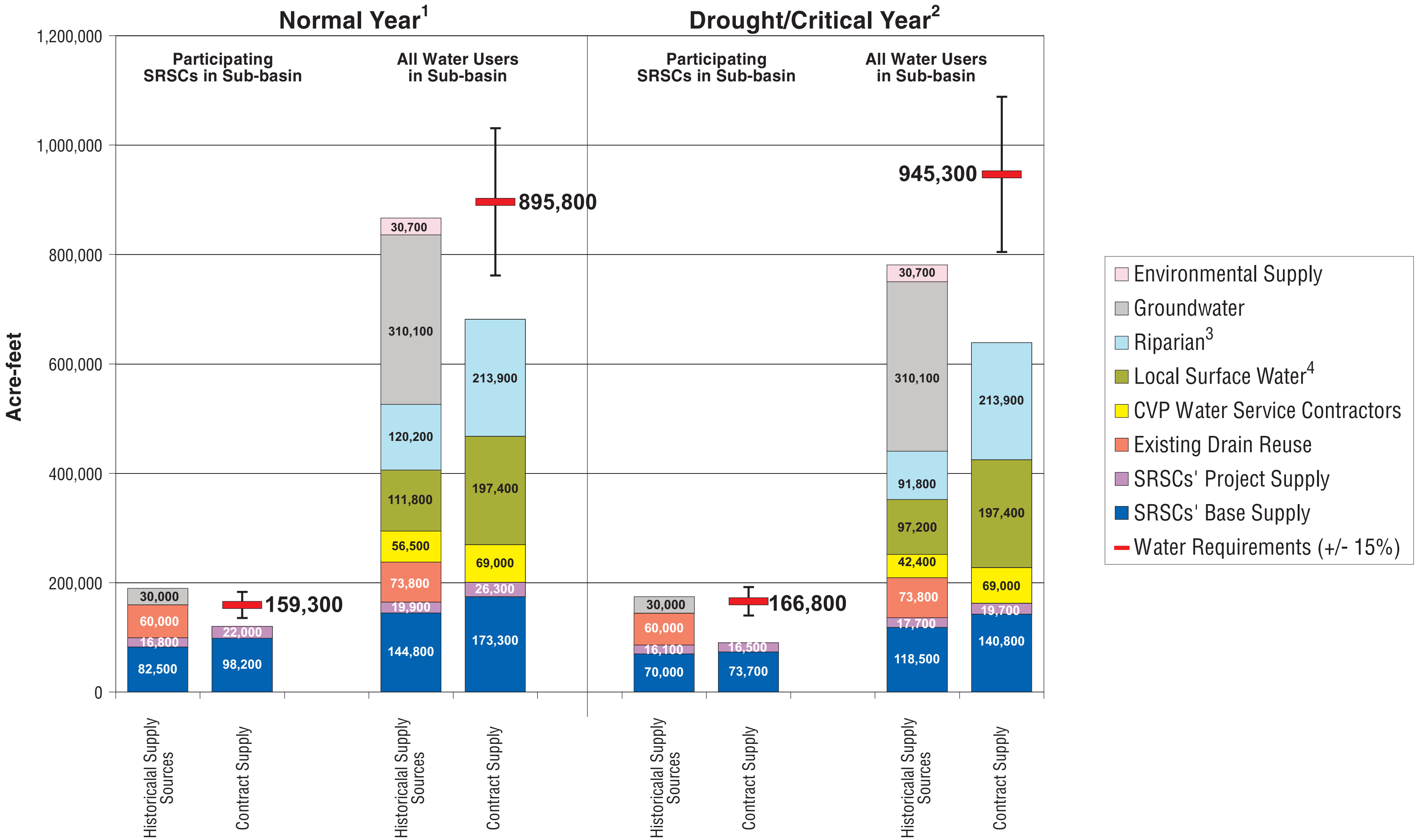
The American Sub-basin has characteristics suitable for further developing conjunctive water management options. There is significant benefit to be gained from conjunctively managing surface and groundwater supplies, ranging from helping to meet water needs for in-basin users to providing greater systemwide flexibility for CVP operations.

In general, successful conjunctive water management projects have certain common elements (see general discussion of conjunctive water management in Section 14). Table 19-5 summarizes the current status of these key elements within the American Sub-basin.

Assessment of Conjunctive Water Management Potential

A critical aspect of developing conjunctive water management projects is the identification, development, and evaluation of these elements. A process diagram was introduced earlier for carrying out this activity (see Regional Conjunctive Water Management Options). This evaluation process is applied here in an effort to assess the opportunity for conjunctive water management in the American River Sub-basin.

Identify Candidate Basins – The DWR (see the DWR *Groundwater Hydrology Technical Memorandum,* 2000) has identified American Sub-basin as having groundwater characteristics suitable for further developing conjunctive water management options. Estimates of perennial yield are limited by availability of data and modeling.



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP water service contractors -- shown here as 100 percent; however, USBR has significantly reduced project deliveries during critcally dry periods.

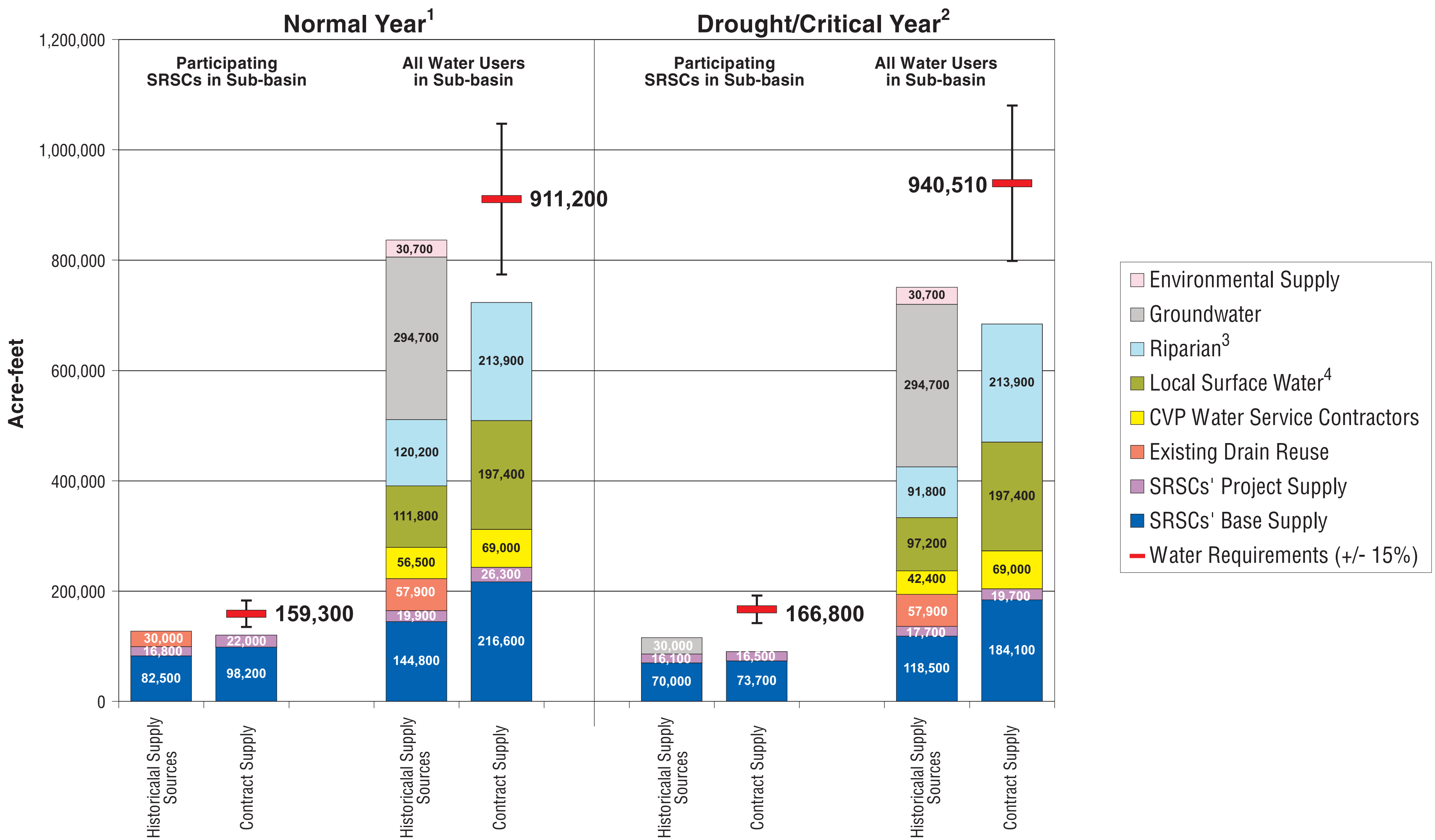
[3]Includes Placer County Water Agency American River total contract entitlements pursuant to agreements with both CVP and PG&E, which have not been fully exercised historically.

[4]Includes South Sutter Water District total entitlements to the Bear River, which have not been fully exercised historically.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 19-1
AMERICAN SUB-BASIN 1995
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK



[1]Water supply based on annual average of 1980-89. Contract amount shown at 100 percent.

[2]Water supply based on annual average of critically dry years ('77, '91, '92, '94). Contract amount: SRSC Base/Project -- 75 percent of total; CVP water service contractors -- shown here as 100 percent; however, USBR has significantly reduced project deliveries during critcally dry periods.

[3]Includes Placer County Water Agency American River total contract entitlements pursuant to agreements with both CVP and PG&E, which have not been fully exercised historically.

[4]Includes South Sutter Water District total entitlements to the Bear River, which have not been fully exercised historically.

Note:
Due to rounding in both TM 6 and TM 2, the quantities detailed on this figure differ slighlty from the quantities detailed on figures presented in TM 2.

FIGURE 19-2
AMERICAN SUB-BASIN 2020
WATER SUPPLIES AND CONTRACT AMOUNTS
TM 6 – SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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W062004006RDD_14 TM 6 (9/30/04)

TABLE 19-1
American Sub-basin Potential Water Needs

	1995 Average Conditions				
	Participating SRSCs (ac-ft)	Other Agricultural Users (ac-ft)	M&I Users[a] (ac-ft)	Managed[b]Environmental Uses (ac-ft)	TOTAL (ac-ft)
Annual Water Requirement	159,300	428,375	277,375	*30,700*[c]	895,750
Annual Water Supplies					
CVP Water Supply[d]					
SRSC Base Supply[e]	98,200	31,797	43,300	0	173,297
SRSC Project Supply[e]	22,000	4,296	0	0	26,296
CVP Water Service Contracts[f]	N/A	0	69,000	0	69,000
SUBTOTAL	120,200	36,093	112,300	0	268,593
Supply from Other Sources[g]					
American River Water Rights[h]	0	39,100	81,100	0	120,200
Local Surface Water[i]	0	110,500	1,300	30,700	142,500
Groundwater	0	187,200	122,900	0	310,100
Reuse/Drainwater	30,000	43,838	0	0	73,838
SUBTOTAL	30,000	380,638	205,300	30,700	646,638
TOTAL SUPPLIES	150,200	416,731	317,600	30,700	915,231

[a] The City of Sacramento water right settlement is represented under SRSC Base Supply, and is the sole contributor to this M&I category. The quantity is for 2020 conditions and represents an estimate of the amount associated with the area north of the American River (data source: DWR Central District Bulletin 160-98 support data).

[b] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.

[c] Numbers in italics are preliminary approximations.

[d] Present contract amounts.

[e] Source is Sacramento River.

[f] Source is American River.

[g] Based on recent average historical use of these "other" supplies.

[h] Includes Placer County Water Agency recent average historical use of American River water pursuant to agreements with both CVP and PG&E.

[i] Includes South Sutter Water District recent average historical use of Bear River water, small MTCR diverters, and an estimate of managed environmental users of water from local streams throughout the sub-basin.

TABLE 19-2
American Sub-basin Potential Water Needs

	1995 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agricultural Users (ac-ft)**	**M&I Users[a] (ac-ft)**	**Managed[b] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	166,800	*459,323*[c]	*288,469*	*30,700*	945,300
Annual Water Supplies					
CVP Water Supply[d]					
SRSC Base Supply[e]	73,650	23,848	43,300	0	140,798
SRSC Project Supply[e]	16,500	3,222	0	0	19,722
CVP Water Service Contracts[f]	N/A	0	51,750 to 69,000[g]	0	51,750 to 69,000
SUBTOTAL	90,150	27,070	95,050 to 112,300	0	212,270 to 229,520
Supply from Other Sources[h]					
American River Water Rights[i]	0	29,325	62,500	0	91,825
Local Surface Water[j]	0	95,875	1,300	30,700	127,875
Groundwater	0	187,200	122,900	0	310,100
Reuse/Drainwater	30,000	43,838	0	0	73,838
SUBTOTAL	30,000	356,238	186,700	30,700	603,638
TOTAL SUPPLIES	120,150	383,308	281,750 to 299,000	30,700	815,908 to 833,158

[a] The City of Sacramento water right settlement is represented under SRSC Base Supply, and is the sole contributor to this M&I category. The quantity is for 2020 conditions and represents an estimate of the amount associated with the area north of the American River (data source: DWR Central District Bulletin 160-98 support data).

[b] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.

[c] Numbers in italics are preliminary approximations.

[d] Present contract amounts.

[e] Source is Sacramento River.

[f] Source is American River.

[g] Quantities are shown as ranges given water service contract supplies have historically been reduced by up to 65 percent in drought years for agricultural water service contractors, and up to 25 percent for M&I and environmental water service contractors.

[h] Based on recent average historical use of these "other" supplies.

[i] Includes Placer County Water Agency recent average historical use of American River water pursuant to agreements with both CVP and PG&E.

[j] Includes South Sutter Water District recent average historical use of Bear River water, small MTCR diverters, and an estimate of managed environmental users of water from local streams throughout the sub-basin.

TABLE 19-3
American Sub-basin Potential Water Needs

	2020 Average Conditions				
	Participating SRSCs (ac-ft)	Other Agriculture Users (ac-ft)	M&I Users[a] (ac-ft)	Managed[b] Environmental Uses (ac-ft)	TOTAL (ac-ft)
Annual Water Requirement	159,300	301,895	419,304	*30,700*[c]	911,199
Annual Water Supplies					
CVP Water Supply[d]					
SRSC Base Supply[e]	98,200	31,797	86,600	0	216,597
SRSC Project Supply[e]	22,000	4,296	0	0	26,296
CVP Water Service Contracts[f]	N/A	0	69,000	0	69,000
SUBTOTAL	120,200	36,093	155,600	0	311,893
Supply from Other Sources[g]					
American River Water Rights[h]	0	39,100	81,100	0	120,200
Local Surface Water[i]	0	110,500	1,300	30,700	142,500
Groundwater	0	121,400	173,300	0	294,700
Reuse/Drainwater	30,000	27,897	0	0	57,897
SUBTOTAL	30,000	298,897	255,700	30,700	615,297
TOTAL SUPPLIES	150,200	334,990	411,300	30,700	927,190

[a] The City of Sacramento water right settlement is represented under SRSC Base Supply, and is the sole contributor to this M&I category. The quantity is for 2020 conditions and represents an estimate of the amount associated with the area north of the American River (DWR Central District Bulletin 160-98).

[b] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.

[c] numbers in italics are preliminary approximations.

[d] Present contract amounts.

[e] Source is Sacramento River.

[f] Source is American River.

[g] Based on recent average historical use of these "other" supplies.

[h] Includes Placer County Water Agency recent average historical use of American River water pursuant to agreements with both CVP and PG&E.

[i] Includes South Sutter Water District recent average historical use of Bear River water, small MTCR diverters, and an estimate of managed environmental users of water from local streams throughout the sub-basin.

TABLE 19-4
American Sub-basin Potential Water Needs

	2020 Drought Conditions				
	Participating SRSCs (ac-ft)	**Other Agriculture Users (ac-ft)**	**M&I Users[a] (ac-ft)**	**Managed[b] Environmental Uses (ac-ft)**	**TOTAL (ac-ft)**
Annual Water Requirement	166,800	*323,706*[c]	*419,304*	*30,700*	940,510
Annual Water Supplies					
CVP Water Supply[d]					
SRSC Base Supply[e]	73,650	23,848	86,600	0	184,098
SRSC Project Supply[e]	16,500	3,222	0	0	19,722
CVP Water Service Contracts[f]	N/A	0	51,750 to 69,000[g]	0	51,750 to 69,000
SUBTOTAL	90,150	27,070	138,350 to 155,600	0	255,570 to 272,820
Supply from Other Sources[h]					
American River Water Rights[i]	0	29,325	62,500	0	91,825
Local Surface Water[j]	0	95,875	1,300	30,700	127,875
Groundwater	0	121,400	173,300	0	294,700
Reuse/Drainwater	30,000	27,897	0	0	57,897
SUBTOTAL	30,000	274,497	237,100	30,700	572,297
TOTAL SUPPLIES	120,150	301,567	375,450 to 392,700	30,700	827,867 to 845,117

[a] The City of Sacramento water right settlement is represented under SRSC Base Supply, and is the sole contributor to this M&I category. The quantity is for 2020 conditions and represents an estimate of the amount associated with the area north of the American River (DWR Central District Bulletin 160-98).
[b] "Managed" refers to supplies or requirements that are specified by contract or formal arrangement for environmental uses. Incidental benefits that are derived through conveyance of water either through streams or agricultural conveyance facilities are not included within this or other uses.
[c] Numbers in italics are preliminary approximations.
[d] Present contract amounts.
[e] Source is Sacramento River.
[f] Source is American River.
[g] Quantities are shown as ranges given water service contract supplies have historically been reduced by up to 65 percent in drought years for agricultural water service contractors, and up to 25 percent for M&I and environmental water service contractors.
[h] Based on recent average historical use of these "other" supplies.
[i] Includes Placer County Water Agency recent average historical use of American River water pursuant to agreements with both the CVP and PG&E.
[j] Includes South Sutter Water District recent average historical use of Bear River water, small MTCR diverters, and an estimate of managed environmental users of water from local streams throughout the sub-basin.

TABLE 19-5
Summary Status of American Sub-basin Conjunctive Water Management Elements

Element	Currently Present	Comments
Available surface supplies	Yes	A complex mix of user types of water supplies result in opportunities for surface supplies.
Usable groundwater storage	Yes	(see the DWR *Groundwater Hydrology Technical Memorandum,* 2000).
Groundwater recharge facilities	No	In-lieu would be more likely.
Groundwater extraction facilities	Some	Additional well fields required.
Transmission/distribution facilities	Some	Need facilities connecting well fields.
Monitoring facilities	Limited	
Institutional framework	AB 3030; Sacramento County Ordinance; SNAGMA	Require close coordination with ongoing programs in the sub-basin.
Financing mechanism	No	Funding could be pursued through DWR ISI, Reclamation, and legislation.

Efforts within the sub-basin have identified opportunities for conjunctively managing available surface and groundwater. NCMWC has submitted an application for funding through the CALFED conjunctive water management grant program where a pilot conjunctive water management program was proposed. Other water purveyors acting on behalf of other regional programs, such as the American River Basin Cooperating Agencies Regional Water Master Plan, have developed conjunctive water management concepts and are also pursuing funding for pilot programs.

Develop Data and Groundwater Model – Districts in coordination with DWR have been collecting important data to allow further evaluation of groundwater management options in the American Sub-basin.

The SNAGMA is a JPA charged with the protection and regulation of groundwater. The SNAGMA is developing a groundwater monitoring network and data management system for the purposes of assessing groundwater resources in the sub-basin and for tracking the performance of future conjunctive water management and other programs.

Formulate Facility and Operational Concepts – In an investigation titled American Basin Conjunctive Use Project (Feasibility Report completed in June 1997), districts supporting the study in coordination with DWR determined that groundwater recharge by direct methods is not generally suitable for much of the American Sub-basin, and that recharge is better accomplished by in-lieu means. The DWR concluded that in-lieu type projects were feasible; however, several key technical issues could not be resolved due to data limitations. Furthermore, there were significant legal, institutional, and political barriers that would also challenge the project implementation.

Presently there are several pilot project proposals in various stages of consideration and are as follows:

- The NCMWC proposal (mentioned earlier) is intended to explore the unresolved technical issues encountered by DWR, namely concerns regarding the potential third party impacts, and impacts on river flows (resulting from complex stream-aquifer interactions). These issues would be evaluated as part of this demonstration project based on data from proposed well and aquifer testing, groundwater level and quality monitoring, and geologic assessments of the stream-aquifer system. This information would ultimately help determine the viability of an expanded project that could achieve several objectives, including increasing dry-year water supply, increasing Delta inflows and/or make transferable water available, and providing a local solution to the northern Sacramento County overdraft problem.

- Another conjunctive water management project has been proposed jointly by the Cooperating Agencies (formed in 1997 by water purveyors to cooperatively implement programs envisioned by the Sacramento Area Water Forum) and SNAGMA. This and future proposed projects originating from this effort are intended to meet similar objectives as those described under the NCMWC pilot project above.

Evaluate Local and System Impacts – Implementation of a conjunctive water management program will result in some physical, social, and economic impacts to the American River Sub-basin. These impacts, listed below, would ultimately be addressed through adoption of specific monitoring programs, and with mitigation measures that would prevent or compensate for these impacts. Potential local impacts could include the following:

- Additional economic costs (such as capital costs, O&M costs, and mitigation and monitoring costs).
- Third party impacts (such as greater pumping lifts, well performance, dewatering of wells, impacts to other water rights holders in the basin).
- Physical impacts (affects on nearby streams, affects on wetland habitat, changes in crop yields for crops once irrigated by surface water and vice versa).

Potential system impacts could include the following:

- Adverse or beneficial changes in CVP operations.

Consider Legal, Institutional, and Stakeholder Needs – Groundwater management in California is an institutional challenge that has not yet been fully addressed. California landowners have a correlative right to extract as much groundwater as they can put to beneficial use on their overlying land. Attempts to manage groundwater in the American River Sub-basin have evolved further than other sub-basins considered in the BWMP. As a result, any proposed conjunctive water management project would require full compliance with general plans and/or regional agreements. In the case of the American Sub-basin, the Sacramento Area Water Forum agreements, of which NCMWC is a signatory, specifically encourage conjunctive water management projects that are designed to meet the objectives described above. Conjunctive water management projects of this type must also be consistent with the goals of SNAGMA and a locally constituted AB 3030 Groundwater Management Plan.

Recommendations

In addition to the overall regional conjunctive water management recommendations made previously (see Section 14), the following recommendations are made specific to SRSCs and other entities within the American Sub-basin:

1. *In addition to conjunctive water management actions that have already been implemented, there are several conjunctive water management program concepts being considered by local districts, some of which involve NCMWC. These and other programs should continue to be tracked in regards to their ability to meet the objectives of the BWMP. Participate in the Cooperating Agencies/SNAGMA Conjunctive Use program at an appropriate level.*
2. *Continue to coordinate with DWR, neighboring counties, and other stakeholders toward regional conjunctive water management programs in a cooperative fashion. This may require forming MOUs and possibly JPAs that, as an initial purpose, would address basin management objectives, transfer issues, and generally define what steps need to be taken to work around barriers that normally hinder regional conjunctive water management programs. [Note: Conjunctive water management projects must also be consistent with the goals of SNAGMA and a locally constituted AB 3030 Groundwater Management Plan.]*
3. *Continue to seek potential funding opportunities, either through direct means or through in-kind services from programs such as:*
   - *The California Water Bond (Proposition 13).*
   - *AB 303 (The Local Groundwater Management Assistance Act 2000).*
   - *The Integrated Storage and Investigation Conjunctive Use Initiative.*
   - *Future CALFED Grant Application Programs.*
4. *Integrate proposed regional conjunctive water management projects into ongoing and future gaming exercises and modeling studies to better define the potential impacts and net benefits.*

Water Transfer Programs

Summary of Recent Water Transfer Activity

Water users in the American Sub-basin have engaged in water transfers in the past, and are expected to continue to use transfers to the extent possible. Natomas Central Mutual Water Company is the only SRSC participating in the BWMP within the sub-basin. Although NCMWC is a member of the Pool, the Company has not contributed or purchased water through the program since 1993. Natomas Mutual Water Company has been active in the transfer arena, most recently through the partially approved/denied proposed short-term out-of-basin transfer in late 1999 of up to 14,000 ac-ft to the SMWD via Western water discussed earlier. The Company completed a successful transfer to the Westlands Water District of 3,000 ac-ft in 1992. Natomas Mutual Water Company conducted a pilot project transfer with the Mohave Water Agency in 1995 for 2,000 ac-ft. That transfer was used as a "test case" in proceeding on the recently partially denied transfer to SMWD. The Company is currently in negotiations with Westlands Water District and DWR (which is representing a group of SWP contractors) to implement a groundwater exchange for approximately 10,000 to 15,000 ac-ft.

Other transfers within the sub-basin include the following:

- Browns Valley (2,000 ac-ft) – Sacramento County to Leguna area
- Placer County to Sacramento Area Flood Control Agency (2,000 ac-ft)
- Conjunctive water management transfer involving SNAGMA and Sacramento Area Flood Control Agency

Potential for Future Water Transfers

Although NCMWC will likely pursue potential water transfers in the future, the Company typically does not have large amounts of water available for transfer given existing crop demands, particularly in dry years. However, the presence of several large municipal users including the City and County of Sacramento and CVP contractors drawing from the American River such as South Sutter Water District, Nevada Irrigation District, and Placer County will likely encourage transfers that are determined to be mutually beneficial. Placer County is currently in the process of attempting to secure a transfer of water rights and point of diversion from the American River to the Sacramento River. In general, users attempting to serve continued urban growth in and around Sacramento can be expected to seek opportunities with NCMWC to secure additional short-term and long-term supplies using transfers as one potential vehicle.

Short-term or temporary transfers could be initiated during drought/critical years when some water purveyors have their surface water supplies reduced sharply, or long-term transfers could be made to permanently reallocate supplies in a beneficial manner. As discussed earlier, the potential to accomplish substantial transfers of water is constrained by existing regulations and policy. Given in-basin needs can be met, the potential for transfers with other Sacramento Valley water users downstream, as well as out-of-basin users, is also a possibility. Such transfers may also result in net increases in in-stream flows along the reach of the river between the Sacramento Sub-basin and the receiving entity's diversion.

Recommendations

In addition to the basinwide transfer-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the American Sub-basin:

1. *Continue to pursue opportunities to transfer supplies within the American Sub-basin, using recent SMWC and RD 108 transfer as a point of reference, to assist in meeting in-sub-basin water requirements.*

2. *Promote and participate in basinwide efforts to encourage transfer of Base and Project Supplies to assist in meeting in-sub-basin and basinwide water requirements.*

Sub-basin Drainwater Management

Existing Development

As shown in Tables 19-1 through 19-4, drainwater reuse accounts for approximately 60,000 to 70,0000 ac-ft/yr of supply within the American Sub-basin. Major entities that use drainwater or are involved in its management within the American Sub-basin include NCMWC, RD 1000, Pleasant Grove-Verona Mutual Water Company, and RD 1001. A drain management agreement between NCMWC and RD 1000 allows NCMWC to maintain water levels in the RD 1000 drainage canal system that are conducive to the operation of a recirculation system. NCMWC uses this agreement to operate a "closed" irrigation system within the RD 1000 boundaries. RD 1001 also operates a closed irrigation system in conjunction with Pleasant Grove-Verona Mutual Water Company. Drainwater reuse plays a major role in the sub-basin, increasing the supply flexibility and reliability, as well as the overall water use efficiency of the sub-basin.

NCMWC operates a closed system for several reasons that include water conservation and benefits to the in-basin users, rice growers, and downstream users. The system that NCMWC implements has been recognized by the SWRCB to conserve over 18,000 ac-ft/yr. In-basin users see the benefit of this closed system through the incorporation of the RD 1000 service area runoff, including the non-NCMWC agricultural water users and the M&I water users within the City of Sacramento. This water reuse allows RD 1000 to reduce the use of its discharge facilities, thus reducing costs to its rate payers. The closed system allows rice growers to reduce holding periods for several herbicides. This has been shown to improve crop vitality and increase yields. Lastly, downstream users benefit from this system through prevention of further Sacramento River water quality degradation caused by agricultural runoff.

On the basis of the current high level of drainwater reuse, existing informal efforts at regional management practices, and the extensive drain reuse infrastructure in place, the American Sub-basin may have potential for effective regional drainwater management.

Potential Program Objectives and Benefits

Potential regional drainwater management program objectives and benefits could include some or all of the following: modification of Sacramento River diversion patterns in support of short-term in-stream flow targets; drought-year increase in drainwater reuse together with other supplies such as groundwater to support beneficial intra-basin or out-of-basin transfers to other water users; improved monitoring of drainwater quality and soil salinity impacts, both by location and season, with increased ability to track soil salinity accumulation and set soil leaching targets; improved management of return flow water quality impacts to meet in-stream water quality targets at key downstream points such as various reclamation district outfall locations; increased supply reliability to drainwater users with few or no alternative supplies.

Recommendations

In addition to the basinwide drainwater management-related recommendations made previously, the following recommendations are made specific to SRSCs and other entities within the American Sub-basin:

1. *Convene a local working group with representatives of the major drainwater users in the American Sub-basin. Begin an initial screening-level evaluation of the feasibility of regional drainwater management and possible opportunities, objectives, and benefits. The following steps would support the initial evaluation.*

2. *Collect and review existing reports, agreements, project proposals, and operations data related to drainwater use and management in the American Sub-basin. Compile this information into a*

summary report that presents key information such as annual drainwater use, seasonal outflow and diversion patterns, major drains and control facilities such as weirs and pump stations, and all major discharge and diversion points.

3. *Identify major information and/or data gaps from above, and produce a list of recommended flow monitoring stations or other data collection steps to fill in critical gaps.*
4. *Apply for available CALFED funding to install regional monitoring stations and provide support for the data collection program, and applicable next steps.*
5. *Evaluate the potential role of regional drainwater management as it may relate to other regional programs such as conjunctive water management and transfers, in-stream.*
6. *As applicable, build from these steps and carry out a detailed feasibility study of a regional drainwater management program for the American Sub-basin.*

Potential does exist within the American Sub-basin to use treated wastewater for any number of uses including landscape irrigation or industrial processes such as cooling systems, or even domestic uses given proper treatment. Use of treated wastewater for supplemental or routine agricultural use is likely not feasible given significant costs related to necessary infrastructure. Although M&I wastewater reuse is not addressed in detail in this BWMP, it is recognized that such reuse could result in numerous potential benefits, both in normal and dry periods. However, M&I wastewater reuse may require substantial infrastructure improvements such as new or upgraded water treatment facilities and separate non-potable distribution systems, and would require substantial public and agency involvement to ensure public acceptance.

Recommendations

The following recommendation is made related to the potential for reuse of treated M&I return water for the American Sub-basin:

1. *Use existing Water Forum process and related study efforts to investigate potential for reuse of M&I treated return water for landscape irrigation or industrial cooling purposes, or other uses determined to be appropriate.*

Environmentally Beneficial Water Management Actions

Summary of Current Activities

Several significant actions and programs have been completed or are underway in the American Sub-basin, related to water management, that are driven primarily by environmental improvement objectives. The following provides a summary of each.

Fish Screen/Passage Improvements – A consolidated fish screen improvement project is proposed that would potentially serve as a Sacramento River diversion point for NCMWC, the City of Sacramento, and Placer County. Placer County involvement is dependent on being able to successfully transfer water rights and point of diversion from the American River to the Sacramento River. The City of Sacramento is also in the process of finalizing design on an intake structure and screen on the Sacramento River near Richards Avenue.

Watershed Management and Restoration – A Habitat Conservation Plan for the Natomas Basin in Sacramento, developed by several agencies including the City of Sacramento, is currently being implemented. The Habitat Conservation Plan includes 53,342 acres, 8,750 of which are proposed to be protected. The area provides habitat to a number of listed species including valley elderberry longhorn beetle, giant garter snake, various ferry shrimp associated with vernal pools, Aleutian Canada goose, Swainson's hawk, and a variety of non-listed species. Current and future uses identified within the area covered by the Habitat Conservation Plan include agriculture, business/commercial construction, residential construction, and utility/infrastructure. Reclamation District 1000 and NCMWC are not signatories to the Habitat Conservation Plan, but are cooperating with the City of Sacramento in its implementation. Natomas Central Mutual Water Company and RD 1000 have submitted their own Habitat Conservation Plan and are awaiting approval from USFWS.

As described in TM 2, rice lands provide habitat for waterfowl during spring and summer months, as well as during winter in fields that are flooded to promote rice stubble decomposition. Such fields add substantially to the amount of habitat available within the basin in addition to the refuges identified above and private wetland areas.

Recommendations

The following recommendations were identified to assist in promoting the maintenance and enhancement of environmental resources within the American Sub-basin:

1. *Continue to work with USFWS, Sacramento County, and other entities involved in ongoing Habitat Conservation Plan process to identify appropriate measures to promote maintenance of habitat associated with agricultural drains, lands, and canals (where feasible) while encouraging existing agricultural uses.*
2. *Continue to seek opportunities to provide habitat for waterfowl through encouraging rice flooding practices, including rice stubble decomposition.*
3. *Promote increased water supply reliability for private wetland areas and development of additional wetland areas where practical.*
4. *Evaluate presence of habitat related to water deliveries in relation to potential conservation options including canal lining and or additional drain maintenance with appropriate agencies.*
5. *Support and seek funding opportunities for additional fish passage enhancement projects including identifying most beneficial screen replacements and conveyance system improvements.*
6. *Support additional sub-basinwide watershed planning and enhancement efforts.*
7. *Support system gaming efforts to evaluate potential for maximizing environmental benefits while ensuring adequate water supplies to meet in-basin user water requirements.*

American Sub-basin Water Management Concepts

In addition to the identification of basinwide, sub-basin, and district-specific water management options, it was determined useful to identify water management concepts that could potentially be implemented at a sub-basin level. Concepts are potential actions based upon grouping identified options that appear to be reasonable and appropriate given the existing and projected water requirements and supplies within a particular sub-basin. It is recognized that the implementation of any of the identified concepts would likely require extensive coordination among stakeholders within a given sub-basin, as well as additional study, and would represent long-term actions. Primary issues associated with implementation of any of the options are discussed under the sub-basin and district-specific option sections. It is also recognized that implementing any concept would provide for optimizing normal and dry-year supplies; the grouping of concepts within normal and drought years below is simply to allow for convenient discussion.

As described above, the identification of sub-basin-specific concepts is driven by the projected water requirement and available water supply. The projected water requirements and supplies for the year 2020 are identified for both the normal and drought condition per data developed in the BWMP in large part obtained from DWR. Supply is identified in terms of current contract supplies and provisions, and is shown as a range for some sub-basins given reductions in dry years and even normal years would vary depending on contract type and the severity of a given year of period. In general, it is assumed that CVP agricultural WSC deliveries could be reduced to zero and M&I WSC amounts reduced by 25 percent in drought years. Where appropriate, concepts that would involve other sub-basins are presented, as well as concepts that would generally be driven only by in-sub-basin users and facilities. It is the intent of these sections to provide for increased discussion, awareness, and analysis as determined appropriate by stakeholders across each sub-basin and the region in general.

Projected year 2020 supply (contracted amount, groundwater, and reuse/drainwater) versus water requirements are as follows:

Normal Year:

- Total water supplies and total contract amounts are generally in balance
- SRSCs (primarily NCMWC) generally in balance

Other entities generally in balance including M&I (requirement of 420,000 ac-ft met by Sacramento, American, and Bear Rivers) and other agriculture (requirement of 300,000 ac-ft met by same).

Drought Year:

- Total requirements exceed contract amount/supply *(approximately 150,000 to 170,000 ac-ft)*
- Majority of deficiency associated with SRSCs, then M&I

Potential Actions

Normal Years

- **Transfer –** The NCMWC could transfer water available in excess of their TDR to meet other in-basin user requirements (primarily M&I users – assumed to be approximately 420,000 ac-ft) and reduce the need to pump groundwater *(current in-sub-basin pumping is approximately 300,000 ac-ft)* if determined to be beneficial. Available water could also be transferred out-of-sub-basin to a variety of potential users.

- **Banking/Conjunctive Water Management –** The NCMWC could bank available supply in excess of TDR in the American Sub-basin groundwater basin, as well as out-of-sub-basin locations (Redding, Colusa, or Butte assuming storage available) or future off-stream storage location (e.g., Sites Reservoir in the Colusa Sub-basin). In-basin banking would infrastructure improvements. Out-of-basin storage would require sufficient pumping to allow for storage (current condition in Redding, Colusa, and Butte Sub-basins is minimal storage is available given natural recharge typically exceeds pumping). Water could be credited either through Shasta release, water exchange, or direct monetary compensation.
- **Drainwater Reuse Management –** The NCMWC could reduce reuse/drainwater use by increasing river diversions to full contract to allow for flushing of salts related to salinity concerns. Increased use of drainwater and general level of reuse in drought years (see below under drought years).
- **Offstream Storage –** (normal and drought conditions) – Multiple in- and out-of-sub-basin management possibilities with potential to assist in meeting water requirements of agricultural, environmental, or M&I users; bank supplies/drought-year protection.

Drought Years

- **Transfers –** The NCMWC could transfer available water in non-critical years, and could be particularly valuable in dry years when SRSC entitlements are not reduced, assuming respective SRSC TDRs can be met. Transfers could be in- or out-of-sub-basin. Water could also be transferred into the sub-basin in particularly dry years from willing sellers including ACID or GCID, or other willing sellers to assist in meeting sub-basin drought-year requirements (including potential NCMWC requirements).
- **Banking/Conjunctive Water Management –** The NCMWC could pump groundwater equal to quantity banked during non-drought years from either in-sub-basin or calls upon water banked out-of-sub-basin (including offstream storage site). See above under normal years.
- **Drainwater Reuse Management (increase reuse/drainwater use) –** SRSCs could increase reuse/drainwater use – to assist in meeting increased TDR requirements in drought conditions (river diversions would be increased in normal and wet conditions to decrease salt loads as described above). River diversions could be reduced to assist other users if respective TDRs can be met (potential to do so in dry years when SRSC entitlements are not reduced; surface water potentially transferred in- or out-of-sub-basin if available).
- **Offstream Storage –** (normal and drought conditions) – Multiple in- and out-of-sub-basin management possibilities with potential to assist in meeting water requirements of agricultural, environmental, or M&I users; bank supplies/drought-year protection.
- **Conservation –** Pursue potential for increased agricultural and M&I conservation (M&I conservation being evaluated through Water Forum process) where sub-basin benefits can be achieved; needs to be evaluated in terms of potential environmental impacts.

Appendix A
Cross-referencing Guide for the Reclamation Standard Criteria Water Management Plans

APPENDIX A

Cross-referencing Guide for Reclamation Standard Criteria Water Management Plans

Much of the information needed by individual SRSCs for the preparation of a U.S. Bureau of Reclamation (Reclamation) Water Management Plan is included in the various technical memoranda (TM) within the Basinwide Water Management Plan (BWMP). Table A-1 is modeled after the Reclamation Evaluation Form for a Water Management Plan and is designed as a cross-referencing tool that indicates where the specific information needed for a Water Management Plan is located within the BWMP. In many cases, the chapter, section, or subsection referenced in Table A-1 provide all of the information necessary to meet the criteria listed in the Reclamation Evaluation Form. However, some of the data contained in the BWMP may not be specific enough for the Water Management Plan, and a district may need to provide additional information to prepare a standard Water Management Plan. In other cases, the criteria listed in the Water Management Plan Evaluation Form may not be applicable to the BWMP, and the data may only be available through the individual districts. Each district should review Table A-1 to locate information specific to its Water Management Plan and to determine what additional data will be needed to fill out the requirements of the Water Management Plan.

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

Template for Reclamation Water Management Plan	Source – Technical Memorandum Location							Other BWMP Documents
	TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	BWMP Summary Report	
Step1: Describe the District								
A. History								
Date district formed - See the *Formation and Right* subsection under each of the individual district sections in TM 2.		X						
Size and irrigation acres - See the *Service Area and Distribution System* subsection under each of the individual district sections in TM 2. - See the *Agricultural* subsection under each of the individual district sections in TM 2.		X						
Water supplies - See the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.			X					
Annual entitlements - See the *Formation and Right* subsection under each of the individual district sections in TM 2. - See the *Water Rights and CVP Water Service Contracts* subsection under the *Sacramento Basin Water Resources Characteristics* chapter in TM 3. - See the *Settlement Contract Entitlements* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.		X	X					
Land use changes - Not applicable to BWMP, data must be provided by the individual districts.								
Cropping patterns – crop names and acres - See the *Agricultural* subsection under each of the individual district sections in TM 2.		X						
Irrigation methods – type and acreage - See the *Service Area and Distribution System* and *Agricultural* subsections under each of the individual district sections in TM 2.		X						

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

Template for Reclamation Water Management Plan	Source – Technical Memorandum Location TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	BWMP Summary Report	Other BWMP Documents
B. Location and Facilities								
Ag. conveyance system - See the *Conveyance Systems Automation of Monitoring and Control* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5. - See the *Distribution Facilities* subsection under each of the individual district sections in the *BWMP Inventory of Existing Facilities Report*.					X			X
Storage facilities, including capacity and location - See the *Supply Facilities* subsection under each of the individual district sections in the *BWMP Inventory of Existing Facilities Report*.								X
Spill recovery system - See the *Tailwater, Reuse/Recirculation, and Water Transfers* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3. - See the *Drain Reuse* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5. - See the *Distribution Facilities* and *Drainage Facilities* subsections under each of the individual district sections in the *BWMP Inventory of Existing Facilities Report*.			X		X			X
Irrigation scheduling system - See the *Agricultural* subsection under each of the individual district sections in TM 2.		X						
Restrictions on water sources - See the *Summary of (District) Options Evaluation* table under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
Planned changes/additions to facilities in 5 years - Not applicable to BWMP; data must be provided by the individual districts.								
C. Topography and Soils								
Topography and impacts on district water management - See the *Topography and Soils* subsection under each of the individual district sections in TM 2.		X						

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

Template for Reclamation Water Management Plan	Source – Technical Memorandum Location							Other BWMP Documents
	TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	BWMP Summary Report	
Soil associations and acreage of each within district - See the *Topography and Soils* subsection under each of the individual district sections in TM 2.		X						
Limitations on district agriculture resulting from soil problems - See the *Topography and Soils* subsection under each of the individual district sections in TM 2.		X						
D. Climate								
General climate of district - See the *Climate* subsection under the *Basin Characteristics* section under the *Sacramento Basin Water Resources Characteristics* chapter in TM 3.			X					
Weather data, specify period of record and reference used - Not applicable to BWMP; data must be provided by the individual districts.								
Average precipitation - See the *Climate* subsection under the *Basin Characteristics* section under the *Sacramento Basin Water Resources Characteristics* chapter in TM 3.			X					
Maximum and minimum temperature - See the *Climate* subsection under the *Basin Characteristics* section under the *Sacramento Basin Water Resources Characteristics* chapter in TM 3.			X					
Wind velocity and frost-free days - Not applicable to BWMP; data must be provided by the individual districts.								
E. Natural and Cultural Resources								
Known natural resources - Not applicable to BWMP; data must be provided by the individual districts.								
Past or present management - Not applicable to BWMP; data must be provided by the individual districts.								
Recreational/cultural resources - Not applicable to BWMP; data must be provided by the individual districts.								

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

Template for Reclamation Water Management Plan	Source – Technical Memorandum Location							Other BWMP Documents
	TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	BWMP Summary Report	
F. Operating Rules/Regulations								
Described rules or regulations - Not applicable to BWMP; copies of district rules and codes must be provided by the individual districts.								
G. Water Measurement, Pricing, and Billing								
Number of customers and number currently measured - Not applicable to BWMP; data must be provided by the individual districts.								
Ag. Measurement - See the *Agricultural* subsection under each of the individual district sections in TM 2. - See the *Farm-level Measurement* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.		X			X			
Type # - Not applicable to BWMP; data must be provided by the individual districts.								
Accuracy - Not applicable to BWMP; data must be provided by the individual districts.								
Reading - Not applicable to BWMP; data must be provided by the individual districts.								
Calibration - Not applicable to BWMP; data must be provided by the individual districts.								
Maintenance - Not applicable to BWMP; data must be provided by the individual districts.								
Water charges (rate structure, frequency, and format) - See the *Existing Pricing Structure* subsection and *Existing SRSC Pricing Structures* table under the *Pricing Structures* chapter in TM 5.					X			
Accounting procedures and record keeping - Not applicable to BWMP; data must be provided by the individual districts.								

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

	Source – Technical Memorandum Location							
Template for Reclamation Water Management Plan	**TM 1**	**TM 2**	**TM 3**	**TM 4**	**TM 5**	**TM 6**	**BWMP Summary Report**	**Other BWMP Documents**
H. Water Shortage Allocation Policies								
Allocation of reduced Ag. water supplies - Not applicable to BWMP; data must be provided by the individual districts.								
Policies that address wasteful water use and enforcement - Not applicable to BWMP; copies of district rules and codes must be provided by the individual districts.								
Step 2: Inventory Water Resources								
A. Surface Water Supply - See the *Sacramento River Supply* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3. - See the *Supply Facilities* subsection under each of the individual district sections in TM 6. - See the *Other Surface Water Source* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM3. - See the *BWMP Inventory of Existing Facilities Report*.			X			X		X
B. Groundwater Supply - See the *Groundwater* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3. - See the *Groundwater* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5. - See the *Supply Facilities* subsection under each of the individual district sections in the *BWMP Inventory of Existing Facilities Report*.			X		X			X
Groundwater basin(s) that underlie the district - See the *Groundwater Sub-basins in Sacramento River Basin* Figure 4 in TM 3.			X					
Map of district-operated wells and groundwater recharge area - See the *(District) Irrigation Current Water Use and Contract Amounts* figure under each of the individual district chapters in TM 6.						X		
Conjunctive water management programs - See the *Conjunctive Water Management Programs* section under each of the individual sub-basin chapters in TM 6.						X		

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

	Source – Technical Memorandum Location							
Template for Reclamation Water Management Plan	**TM 1**	**TM 2**	**TM 3**	**TM 4**	**TM 5**	**TM 6**	**BWMP Summary Report**	**Other BWMP Documents**
Current groundwater management plan - See the *Assembly Bill 3030* subsection under the *Conjunctive Water Management* section under the *Conjunctive Water Management and Groundwater Use* chapter in TM 5.					X			
C. Other Water Supplies								
Long-term water supplies not described above - See the *Other Surface Water Sources* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.			X					
D. Source Water Quality Monitoring Practices								
Surface or groundwater quality problems/how the quality problems limit the use of the water - See the *Groundwater* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5. Additional data must be provided by the individual districts.					X			
Water quality monitoring programs for surface water - Water quality monitoring data for the individual districts may be available through the Department of Water Resources (DWR). See the *Quality* subsection under the *Surface Water Resources* section under the *Sacramento Basin Water Resources Characteristics* chapter in TM 3. Additional data must be provided by the individual districts.			X					
Water quality monitoring programs for groundwater - Groundwater quality monitoring data for the individual districts may be available through DWR. See the *Groundwater Resources* section under the *Sacramento Basin Water Resources Characteristics* chapter in TM 3. Additional data must be provided by the individual districts.			X					
Current year total dissolved solids range for surface and groundwater - Not applicable to BWMP; data must be provided by the individual districts.								
E1. Agricultural								
Crop name, irrigation methods, and acreages - See the *Agricultural* subsection under each of the individual district sections in TM 2.		X						

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

Template for Reclamation Water Management Plan	Source – Technical Memorandum Location							Other BWMP Documents
	TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	BWMP Summary Report	
E2. Groundwater Recharge								
Recharge areas and method - An active groundwater recharge program is not being implemented in any of the districts. See the *Groundwater* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5 for the status of groundwater use in the various districts.					X			
E4. Transfers and Exchanges								
All into/out of district transfers - See the *Tailwater, Reuse/Recirculation, and Water Transfers* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.			X					
Trades, wheeling, or other transactions - See the *Tailwater, Reuse/Recirculation, and Water Transfers* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.			X					
E5. Other								
Other uses of water - See the *Municipal and Industrial* and *Environmental* subsections under each of the individual district sections in TM 2.		X						
F. Irrigation Drainage from the District								
Identify where return flows go (if applicable) - See the *Tailwater, Reuse/Recirculation, and Water Transfers* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3. - See the *Drain Reuse* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5. - See the *Drainage Facilities* subsection under each of the individual district sections in the *BWMP Inventory of Existing Facilities Report*.			X		X			X

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

Template for Reclamation Water Management Plan	Source – Technical Memorandum Location							Other BWMP Documents
	TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	BWMP Summary Report	
Identify location of reuse and type of reuse - See the *Drain Reuse* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
Drainage water quality testing program - Water quality monitoring data for the individual districts may be available through DWR. See the *Quality* subsection under the *Surface Water Resources* section under the *Sacramento Basin Water Resources Characteristics* chapter in TM 3. Additional data must be provided by the individual districts.			X					
Role in the drainage water quality testing program - Not applicable to BWMP; data must be provided by the individual districts.								
Usage limitations resulting from drainage water quality - See the *Tailwater, Reuse/Recirculation, and Water Transfers* subsection under each of the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3. Additional data must be provided by the individual districts.			X					
G. Water Accounting (Inventory)								
1. Quantify district water supplies - See the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.			X					
2. Quantify water used - See the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.			X					
3. Overall water account - See the individual district sections under the *SRSC Water Resources Characteristics* chapter in TM 3.			X					

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

	Source – Technical Memorandum Location							
Template for Reclamation Water Management Plan	**TM 1**	**TM 2**	**TM 3**	**TM 4**	**TM 5**	**TM 6**	**BWMP Summary Report**	**Other BWMP Documents**
Step 3: Best Management Practices for Agricultural Contractors								
A. Critical Best Management Practices for Agricultural Contractors								
1. Measure the volume of water delivered to each customer - See the *Water Measurement* chapter in TM 5. - See the *Water Measurement* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
2. Designate water management coordinator - Not applicable to BWMP; data must be provided by the individual districts.								
3. Provide or support the following water management services								
a. On-farm irrigation system evaluations - Not applicable to BWMP; data must be provided by the individual districts.								
b. Irrigation scheduling and crop evapotranspiration information - Not applicable to BWMP; data must be provided by the individual districts								
c. Surface, ground, and drainage water quantity and quality data - Not applicable to BWMP; data must be provided by the individual districts.								
d. Educational programs and materials for farmers, staff, and public - Not applicable to BWMP; data must be provided by the individual districts.								
4. Adopt a water pricing structure based on quantity - See the *Pricing Structures* chapter in TM 5.					X			
5. Evaluate operational practices and procedures - Not applicable to BWMP; data must be provided by the individual districts.								
6. Contractor pump efficiency evaluations - Not applicable to BWMP; data must be provided by the individual districts.								
B. Exemptible Best Management Practices for Agricultural Contractors								
1. Facilitate financing of on-farm capital improvements - See the *State and Federal Agricultural Water Use Efficiency Programs* section under the *Introduction* chapter in TM 5. Specific data must be provided by the individual districts.					X			

TABLE A-1
Template for Reclamation Water Management Plan and Cross-referencing Tool for Locating Management Plan Criteria in the Sacramento River BWMP

Template for Reclamation Water Management Plan	Source – Technical Memorandum Location							Other BWMP Documents
	TM 1	TM 2	TM 3	TM 4	TM 5	TM 6	BWMP Summary Report	
2. Incentive pricing - See the *Pricing Structures* chapter in TM 5. Specific data must be provided by the individual districts.					X			
3. Line or pipe ditches or canals/construct regulatory reservoirs - See the *Canal Lining* subsection under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
4. Increase flexibility of ordering and deliveries - See the *State and Federal Agricultural Water Use Efficiency Programs* section under the *Introduction* chapter in TM 5. Specific data must be provided by the individual districts. - See the *Conveyance Systems Automation of Monitoring and Control, Water Measurement,* and *Farm-level Measurement* subsections under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
5. Construct/operate contractor spill and tailwater recovery systems - See the *Drain Reuse* subsections under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
6. Optimize conjunctive water management - See the *Conjunctive Water Management and Groundwater Use* chapter in TM 5. - See the *Groundwater* subsections under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
7. Automate canal structures - See the *Conveyance Systems Automation of Monitoring and Control, Water Measurement,* and *Farm-level Measurement* subsections under each of the individual district sections under the *Preliminary Evaluation of District-level Water Management and Supply Options* chapter in TM 5.					X			
8. Facilitate or promote pump testing and evaluation - Not applicable to BWMP; data must be provided by the individual districts.								

Appendix B
Sacramento River Basinwide Water Management Plan; Comparison to Draft Criteria for Regional Water Management Plan

APPENDIX B

Sacramento River Basinwide Water Management Plan; Comparison to Draft Criteria for Regional Water Management Plan

Background

In 1996, eight Sacramento River Settlement Contractors (SRSC) commenced litigation against the United States of America and others for the purpose of establishing that Section 3404(c)(3) of the Central Valley Project Improvement Act (CVPIA) does not apply to Sacramento River water rights SRSCs. The litigation reached settlement in January 1997, with an agreement that Section 3404(c)(3) of CVPIA does not apply to SRSCs. As part of the settlement, the SRSCs and U.S. Bureau of Reclamation (**Reclamation**) entered into a Contract Renewal Memorandum of Understanding (MOU). The MOU identified the following four major types of data or documents that were to be prepared as an aid in contract renewal negotiations:

- Update and extension of the 1956 Cooperative Study
- A Basinwide Water Management Plan (BWMP) for the Sacramento River
- Contracting principles
- Discussions of obligations to meet water quality, endangered species, and other environmental needs of the San Francisco Bay/Sacramento-San Joaquin Delta

In response to the agreement, Reclamation prepared a draft Criteria for Evaluating Regional Water Management Plans in the Sacramento Valley (Draft Regional Criteria). The Draft Regional Criteria are, in Reclamation's assessment, the minimum requirements a regional water management plan must meet to satisfy both the Reclamation Reform Act and the CVPIA. The Draft Regional Criteria were issued in 1997, but have not been finalized.

This appendix provides a summary comparison between the scope of work, methods, and products of the BWMP and the Draft Regional Criteria, and through the process provides feedback and refinement for the Draft Regional Criteria. Given the complexity of regional water planning in the Sacramento Valley, the dynamic nature of water management in the West today, and the different emphasis in content between the scope of work for the BWMP and the Draft Regional Criteria, it is expected that the BWMP will not meet every detail of content specified in the Draft Regional Criteria. However, the practical experience and insight into the regional planning process gained from the execution of the BWMP can provide useful feedback on the Draft Regional Criteria for consideration by Reclamation and other interested parties.

The following table provides a detailed breakdown by Draft Regional Criteria content. It is anticipated that following completion of the BWMP and final review and comments by Reclamation, there will be a joint effort to refine and re-issue the Draft Regional Criteria for use in future regional water management planning efforts.

TABLE B-1
Summary Comparison of Reclamation Draft Regional Plan Criteria and the SRBWMP Study

Draft Regional Plan Process Steps	Draft Regional Criteria Detailed Topics per Step	Location of Information in Sacramento River BWMP	Comments and/or Suggested Revision for Regional Plan Criteria
I. Describe Region	History	See TM 2 and TM 3	None.
Intent: "To describe the physical aspects of the participating districts as a basis for evaluating potential and actual water management improvements within the region."	Location and Facilities	See TM 5 and Facilities Inventory Appendix	
	Topography and Soils	See TM 2	The suggested level of detail for soils characterization may not be practical, given the time and cost to summarize by acreage all of the major soil types. The Natural Resources Conservation Service is in the process of digitizing the county-level soil surveys, and when this data is available in electronic format this type of summary can then be done with reasonable efforts.
	Climate	See TM 2	None.
	Natural and Cultural Resources	Not is scope of BWMP	It is unclear what the purpose of this information is in a water management plan. It appears to be more suitable for NEPA or California Environmental Quality Act documentation, which may become necessary as specific elements of the BWMP move forward (i.e., construction of a new reservoir).
	Operating Rules and Regulations	See TM 2 and TM 5	None.
	Water Measurement, Pricing, and Billing	See TM 5	The amount of detail suggested in the Draft Regional Criteria may not be practical. For example, in terms of measurement device inventory, this amounts to thousands of devices on a regional scale. It is suggested that the regional plan focus on summarizing this information for each district. The Draft Regional Criteria also do not discuss the other levels of operations measurement- i.e., canals, laterals, drains, wells, etc…The suggested revision would be that the Draft Regional Criteria require a summary table of each district's measurement practices by operations level, describing the types of devices typically used, and general maintenance and calibration practices.
	Water Shortage Allocation Policies	See TM 5	Could be combined under "Operating Rules and Regulations" section.
	Water Quality	See TM 3	BWMP does not address water quality to level suggested in the Draft Regional Criteria.
II. Inventory Water Resources	Surface Water Supply	See TM 3 and TM 6	None.
	Groundwater Supply	See TM 3 and TM 6	None.
	Other Water Supplies		
	Water Use: ag., M&I, env, recharge, transfers/exchanges, other	See TM 2, TM 4, and TM 6	There is a high level of detail suggested for this in the Draft Regional Criteria. This level of detail may not practical for a regional plan, as opposed to a district-level plan. A suggested revision for the water balances is that first it should reflects limits of available data and also the intended use of the data, i.e., providing a regional water balance as compared to individual district water balances. During the BWMP process, the use of a sub-basin approach for water balances provided useful and reasonably obtainable data for evaluation of existing regional water use and management. Major supply and use elements of the water balances were analyzed at the sub-basin level, including drainwater inflows and outflows, groundwater pumping, and surface water supplies. It is suggested that the Draft Regional Criteria be revised to clarify the boundaries of any required water balances, and that level of detail requested reflect the available data.
	Agricultural Drainage	See TM 3, TM 5, and TM 6	
	Water Accounting	See TM 4	
	Sacramento Valley Water Inventory	See TM 3 and TM 4	
Develop Water Management Objectives	Ecosystem – in-stream flows, temperature, habitat, fish screens, ESA species issues	See MOU and TM 1 for BWMP objectives	The "Objectives" section is where the Draft Regional Criteria seem to fully embrace the "regional management" concept. The emphasis on specific, quantifiable objectives for regional management provides a helpful focus. However, many of the specific objectives (in-stream flows, temperature, optimizing recreation, and energy production, etc…) are things that individual water users do not have a great deal of influence over.
	CVP Operations Flexibility: diversion and flow coordination, drought planning, conjunctive water management		A suggested revision to the Draft Regional Criteria is to focus more on the analysis and evaluation of regional actions, including CVP operations. The BWMP process has shown that the regional "gaming" exercises are very helpful in clarifying the interactions between the different regional water management elements and tradeoffs between a wide range of potential regional actions such as conjunctive water management, drainwater management, CVP operational changes, etc… Again, the Draft Regional Criteria appear to have "regional goals" but a narrow focus on district-level actions or programs that cannot reasonably influence or achieve the goals.
	General Water-related Benefits: optimize multiple use, maintain agriculture, identify barriers to improved management		

TABLE B-1
Summary Comparison of Reclamation Draft Regional Plan Criteria and the SRBWMP Study

Draft Regional Plan Process Steps	Draft Regional Criteria Detailed Topics per Step	Location of Information in Sacramento River BWMP	Comments and/or Suggested Revision for Regional Plan Criteria
Identify Actions for Supporting Objectives	Grower education and "price signal" are required Consider partnerships for non cost-effective actions	See TM 5 and TM 6	It is suggested that the Draft Regional Criteria revise this section to reflect the approach used in the BWMP. This approach emphasized starting with a wide range of individual actions (the options “menu”), and evaluating each option both for each district and regionally. Based on the evaluation in terms of benefits, costs, and implementation issues, these individual options are then combined into a range of comprehensive alternatives for application at the local and regional level. These alternatives are then further refined using regional gaming exercises. Regarding the “pricing signal,” it is suggested that the issue of efficiency should be considered first, and if the sub-basin- or district-level efficiency is reasonable, there may not be a need for increased price pressures for their own sake.
Monitoring Program	Monitor for each objective Need schedule, budget, responsible party Annual reporting requirements	Monitoring program not part of this phase of BWMP	It is anticipated that the options and programs put forth in the BWMP will take several years or more to implement, and a detailed monitoring program is not feasible at this time. However the BWMP does advocate many actions that will address this issue, such as improved regional water measurement, drainwater quality monitoring, and groundwater monitoring.
Public Involvement	Wide range of parties: see list	See MOU. Meetings and outreach efforts held with environmental community, DWR, Reclamation, district boards	The Draft Regional Criteria may be unnecessarily broad here. “Outside parties” opens up the planning process to virtually the entire State of California, which may not be practical. Soliciting and responding to this level of review may be neither practical nor helpful in producing an effective regional plan. It is suggested that the Draft Regional Criteria be revised to more clearly focus the roles and responsibilities of the parties providing review. Examples could include all participating district boards, public meetings at key stages with a set number of public locals within the basin, and specific government agencies such as DWR and Reclamation.
Implementation Schedule		See the BWMP Summary Report	

Report

Sacramento River Basinwide Water Management Plan Inventory of Existing Facilities

CH2MHILL

in association with

MONTGOMERY WATSON HARZA

MBK

October 2004

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Acronyms and Abbreviations

ac-ft/yr	acre-feet per year
ACID	Anderson-Cottonwood Irrigation District
CDMWC	Colusa Drain Mutual Water Company
cfs	cubic feet per second
GCID	Glenn-Colusa Irrigation District
MFWC	Meridian Farms Water Company
MID	Maxwell Irrigation District
MTCR	M&T Chico Ranch
NCMWC	Natomas Central Mutual Water Company
NWR	National Wildlife Refuge
PCGID	Princeton-Codora-Glenn Irrigation District
PID	Provident Irrigation District
PMWC	Pelger Mutual Water Company
RD 108	Reclamation District No. 108
RD 1400	Reclamation District No. 1400
SMWC	Sutter Mutual Water Company
TIDC	Tisdale Irrigation and Drainage Company

Inventory of Existing Facilities

The inventory of existing facilities summarizes the main water supply, conveyance, and drainage facilities for each of the participating Sacramento River Settlement Contractors. New water management and supply alternatives are considered from the perspective of each district or company's existing system operations and the irrigation supply, distribution, and drainage infrastructure. Any new alternatives must function within the constraints of these existing facilities and operating practices, or they will necessitate modifications of the facilities and/or operating practices. The scope of this facility summary is limited to those facilities that are key components of each district or company's supply and internal operations and management system. The maps and discussions for each service area are not intended to provide a high level of detail, but rather to show locations of primary facilities only. The California Department of Water Resources Division of Local Planning and Assistance has conducted a more detailed mapping effort over the past year, and has produced detailed maps and Geographic Information System files of each of the participating Sacramento River Settlement Contractor service areas. These Division of Local Planning and Assistance maps and the official district or company maps should be consulted for more detailed information on facilities.

The following sections present a facility summary for each district or company, including key data for each facility and a district or company map showing the location of each facility. Figure 1 presents an overview of the project area for reference (all figures are located at the end of this report).

Facility information was collected for pump stations, gravity surface diversions, wells, canals, major distribution laterals, interties between districts, drainage canals, and drain pumps. The information was obtained from internal district or company reports and maps, communication with the districts, and various California Department of Water Resources reports and maps. The facility information is summarized and stored in database and Geographic Information System files for use in mapping and analysis.

Anderson-Cottonwood Irrigation District

Supply Facilities

Anderson-Cottonwood Irrigation District's (ACID or District) primary water source is surface water diversion from the Sacramento River. Water pools behind the District's seasonal dam (creating Lake Redding) and flows by gravity through an intake screen, tunnel, and ultimately into the main canal. ACID, in 1999, completed the improvements to the fish ladder and screen facilities as part of a CALFED-funded effort to enhance the Sacramento River anadromous fishery. ACID also has one pump station diversion on the Sacramento River, which is used to supply water to its Churn Creek Bottom Canal. The District does not currently have any significant groundwater pumping capability, although the District service area does overlay portions of the Redding Groundwater Basin. Table 1 summarizes ACID's surface water supply facilities. See Figure 2 for a map of ACID's major conveyance facilities.

TABLE 1
ACID Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
ACID Diversion Dam	Sacramento River	Gravity	450	114,700[a]
Churn Creek Bottom Pump Station	Sacramento River	Pump	75	19,400[a]

[a]Estimated proportion of total diversions based on pump station capacity

Notes:
cfs = cubic feet per second
ac-ft/yr = acre-feet per year

Distribution Facilities

ACID's distribution system includes approximately 30 miles of unlined canals and main laterals. Approximately 5 miles of the main canal are concrete lined. The main canal flows through several inverted siphons for conveying the canal flows under cross drainage channels such as Clear Creek. The District has an ongoing program for replacement of open-channel farm laterals with pipeline laterals. Several wasteways are located along the canal route at creek crossings and natural drains. These wasteways return water to the river or local streams when flow exceeds the capacity of the canal, which typically occurs in the winter months during storm runoff. Table 2 summarizes ACID's main canal and irrigation lateral features.

TABLE 2
ACID Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
ACID Canal	ACID Diversion Dam	450	Partial (5 miles)	Cottonwood Creek	25
Churn Creek Bottom Canal	Churn Creek Pump Station	75	No	None	25

Drainage Facilities

ACID has a network of unlined drainage ditches for conveying irrigation return flows. The drains generally empty into the Sacramento River or one of the local tributary creeks. Most of the soils in the District's service area are well drained; therefore, the field-applied water generally percolates directly to the underlying groundwater basin, which minimizes the need for extensive drainage facilities. All drainage flows out of the District by gravity. However, the District operates five drain pump stations for recapture of drain flows. Table 3 summarizes these drain recapture facilities.

TABLE 3
ACID Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Simpson	Anderson Creek	Lateral	10	1,400
Jesson	Anderson Creek	Lateral	5	700
Supan	Anderson Creek	Lateral	10	1,400
Perry's Pond	Perry's Pond	Lateral	5	700
Dymesich's Pond	Dymesich's Pond	Lateral	5	700

Glenn-Colusa Irrigation District

Supply Facilities

Glenn-Colusa Irrigation District's (GCID or District) main supply facility is the Hamilton City Pump Station located on the Sacramento River. The existing pump station was constructed in 1984. GCID, in 2001, completed the improvement and enlargement of the fish screen, including the construction of a gradient control facility for the Oxbow Channel where the pump station is located. The District has historically diverted from Stony Creek via a seasonal gravel dam. This diversion is no longer used following the construction of the Stony Creek Siphon, which conveys main canal flows under the Stony Creek Canal. GCID now receives its Stony Creek water supply through diversion from the Sacramento River or via U.S. Bureau of Reclamation's Tehama-Colusa Canal facilities. GCID can convey refuge water and some of the Settlement Contract water through the Tehama-Colusa Canal Authority via two points of interconnection with the GCID Main Canal: an intertie near the Glenn and Colusa County boundary line and a crosstie west of Williams. Table 4 summarizes GCID's surface water supply facilities. See Figure 3 for a map of GCID's major conveyance facilities.

TABLE 4
GCID Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Hamilton City Pump Station (Mile 1.4)	Sacramento River	Pump	3,000	659,900
Tehama-Colusa Canal Intertie (Mile 37.2)	Tehama-Colusa Canal	Gravity	1,000	25,400
Tehama-Colusa Canal Crosstie (Lateral 56-1G)	Tehama-Colusa Canal	Gravity	130	23,400

GCID currently operates one groundwater well near the north end of the main canal. However, the supply from this well is negligible relative to the total District supply. Approximately 100 private landowner wells are used for irrigation supply, with a combined capacity of approximately 500 cfs. These wells are used as part of a voluntary groundwater conjunctive water management program encompassing the entire District.

Distribution Facilities

GCID has approximately 65 miles of main canal and 450 miles of major laterals. The main canal is the primary conveyance facility for the District. The main canal generally runs along the west side of the District and supplies the various laterals for delivery to field turnouts. Several main canal major improvements have been made recently, including upgrades being constructed this year. These include the installation of new cross-drainage structures and the replacement of existing drainage and control structures. These improvements will allow year-round operation of the main canal for supplying the Sacramento National Wildlife Refuge (NWR) complex lands. Table 5 summarizes GCID's main canal and irrigation lateral features.

Drainage Facilities

GCID has a network of unlined drainage ditches for conveying irrigation return flows and regional surface runoff. The drainage ditches generally empty into regional sloughs and creeks, which in turn drain into the Colusa Basin Drain. The District operates 19 drain recapture pump stations to divert drainwater for reuse. These pump stations have a total combined capacity of 912 cfs, and recapture an average of 76,000 ac-ft/season. The District also has 18 gravity surface diversions for recapturing drainwater, which recapture an average of 77,000 ac-ft/season. These facilities are not shown on Figure 3.

Maxwell Irrigation District

Supply Facilities

Maxwell Irrigation District (MID or District) operates one pumping plant on the Sacramento River located northeast of the Delevan NWR. The Maxwell Pump Station supplies MID's main canal. The Maxwell Pump Station was relocated in 1994, with new pumps and fish screens, to a location directly on the west bank of the Sacramento River. The previous location was on a back slough off of the river. During low river levels, the water elevation in the slough and interference from another pump station closer to the mouth of the slough prevented running MID's pumps at full capacity. The new pump station allows MID to divert its full Sacramento River supply. MID also uses return flow drainwater to supplement its Sacramento River supply. Drainwater use is discussed below. Table 6 summarizes the District's primary surface water supply facilities. The District does not use groundwater. See Figure 4 for a map of MID's major conveyance facilities.

Distribution Facilities

MID's distribution and conveyance system includes approximately 4 miles of main canals and laterals. The MID Supply Canal conveys water from the Maxwell Pump Station to the MID service area. The MID Supply Canal supplies four main laterals, including the Highline Lateral, Lateral South, Lateral "F," and the 2-Mile Supply Canal. The MID Supply Canal merges with the Stone Corral Creek channel for approximately 0.25 mile, just before entering the MID service area. A check structure on Stone Corral Creek and lift pump station (the main pumps) are used to convey the water out of Stone Corral Creek and into the MID Supply Canal reach that runs along the north boundary of the District. Two more lift pumps, the S-turn Pumps and West Pumps, are used to lift water from the Supply Canal into the Lateral "F" and 2-Mile Supply Canal, respectively. The Highline Lateral and Lateral South are gravity flow diversions off the Supply Canal. Table 7 summarizes MID's primary distribution facilities.

TABLE 5
GCID Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
GCID Main Canal	Hamilton City Pump Station	3,000	No	NA	13
River Branch Canal (Lateral 12-4)	GCID Main Canal @ MCM 12.8/12.9	200	No	Lower part of PCGID	15
Bondurant Slough (Drain A) (Lateral 17-1 & 17-2)	GCID Main Canal (48" Sluice Gate)	200	No	Colusa Basin Drain	12
Quint Canal (Lateral 21-2)	GCID Main Canal	100	No	Colusa Basin Drain (20-47 Drain)	12
Willow Creek (Drain B)	GCID Main Canal	100	No	Quint Canal	12
Lateral 25-1	GCID Main Canal	50	No	Central Canal	12
Lateral 26-2	GCID Main Canal	130	No	Sacramento NWR	10
Lateral 35-1	GCID Main Canal	30	No	Sacramento NWR	10
Hunter Creek (Drain D) (aka Willits Slough)	GCID Main Canal (Sluice Gate @ MCM 40.3)	75	No	Logan Creek & Colusa Basin Drain	10 (clay)
Lateral 41-1	GCID Main Canal	80	No	Delevan NWR	10 (clay)
Stone Corral Creek (Drain E)	GCID Main Canal	50	No	Delevan, Maxwell & Colusa Basin Drain	<10
Lateral 45-1 (Drain F3 System)	GCID Main Canal	43	No	Kulh Weir-MID	11
Lateral 48-1 (Lurline Creek System)	GCID Main Canal	100 (Lurline Creek)	No	CDMWC & MID	12
Lateral 49-2 (Lurline Creek System)	GCID Main Canal	100 (Lurline Creek)	No	CDMWC & MID	12
Lateral 51-1 (Freshwater Creek System	GCID Main Canal	50	No	SMWC/CDMWC Colusa Drain	12
Salt Creek System (including Spring Creek)	GCID Main Canal	50	No	Joins Freshwater Creek and goes into Colusa Drain (SJ Weir)	10 (can gain water)
Lateral 64-1 (@ M.P. 64.95)	GCID Main Canal	80	No	Colusa NWR	10
Lateral 56-1	Tehama-Colusa Canal Crosstie	130	No	Spring Creek/Salter System	10

Notes:

NA = not applicable

PCGID = Princeton-Codora-Glenn Irrigation District

SMWC = Sutter Mutual Water Company

CDMWC = Colusa Drain Mutual Water Company

TABLE 6
MID Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Maxwell Pump Station	Sacramento River	Pump	80	11,900

TABLE 7
MID Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
MID Supply Canal	Maxwell Pump Station	80	No	None – feeds laterals	15
2-Mile Supply Canal	Main Supply Canal	40	No	None – feeds laterals	15
Highline Lateral	Main Supply Canal	30	No	Lateral "O" Drain	15
Lateral South	MID Supply Canal	30	No	Lurline Creek Drain	15
Lateral "F"	MID Supply Canal	30	No	Lurline Creek Drain	15

Drainage Facilities

MID has a network of unlined drainage ditches for conveying irrigation return flows. The drains generally empty into the Colusa Basin Drain. The District operates two pumping plants that recapture return flows: Lurline Drain Pump and Cat Crossing Drain Pump. Tables 8 and 9 summarize the main MID drainage facilities. Drain flow recapture is used as a regular part of the District's supply. The supply and timing of the drainwater in Lurline Creek is dependent on upstream irrigators within the GCID service area.

TABLE 8
MID Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Cat Crossing Pumps	Lateral "O" Drain	Highline Lateral	10	Unknown
Lurline Pumps (Use only at start up – low use)	Lateral "F" Drain and Lurline Creek	Local supply ditch	10	Unknown

TABLE 9
MID Drainage Laterals

Name	End Spill	D/S Diverters/Recapture
Stone Corral Creek	Colusa Basin Drain	Colusa Basin Drain Users
Lateral "F" Drain	Lurline Creek Drain to Colusa Basin	Colusa Basin Drain Users
Lateral "O" Drain	Colusa Basin Drain	Colusa Basin Drain Users
Lurline Creek	Colusa Basin Drain	Colusa Basin Drain Users

M&T Chico Ranch

Supply Facilities

M&T Chico Ranch's (MTCR or District) main supply facility, which is the Phelan Parrott Pumping Plant located on the Sacramento River at River Mile 193, has a capacity of 125 cfs. The pump station supplies the Phelan Parrott Canal, which supplies the Parrott Lateral and other District laterals. Table 10 summarizes MTCR's surface water supply facilities. See Figure 5 for a map of MTCR's major conveyance facilities.

TABLE 10
MTCR Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Phelan Parrott Pumping Plant	Sacramento River	Pump	125	10,000

Approximately 27 private landowner wells are used for irrigation.

Distribution Facilities

The Phelan Parrott Canal and Parrott Lateral are the primary conveyance facilities for the District. Table 11 summarizes MTCR's main canal and irrigation lateral features.

TABLE 11
MTCR Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Phelan Parrott Canal	Phelan Parrott Pumping Plant	125	No	Parrott Lateral	NA
Parrott Lateral	Phelan Parrott Canal	125	No	Llano Seco	NA

NA = not available

Drainage Facilities

MTCR is drained to the south via Angel and Edgar Sloughs. The District operates a tailwater recovery station along Edgar Slough. The recovered water then supplies a District lateral.

Meridian Farms Water Company

Supply Facilities

Meridian Farms Water Company's (MFWC or Company) main supply facility is River Pump No. 1 located at River Mile 134 on the Sacramento River. MFWC also pumps water from the Sacramento River using River Pump No. 3 at River Mile 128.6 and River Pump No. 4 at River Mile 126. Table 12 summarizes MFWC's surface water supply facilities. See Figure 6 for a map of MFWC's major conveyance facilities. MFWC currently operates four groundwater wells, shown on Figure 6, with a combined capacity of 25 cfs.

TABLE 12
MFWC Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
River Pump No. 1	Sacramento River	Pump	100-125	17,000
River Pump No. 3	Sacramento River	Pump	40	3,500
River Pump No. 4	Sacramento River	Pump	30-35	5,500

Distribution Facilities

MFWC has approximately 16 miles of main canal and 19 miles of major laterals. The main canals are the primary conveyance facilities for the Company. Table 13 summarizes MFWC's main canal and irrigation lateral features. MFWC has four relift pumps that are used to convey water from canals with lower elevations to canals with higher elevations.

TABLE 13
MFWC Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Railroad Main Lateral	River Pump No. 1	40	Partial (2.5 miles)	Eastern District Boundary, 1/4 mile South of Highway 20	15
No. 1 Main Lateral	River Pump No. 1	100	Yes	Drain Pump No. 9	15
No. 3 Main Lateral	River Pump No. 3	30	Partial (0.5 mile)	Hageman Road Drain	15
No. 4 Main Lateral	River Pump No. 4	50	Partial (0.25 mile)	Mills Road Drain	15
No. 5 Main Lateral	Drain Pump No. 5	50	No	Wood Road Southern Drain	15
No. 7 Main Lateral	Drain Pump No. 7	50	No	Wood Road Southern Drain	15

Drainage Facilities

MFWC has a network of drainage lines for conveying irrigation return flows and regional surface runoff. The flows are generally from north to south within the Company. Drainage water is pumped via several relift pumps back into supply laterals. Forty percent of the water users within the Company are supplied with water from the drains. For MFWC, the drains act as a key part of their distribution facilities. MFWC pumps approximately 15,000 ac-ft of water from the drains annually. The Reclamation District 70 Drain Pump Station shown on Figure 6 is not used for irrigation. This pump discharges regional drainage into the Sacramento River when a gravity discharge is prevented by a high river stage. Tables 14 and 15 summarize the MFWC drainage facilities.

TABLE 14
MFWC Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping (ac-ft/yr)
Drain Pump No. 5	Wood Road-Southern Drain	No. 5 Main Lateral	23	2,700
Drain Pump No. 7	Mills Road Drain	No. 7 Main Lateral	34	3,900
Drain Pump No. 9	Wood Road-Northern Drain	Long Lake Lateral	23	2,700
Drain Pump No. 10	Summy Road Drain	No. 1 Main Lateral	27	3,000
Drexler Drain Pump No. 11	Wood Road-Northern Drain	Drexler Road Lateral	23	2,700

TABLE 15
MFWC Drainage Laterals

Name	End Spill	D/S Diverters/Recapture[a]
Wood Road-Northern Drain	Long Lake	No
Summy Road Drain	Hageman Road Drain	No
Hageman Road Drain	Mills Road Drain	No
Mills Road Drain	Wood Road-Southern Drain	No
Wood Road-Southern Drain	Sacramento River	No
Girdner Road Drain	Wood Road-Southern Drain	No
Gormire Road Drain	Girdner Road Drain	No

[a]All drainage that leaves the Company is discharged to Sacramento River via the Reclamation District 70 Pump Station.

Natomas Central Mutual Water Company

Supply Facilities

Natomas Central Mutual Water Company (NCMWC or Company) has two main pump stations located on the Sacramento River: Prichard Lake Pumping Plant and Elkhorn Pumping Plant. NCMWC also diverts water from the Cross Canal at the Northern Main Pumping Plant. The Cross Canal is located along the northern boundary of the service area. Diversions from the Cross Canal generally flow from north to south; water diverted from the Sacramento River generally flows east or south. Table 16 summarizes these surface water supply facilities. A separate 75-cfs capacity pump at the Elkhorn Pumping Plant supplies landscape irrigation water for the Sacramento Metropolitan Airport. See Figure 7 for a map of NCMWC's major conveyance facilities.

The Company owns groundwater wells, which are rarely used for water supply.

TABLE 16
NCMWC Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Northern Main Pumping Plant	Cross Canal	Pump	NA	37,00
Prichard Lake Pumping Plant	Sacramento River	Pump	NA	10,000
Elkhorn Pumping Plant	Sacramento River	Pump	NA	10,500
Bennett Pumping Plant	Cross Canal	Pump	NA	15,200
Riverside Pumping Plant	Sacramento River	Pump	NA	7,000

NA = not available

Distribution Facilities

The Company's distribution and conveyance system includes approximately 260 miles of canals and laterals. Two main canals, the Northern Main Canal and the Pleasant Grove Canal, serve the northern and eastern portion of the Company service area with water from the Northern Main Pumping Plant. The Central Main Canal, the Garden Highway Canals, and their associated laterals serve the central and southern portions of the service area. Table 17 summarizes the main distribution facilities.

TABLE 17
NCMWC Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Bennett Main Canal	Bennett Pumping Plant (Cross Canal)	NA	No	Sankey Road Ditch	NA
Central Main Canal	Prichard Lake Pumping Plant	NA	No	Plant 13 Pumps/Plant 8 Pumps	NA
Northern Main Canal	Northern Pumping Plant (cross canal)	NA	No	Swimming Hole Diversion	NA
Pleasant Grove Canal	Northern Main Pumping Plant	NA	No	None	NA
East Drain	East Drain Pumps	NA	No	None	NA
Garden Highway South	Drain Pump No. 3	NA	No	None	NA
Garden Highway North	Elkhorn Pumping Plant	NA	No	None	NA
Reservoir Road	Elkhorn Pumping Plant	NA	No	Airport Drain	NA
State Check Ditch	Plant No. 13 Pumps	NA	No	Del Paso Road	NA
Pullman	Pullman Pumps	NA	No	No. 3	NA
No. 3	Pullman	NA	No	Lateral 3C	NA
No. 8	Central Main Canal	NA	No	Sills Lateral	NA
No. 13	Plant No. 13 Pumps	NA	No	State Check Ditch	NA
GB	Central Main Canal	NA	No	No. 8	NA

NA = not applicable

Drainage Facilities

NCMWC is drained by four main drainage canals: Natomas East Main Drainage, North Drainage, East Drainage, and West Drainage Canals. The Natomas East Main Drainage Canal drains directly into the Sacramento River, just north of its confluence with the American River. The West Drainage Canal and the East Drainage Canal join in the south and drain to the Sacramento River in the southern portion of the Company via a drain pump. In addition, the Company completed the installation of a drainwater recirculation system in 1986 to increase water quality for the City of Sacramento and increase overall efficiency of the Company. The recirculation system includes 30 pumping stations at various locations that recapture drainwater for use either directly onto fields or back into the main irrigation canals. Tables 18 and 19 summarize the main NCMWC drainage facilities.

TABLE 18
NCMWC Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Snake Ditch Pump	Main Drainage Canal	Snake Ditch	NA	NA
San Juan 30 Horse Pump	San Juan Horse Ditch	San Juan Lateral	NA	NA
Plant No. 13 Pumps	West Drainage Canal	No. 13	NA	NA
Plant No. 8 Pumps	East Drainage Canal	H Road Lateral	NA	NA
East Drain Pumps	Lateral of East Drainage Canal	East Drain	NA	NA
T-Drain Pump	T-Drain	Northern Main	NA	NA

NA = not available

TABLE 19
NCMWC Drainage Laterals

Name	End Spill	D/S Diverters/Recapture
T-Drain	Northern Main Canal	NA
North Drainage Canal	H1/Pullman Pumps	NA
East Drainage Canal	Natomas East Main Drainage Canal	NA
Airport Drain	West Drainage Canal	NA
West Drainage Canal	Fisherman’s Lake/Natomas Main Drainage	NA
Fisherman’s Lake	West Drainage Canal	NA
San Juan 30 Horse Ditch	West Drainage Canal	NA
Natomas East Main Drainage Canal	Reclamation District 1000 Pumping Plant	NA

During the growing season, drains are managed by NCMWC to deliver water. Reclamation District 1000 manages the drainwater in the off season (after October 1), when most drainage is returned to the Sacramento River.

Pelger Mutual Water Company

Supply Facilities

Pelger Mutual Water Company's (PMWC or Company) primary water supply facility is the Pelger Pump Station located on the Sacramento River. The Pelger Pump Station supplies the Company's main canal, which runs east from the Sacramento River to the western boundary of the Company service area. The Company also relies heavily on drainwater for a secondary supply, with diversions from the Reclamation District 1500 Drain just east of the Company service area. The Pelger Diversion Dam located on the Reclamation District 1500 Reclamation Drain is used to back up drainwater from regional sources into the PMWC's L-Lateral, for supply to service laterals. PMWC has usable groundwater resources within its service area. Groundwater is typically used only during drought conditions. Total current groundwater pumping capacity is 25 cfs from three private wells that are operated by the Company under cooperative agreements with the land owners.

The Company actively manages three main water sources to meet its needs: river diversions, drain recycling, and groundwater pumping. Since 1990, the majority of irrigation water requirements have been met by drainwater use (approximately 50 to 75 percent, depending on year), with the remainder met by Sacramento River diversions (15 to 50 percent) and groundwater (0 to 25 percent). The flexibility to supply water from these various sources is a function of the infrastructure in the Company and the relatively small acreage served. Tables 20 and 21 summarize the surface water supply facilities. See Figure 8 for a map of PMWC's major conveyance facilities.

TABLE 20
PMWC Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Pelger Pump Station	Sacramento River	Pump	55	4,600

TABLE 21
PMWC Groundwater Wells (Private)

Map ID	Capacity (cfs)	Water Quality
Well No. 1	8	Good
Well No. 2	8	Good
Well No. 4	10	Good

Distribution Facilities

The Company's distribution and conveyance system includes approximately 10 miles of canals and laterals. The Pelger Main Canal serves laterals in the northern portion of the Company service area, and is supplied from the Pelger Pump Station. The first 1.5 miles of the Main Canal, starting at the Pelger Pumping Plant, are lined to minimize losses in areas of high permeability soils. The L-Lateral in the center portion of the Company service area is supplied by U.S. Bureau of Reclamation drainwater ponded behind the Pelger Diversion Dam. Table 22 summarizes PMWC's primary distribution facilities.

TABLE 22
PMWC Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Main Canal	Pelger Pump Station	40	Yes (partial)	NA	15
L-Lateral	N/A	N/A	No	SMWC Reclamation Drain	15

Drainage Facilities

PMWC has a network of unlined drainage ditches and drain pump stations for conveying irrigation return flows. The drains and pumps are also an integral part of the water supply and distribution system for capturing and reusing drainwater. Area drains generally empty into the Reclamation Drain to the east. The western edge of the Company abuts a number of independent farmers with individual contracts with U.S. Bureau of Reclamation. These landowners are not located within the Company service area, but do contribute drainwater that may be reused by Company farmers. Tables 23 and 24 summarize the main PMWC drainage facilities.

TABLE 23
PMWC Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Low Lift Drain Pump No. 1	Local drain	Supply ditch	20	1,800
Low Lift Drain Pump No. 2	Local drain	Supply ditch	17	1,000
Low Lift Drain Pump No. 3	Local drain	Supply ditch	9	390
Low Lift Drain Pump No. 4	Local drain	Supply ditch	16	500
Low Lift Drain Pump No. 5	Local drain	Supply ditch	9	570
Low Lift Drain Pump No. 6	Local drain	Supply ditch	8	1,000

TABLE 24
PMWC Drainage Laterals

Name	End Spill	D/S Diverters/Recapture
L-Lateral Drain	Reclamation Drain	SMWC service area users
Multiple Unnamed Drains	Sacramento River and Reclamation Drain	Reclamation Drain diverters

Princeton-Codora-Glenn Irrigation District

Supply Facilities

Princeton-Codora-Glenn Irrigation District's (PCGID or District) primary water supply facilities include two surface water diversions on the Sacramento River: Sidds Landing Pump Station, which is operated in conjunction with the Provident Irrigation District (PID), and Schaad Pump Station, which is similar to the Sidds' facility in design and construction. Table 25 summarizes PCGID's surface water supply facilities. See Figure 9 for a map of PCGID's major conveyance facilities.

TABLE 25
PCGID Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Sidds Landing Pump Station	Sacramento River	Pump	300	42,000
Schaad Pump Station	Sacramento River	Pump	130	22,000

PCGID operates five District-owned wells. Operation of these wells is coordinated with the Sacramento River pump stations to maximize flexibility and provide additional supplies during drought periods. Table 26 summarizes the District-owned groundwater wells. In addition, approximately 15 private wells are located within the District boundary. The District has no formal agreement with growers with regard to pumping private wells. A total of approximately 3,000 ac-ft/yr is available for pumping from the wells that are currently developed.

TABLE 26
PCGID Groundwater Wells

Map ID	Capacity (cfs)	Water Quality	Notes
Wright Well	4.5	Good	Little use–for an orchard only
Jones Well	8.2	Good	Drought/Supplemental
Calvert Well	7.8	Good	Drought/Supplemental
Tobin Well	8	Good	Drought/Supplemental
Spencer Road Well[a]	5.6	Good	Drought/Supplemental

[a]Well construction in progress.

Distribution Facilities

PCGID's distribution system includes approximately 63 miles of unlined canals and main laterals. The River Branch Canal conveys water from Sidds Landing Pump Station at the northern end of the District down to the Armfield, Barnes, and four laterals in the central and southern portions of the District. The Schaad Pump Station supplies the Tobin Canal, Hart Canal, and the southern end of the River Branch Canal. Table 27 summarizes PCGID's main canal and irrigation lateral features.

TABLE 27
PCGID Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
River Branch Canal	Sidds Landing Pumping Plant	350	No	None	25
Glenn Lateral	Sidds Landing Pumping Plant	100	No	Colusa Drain	15
Rasor Ditch Canal	River Branch Canal	60	No	Colusa Drain	15
Wood Canal	River Branch Canal	60	No	Tobin Canal	15
Armfield Canal	River Branch Canal	75	No	Tobin Canal	15
Edwards Canal	River Branch Canal	50	No	None	15
Tobin Canal	River Branch Canal	100	No	Colusa Drain	15
Commons Canal	Hart Canal	150	No	None	15
Hart Canal	River Branch Canal	200	No	Colusa Drain	15
Barnes Canal	River Branch Canal	60	No	Colusa Drain	15
Bert Nielsen Canal	River Branch Canal	150	No	Colusa Drain	15
Monolux Lateral	Hart Canal	75	No	Colusa Drain	15

Drainage Facilities

PCGID has a network of unlined drainage ditches for conveying irrigation return flows. Some of the water in PCGID's drains comes from GCID via the Colusa Basin Drain; the rest is made up of internal District drainage. PCGID currently operates four drain pumps for recapturing and recirculating the water from the drains. The District has flow meters with totalizers on each of the drain pumps, which allows them to keep records of their total drain pumpage. Approximately 25,000 ac-ft/yr are recycled from the drains within PCGID. Drains within the District generally empty into the Colusa Basin Drain, which flows south along the western boundary of the District. Table 28 summarizes PCGID's major drainage facilities.

TABLE 28
PCGID Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Hart Drain Pump	Hart Canal	Hart Canal	70	18,900
Spencer Drain Pump	Inter-district drains	Monolux Lateral	21	2,200
Dodge Drain Pumps	Inter-district drains	Bert Nielson Canal	29	7,300
Riz Road Pump[a]	Colusa Drain	Riz Lateral	35	Not known
Petty Pump	Local Drain	Wood Canal	10	2,000

[a]Currently down. Will be back in operation soon. Was not used in last couple of years.

Provident Irrigation District

Supply Facilities

Provident Irrigation District's (PID or District) primary water supply facility is a surface water diversion on the Sacramento River at Sidds Landing Pump Station. The District operates Sidds Landing Pump Station in cooperation with PCGID. The District also operates two gravity surface diversions on adjacent drainage channels that convey return flows from GCID lands to the west of PID. Table 29 summarizes PID's surface water supply facilities. See Figure 9 for a map of PID's major conveyance facilities.

TABLE 29
PID Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Sidds Landing Pump Station	Sacramento River	Pump	300	58,000
Drain 13 Gravity Surface Diversion	Drain 13	Gravity	100	9,500
Drain 55 Gravity Surface Diversion	Drain 55	Gravity	100	30,000

During the 1976 to 1977 drought, PID installed three groundwater wells to supplement its water supply. An additional well was installed in 1991. Table 30 summarizes the District's groundwater well data. During the drought of 1986 to 1993, several private groundwater wells were installed. There is no formal agreement between the District and the landowners regarding pumping of private wells. Approximately 7,200 ac-ft/yr can currently be pumped from all groundwater wells within the District.

TABLE 30
PID Groundwater Wells

Map ID	Capacity (cfs)	Historical Pumping (ac-ft/yr)	Water Quality
AG Well No. 1	4.5	534	Good
AG Well No. 2	10.7	280	Good
AG Well No. 3	12.9	207	Good
AG Well No. 4	11.1	302	Good

Distribution Facilities

PID's distribution and conveyance system includes approximately 58 miles of unlined canals and main laterals. The Main Canal runs from Sidds Landing Pump Station through the northern portion of the District. The PID main canal also supplies other canals in the Willow Creek Mutual Water Company to the west of PID's southern service area. Table 31 summarizes PID's distribution facilities.

TABLE 31
PID Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Provident Main Canal	Sidds Pump Station	400	No	NA	15
Quint Canal	GCID Main Canal	80	No	Colusa Drain	15
Wylie Canal	Provident Main Canal	60	No	Quint Canal	15
Unnamed Lateral	Provident Main Canal and possibly groundwater pump No. 1	100	No	Unnamed Creek to Colusa Drain	15
North Lateral	Provident Main Canal	300	No	Colusa Basin Drain	15

Drainage Facilities

PID has a network of unlined drainage ditches for conveying irrigation return flows. The drains generally empty into the Colusa Basin Drain. The District operates six pumping plants that recapture return flows. Table 32 summarizes the drain recapture facilities, and Table 33 summarizes the main drain laterals.

TABLE 32
PID Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Colusa Drain Pump	Colusa Basin Drain	Provident Main Canal	53	5,700
Sprague Drain Pump	Unnamed Creek	Booster Ditch	18	2,100
Willow Creek Drain Pump	Willow Creek	Quint Canal/ Provident Main Canal	40	2,200
Green Camp Pump	Unnamed Creek	Provident Main Canal	16	680
57 Pumps	Colusa Drain	N Lateral	39	8,300
Drain 13 Booster Pump	Drain 13	Booster Ditch	48	10,400

TABLE 33
PID Drainage Laterals

Name	End Spill	Downstream Diverters/Recapture
Colusa Basin Drain	Sacramento River	Downstream diversions outside District
Willow Creek Drain	Colusa Basin Drain	Downstream diversions outside District
Drain 55	Colusa Basin Drain	Downstream diversions outside District
Drain 13	Colusa Basin Drain	Downstream diversions outside District

Reclamation District No. 108

Supply Facilities

Reclamation District No. 108's (RD 108 or District) primary water supply facilities include seven pumping plants along the Sacramento River for diversion of water. The largest of these is the Wilkins Slough Pumping Plant near the northeast boundary of the District, which supplies the Wilkins Slough Main Canal. A new fish screen facility was recently completed at Wilkins Slough Pumping Plant. Table 34 summarizes RD 108's surface water supply facilities. See Figure 10 for a map of RD 108's major conveyance facilities.

TABLE 34
RD 108 Surface Water Pumping Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Wilkins Slough Pumping Plant	Sacramento River	Pump/Gravity	700	95,000
Steiner Bend – N Pump Station	Sacramento River	Pump	8	350
Steiner Bend – S Pump Station	Sacramento River	Pump	30	1,600
Boyer's Bend Pump Station	Sacramento River	Pump	116	14,100
Howell's Landing Pump Station	Sacramento River	Pump	71	6,300
Tyndall Mound Pump Station	Sacramento River	Pump/Gravity	190	18,500
El Dorado Bend Pump Station	Sacramento River	Pump/Gravity	80	6,400

The District owns and operates three groundwater wells, which have a total capacity of approximately 20 cfs. The wells are located in the northern portion of the District, and are typically used during drought conditions to supplement reduced surface water supplies. Table 35 summarizes the RD 108 groundwater wells. In addition, several landowners own wells within the District, which they operate as needed.

TABLE 35
RD 108 Groundwater Wells

Map ID	Capacity (cfs)	Historical Pumping (ac-ft/yr)	Water Quality
Well No. 1	7	1,700	Good
Well No. 2	6	1,500	Good
Well No. 4	7	1,700	Good

Distribution Facilities

RD 108's distribution and conveyance system includes approximately 84 miles of earthen canals and 35 miles of concrete-lined canals. The Wilkins Slough Main Canal serves laterals in the northern and western portions of the District, and is supplied from the Wilkins Slough Pumping Plant. Irrigation Canals 12, 13, and 15 serve the central portion with water from Boyers Bend, Howells Landing, and Tyndall Mound pump stations. Irrigation Canal 10P and 14 serve the western and southern boundary of the District, and are supplied from the Wilkins Slough Pump Station via the Main Canal and the El Dorado Bend Pump Station. Several of these canals can also be supplied by the District's drain recapture pumps, as described below. Table 36 summarizes RD 108's primary distribution facilities.

TABLE 36
RD 108 Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Wilkins Slough Main Canal	Wilkins Slough Pumping Plant	800	Earth	None	[a]
Irrigation Canal No. 12	Boyer's Bend Pumping Plant	100	Concrete	Main Drainage Canal	[a]
Irrigation Canal No. 13	Tyndall Mound Pumping Plant	130	Concrete	Main Drainage Canal	[a]
Irrigation Canal No. 14	El Dorado Pumping Plant	300	Earth	Main Drainage Canal	[a]
Irrigation Canal No. 15	Howell's Landing Pumping Plant	70	Concrete	Main Drainage Canal	[a]
Irrigation Canal No. 10P	Riggs Ranch Drain Pump	500	Earth	Main Drainage Canal	[a]
Lateral No. 10-S	Wilkins Slough Main Canal	250	Earth	Main Drainage Canal	[a]

[a]Varies. See District deep percolation studies.

Drainage Facilities

RD 108 has an extensive network of drainage facilities, including over 300 miles of drains and five major drain pump stations for removal or reuse of irrigation return flows and winter stormwater runoff. Because of the District's topography and the surrounding levees, all drainage must be pumped out of the District. The drainage is generally conveyed to the southeast corner of the District where the Rough and Ready, El Dorado Bend, and Sycamore Slough pumping plants are used to convey the drainage either through the flood control levees and into the Sacramento River or back into the distribution laterals for reuse. Sycamore Slough lifts drainage water into Lateral 14A, which conveys water to El Dorado for removal or to the irrigation system for reuse. The Riggs Ranch Pumping Plant conveys drainage from the northern portion of the District into either the Colusa Basin Drain or back into the supply conveyance system (Irrigation Canal 10P) for reuse. The Lateral 8 Pumping Plant lifts drainage water into Wilkins Slough Main Canal for reuse. The Rough and Ready Drain Pump Station shown on Figure 10 is not used for irrigation. The pump discharges regional drainage into the Sacramento River when a gravity discharge is prevented by a high river stage. Tables 37 and 38 summarize the main RD 108 drainage facilities.

TABLE 37
RD 108 Drain Pump and Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
Sycamore Slough	Main Drainage Canal	Irrigation Canal 14	170	10,000
Riggs Ranch	Drain No. 9	Irrigation Canal 10P/Colusa Basin Drainage Canal	150	5,000
Lateral 8	Drain No. 8	Wilkins Slough Main Canal	200	4,000

TABLE 38
RD 108 Drainage Laterals

Name	End Spill	D/S Diverters/Recapture
Main Drainage Canal	Rough and Ready Drain Pump/Sycamore Slough Drain Pump	No
Drain No. 8	Main Drainage Canal	No
Drain No. 9	Main Drainage Canal	No

Reclamation District No. 1004

Supply Facilities

Reclamation District No. 1004's (RD 1004 or District) primary water supply facility is a surface water diversion on the Sacramento River northeast of the town of Princeton from the RD 1004 Pump Station. The eastern portion of the District is also served by the White Mallard Diversion, located on Butte Creek. Table 39 summarizes RD 1004's primary surface water supply facilities. See Figure 11 for a map of the RD 1004 major conveyance facilities. The District owns one well that is used only in drought years and is not a significant water source. There are private wells owned and operated by growers, independent of District operations.

TABLE 39
RD 1004 Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
RD 1004 Pump Station at River Mile 112.1	Sacramento River	Pump	360	49,000
White Mallard Dam/Gravity Surface Diversion	Butte Creek	Gravity	80	3,300
Behring Pump	Butte Creek	Pump	95	600
Butte Creek Farms	Sacramento River	Pump	30	3,000
Rancho Caleta West	Sacramento River	Pump	10	50
Rancho Caleta East (Inactive)	Sacramento River	Pump	0	0

Distribution Facilities

The District's distribution and conveyance system includes approximately 50 miles of canals and laterals. Several other main canals are located throughout the District, and generally flow from north to south. These additional canals include the Frog Pond Canal, the Morgan Levee Canal, and the White Mallard Canal. Major laterals include the Terril Highline Lateral, the District Borrow Pit Lateral, and Avis Channel. Table 40 summarizes the District's primary distribution facilities.

TABLE 40
RD 1004 Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Terril Highline	Drumheller Slough	110	No	East Levee Drain	5
Main Canal	RD 1004 Pump Station	360	Partial (1,300 feet)	5-Points Drain	7
White Mallard Canal	White Mallard Diversion Dam	180	No	5-Points Drain	5
Avis Channel	Main Canal	95	No	East Levee Drain	5
Morgan Levee Canal	District Borrow Pit	80	No	Frog Pond Drain	5
Frog Pond Canal	Main Canal	80	No	Frog Pond Drain	5
Boat Canal	Main Canal	100	No	Butte Creek Drain	5
District Borrow Pit Lateral	Felly Pump No. 119 & No. 120	90	No	5-Points Drain	5

Drainage Facilities

RD 1004 has a network of unlined drainage ditches for conveying irrigation return flows. The East Levee Drain accommodates a majority of the drainage in the eastern portion of the District. The East Levee Drain discharges into Butte Creek via the 5-Points Drain Pump and drain lateral. Several major drain laterals and six drain pump stations are also located in the southern portion of the District. Drainage flows in this portion of the District are pumped to the Sacramento River via the three drain pump stations. In addition, the District operates six pumping plants that recapture return flows within the District. Table 41 and Table 42 summarize the main drainage facilities within RD 1004.

TABLE 41
RD 1004 Drain Pump Stations

Pump Station ID	Source	Discharges To	Capacity (cfs)	Average Historical Pumping Total (ac-ft/yr)
5-Points Drain Pump	East Levee Drain	5-Points Drain to Butte Creek	30	2,000
Pole Line No. 107	Womble Drain	Main Canal	40	1800
Trailer Camp No. 108	Gridley Highway Drain	Terril Highline	25	3,000
Drumheller No. 113	Drumheller Slough	Avis Channel	30	NA
Pearl No. 114	Drumheller Slough	Boat Canal	30	1,700
Butte Lodge	Butte Creek Drain/Butte Lodge Drain	Flyway Ditch	20	1,300

TABLE 42
RD 1004 Drainage Laterals

Name	End Spill	D/S Diverters/Recapture
Butte Creek Drain	Butte Creek	Butte Slough diverters
Butte Lodge Drain	Butte Creek	Butte Slough diverters
5-Points Drain	Butte Creek	Butte Slough diverters
North Levee Drain	East Levee Drain/5-Points Drain/Butte Creek	Butte Slough diverters
Womble Drain	Drumheller Slough	Butte Slough diverters
Frog Pond Drain	Drumheller Slough	Butte Slough diverters

Sutter Mutual Water Company

Supply Facilities

Sutter Mutual Water Company (SMWC or Company) operates three pumping plants located on the Sacramento River: Tisdale Pumping Station, State Ranch Bend Pumping Plant, and Portuguese Bend Pumping Plant. Company operations are coordinated with Reclamation District 1500 and Pelger Mutual Water Company to manage the supply and conveyance of drainwater. Reclamation District 1500 manages drainage within the SMWC service area. SMWC also supplies water to users in the Reclamation District 1660 area north of the Tisdale Bypass. Table 43 summarizes the primary SMWC surface water supply facilities. The Company does not own or operate any groundwater wells. Approximately 38 groundwater wells have been drilled within the Company boundaries, but most have been abandoned because of high salinity levels and lack of sustained yield. See Figure 8 for a map of SMWC's major conveyance facilities.

TABLE 43
SMWC Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Tisdale Pumping Plant	Sacramento River	Pump	960	170,500
State Ranch Bend Pumping Plant	Sacramento River	Pump	128	23,000
Portuguese Bend Pumping Plant	Sacramento River	Pump	106	11,800

Distribution Facilities

SMWC's distribution and conveyance system includes approximately 56 miles of irrigation water delivery canals and 144 miles of laterals. The Company service area's main distribution facilities include seven canals, listed in Table 44. The Main Canal supplies water from the Tisdale Pumping Plant to the West Canal, Reclamation District 1660 Main Canal, the Central Canal, and the East Canal. The State Ranch Bend Main Canal supplies water from the State Ranch Bend Pumping Plant to Lateral S and the West Side Canal. The Portuguese Bend Main Canal supplies water from the Portuguese Bend Pumping Plant to the southern end of the Company service area.

TABLE 44
SMWC Canals and Laterals

Facility Name	Source Facility	Capacity (cfs)	Lined	End Spill Location	Percent Leakage Loss Estimate
Main Canal	Tisdale Pumping Plant	960	No	Reclamation Drain	15
East Canal	Main Canal	300	No	Reclamation Drain	15
Central Canal	East Canal	300	No	Reclamation Drain	15
West Canal	Main Canal	300	No	Reclamation Drain	15
Portuguese Bend Main Canal	Portuguese Bend Pumping Plant	106	No	Reclamation Drain	15
State Ranch Bend	State Ranch Bend Pump Plant	128	No	Risers into drains along canals	15
1660 Main Canal	Main Canal	45	No	Risers into drains along canals	15

Drainage Facilities

Drainage for SMWC is handled by Reclamation District 1500. The area is interlaced with drainage ditches that carry water towards the Reclamation Main Drain and eventually out of the service area at the southern end of the Company via the Reclamation District 1500 Karnak Pumping Plant. The Company operates twelve drain recapture pumps, ranging in size from 12 to 70 cfs. The Company reuses between 7,000 and 15,000 ac-ft/yr of drainwater with these pumps.

The western edge of the Company abuts a number of independent farmers with individual contracts with U.S. Bureau of Reclamation. These landowners contribute drainwater that may be used by Company farmers. However, the high water table and its saline nature limit the amount of water that can be reused without impacting crop yields. In addition to the Company recapture system, individual farmers reuse drainwater with their own pumps.

Tisdale Irrigation and Drainage Company

Supply Facilities

Tisdale Irrigation and Drainage Company's (TIDC or Company) main supply facilities are two pump stations along the Sacramento River. Table 45 summarizes TIDC's surface water supply facilities. See Figure 12 for a map of TIDC's major conveyance facilities.

TABLE 45
TIDC Surface Water Supply Facilities

Facility Name	Water Source	Pump/Gravity	Capacity (cfs)	Average Historical Diversion (ac-ft/yr)
Winship Pump Station	Sacramento River	Pump	30	NA
Harris Pump Station	Sacramento River	Pump	15	NA

TIDC currently operates one groundwater well within the Company with a capacity of 5 cfs. This well is used every year to supplement the surface water supply. There are

approximately three private landowner wells that are used for backup, with a combined capacity of approximately 18 cfs. The private landowner wells are only used during drought years.

Distribution and Drainage Facilities

TIDC has approximately 2.3 miles of main canal and 3.9 miles of major laterals. TIDC has a network of drainage lines for conveying irrigation return flows and regional surface runoff. The return flows are generally recaptured in the Main Drain along the east side of the service area. Large flash board risers hold the water back. Growers then lift the water from the Main Drain with their pumps.

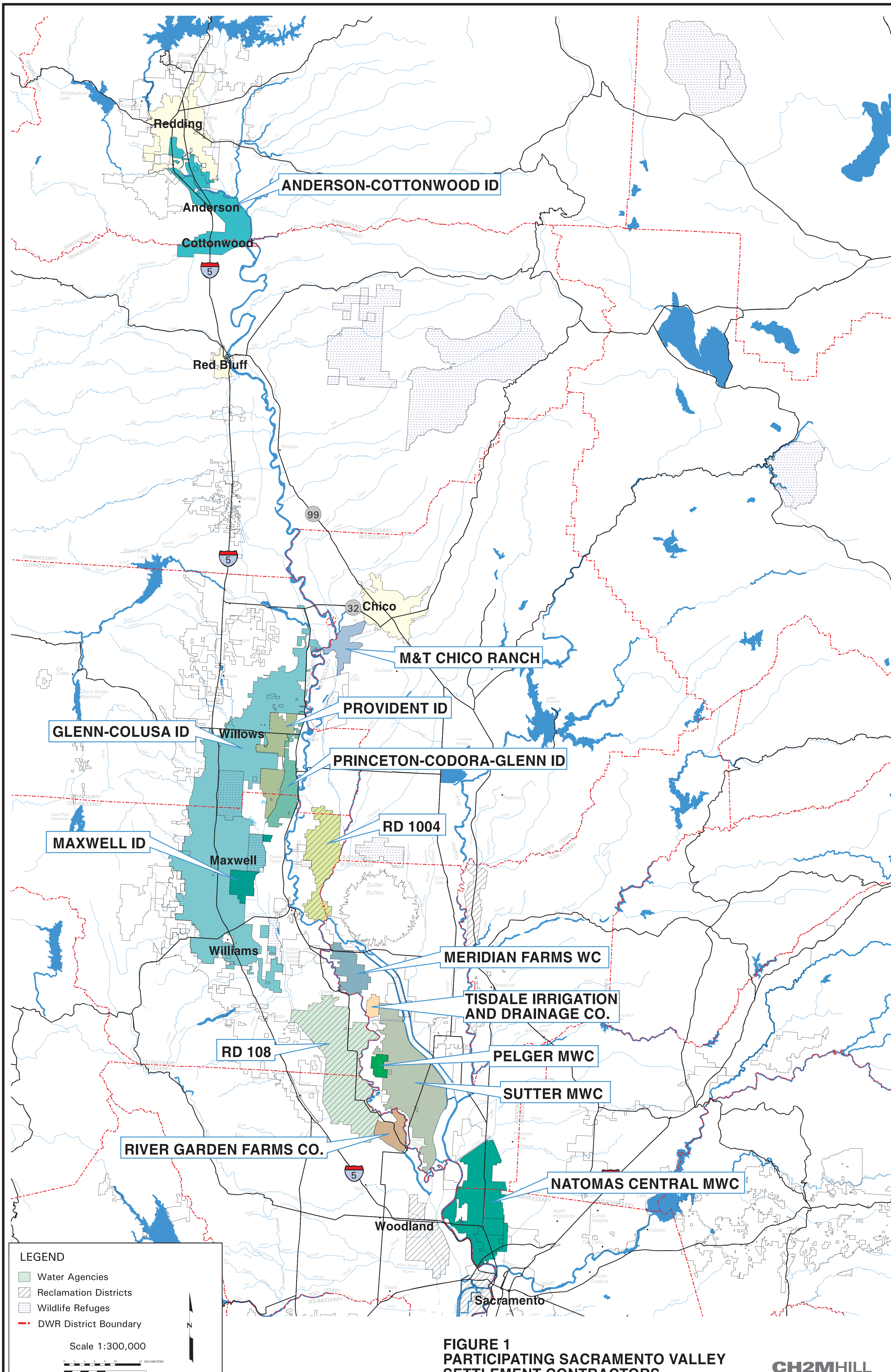

FIGURE 1
PARTICIPATING SACRAMENTO VALLEY SETTLEMENT CONTRACTORS
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL
in association with
MONTGOMERY WATSON HARZA
MBK

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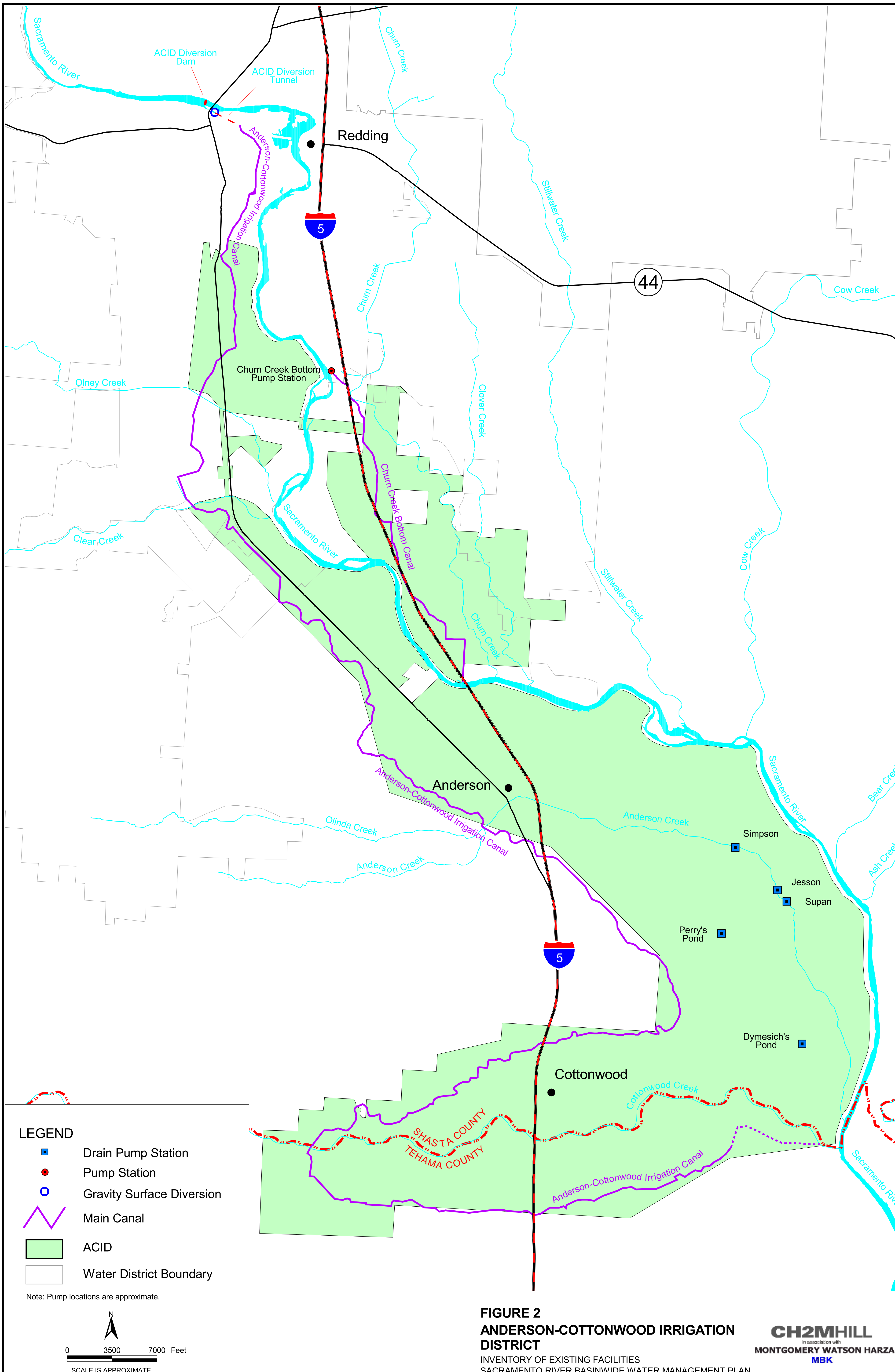

FIGURE 2
ANDERSON-COTTONWOOD IRRIGATION DISTRICT
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

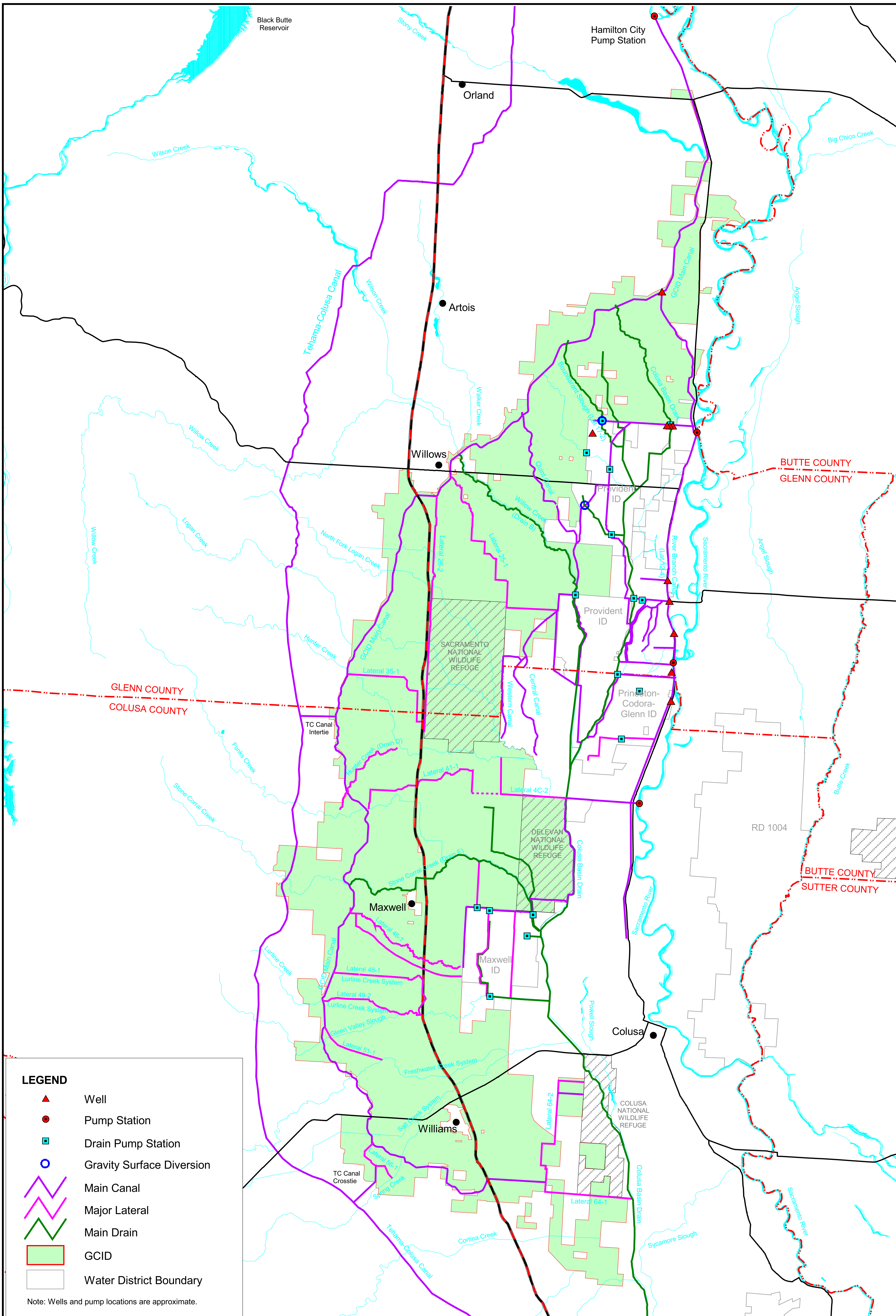

FIGURE 3
GLENN-COLUSA IRRIGATION DISTRICT
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

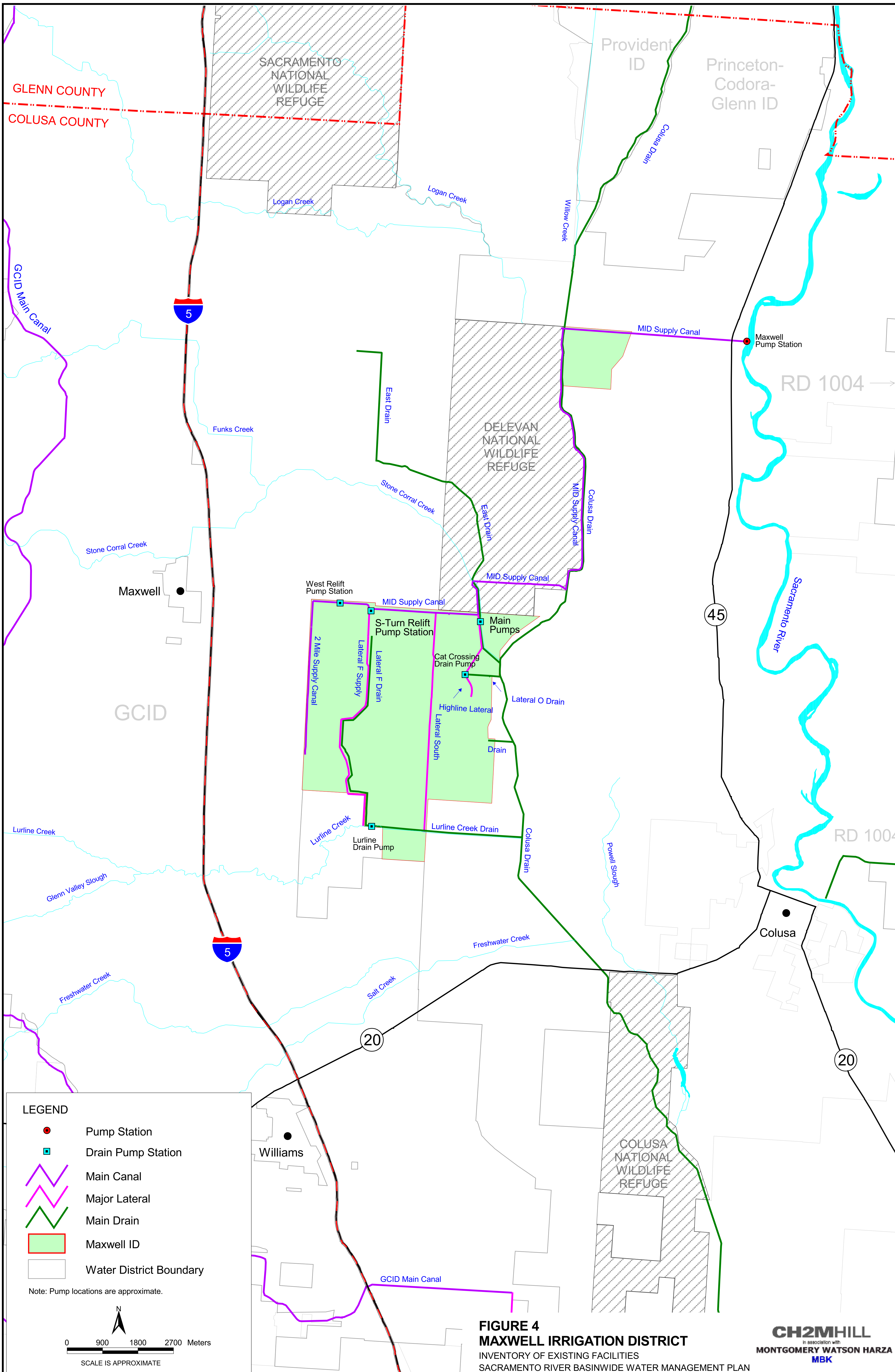

FIGURE 4
MAXWELL IRRIGATION DISTRICT
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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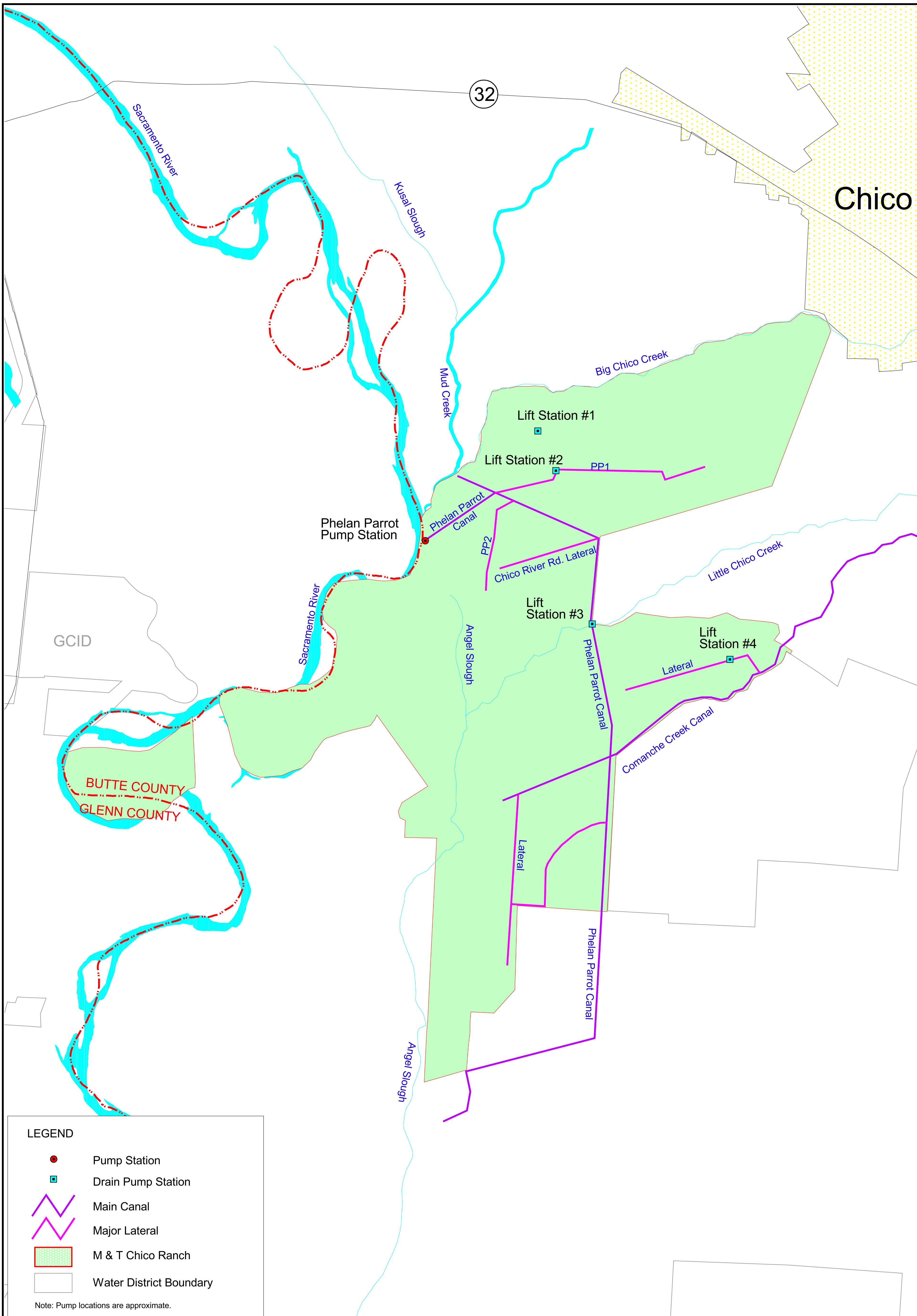

FIGURE 5
M & T CHICO RANCH
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

CH2MHILL in association with MONTGOMERY WATSON HARZA MBK

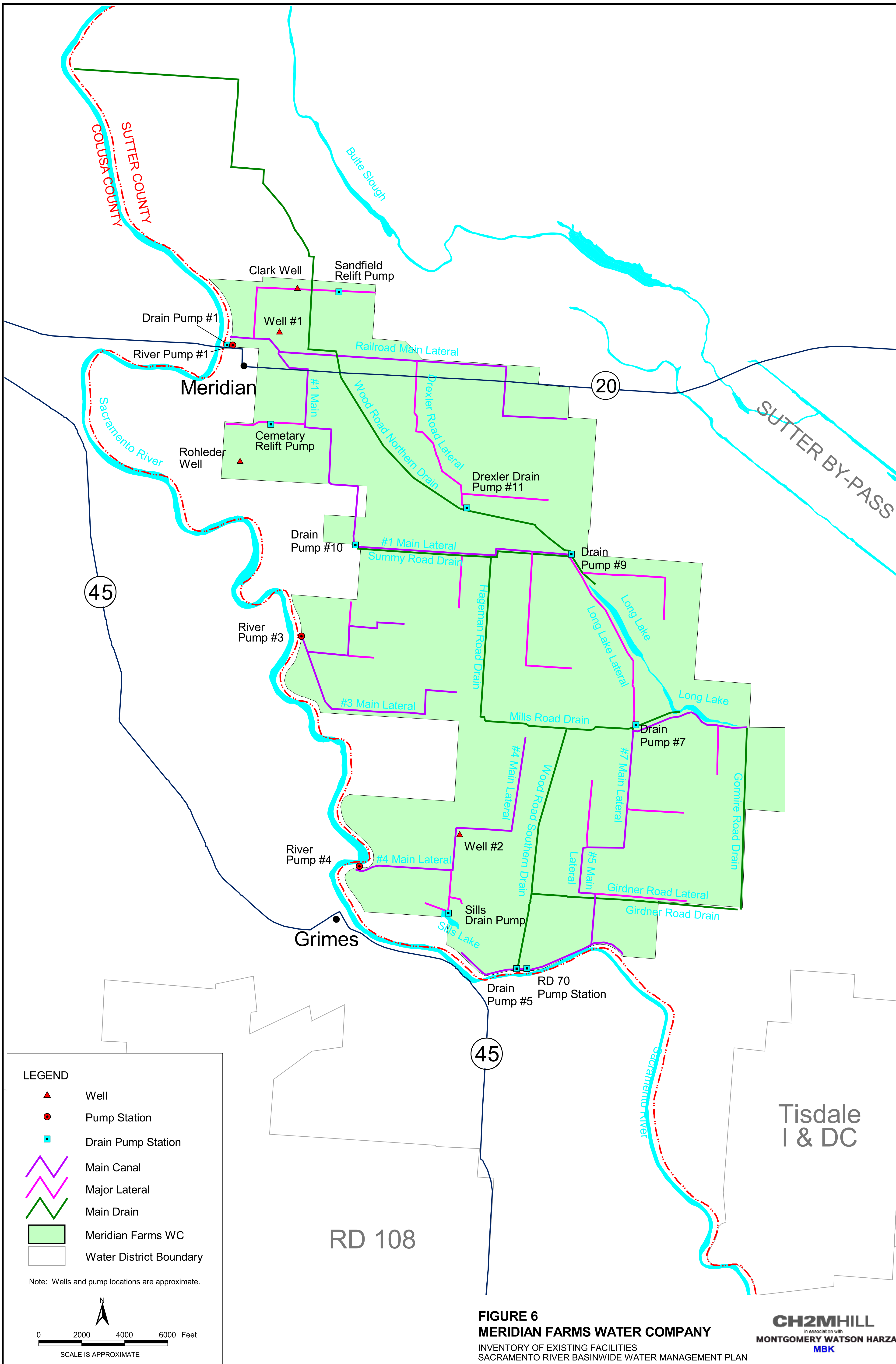

FIGURE 6
MERIDIAN FARMS WATER COMPANY
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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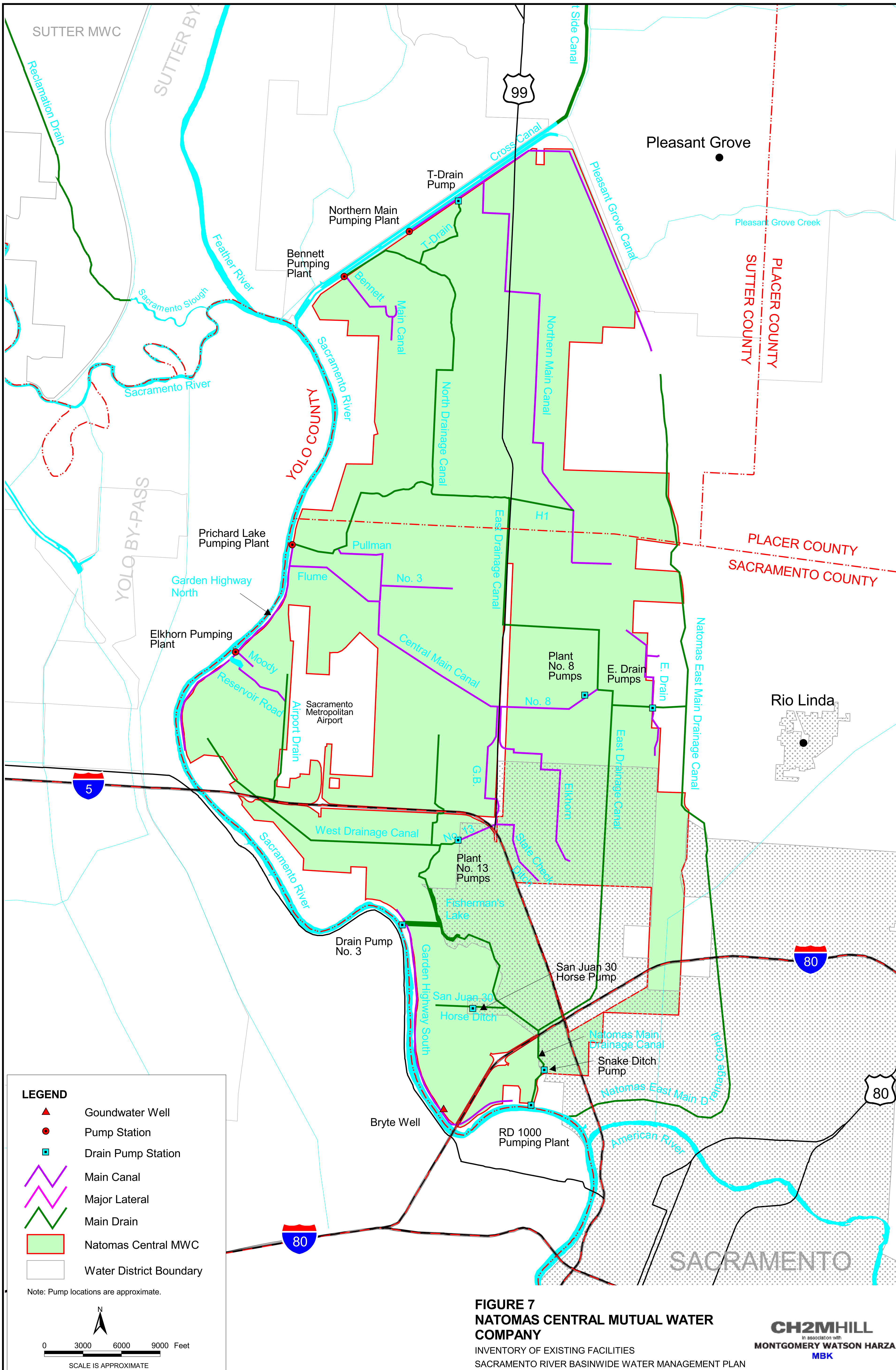

FIGURE 7
NATOMAS CENTRAL MUTUAL WATER COMPANY
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

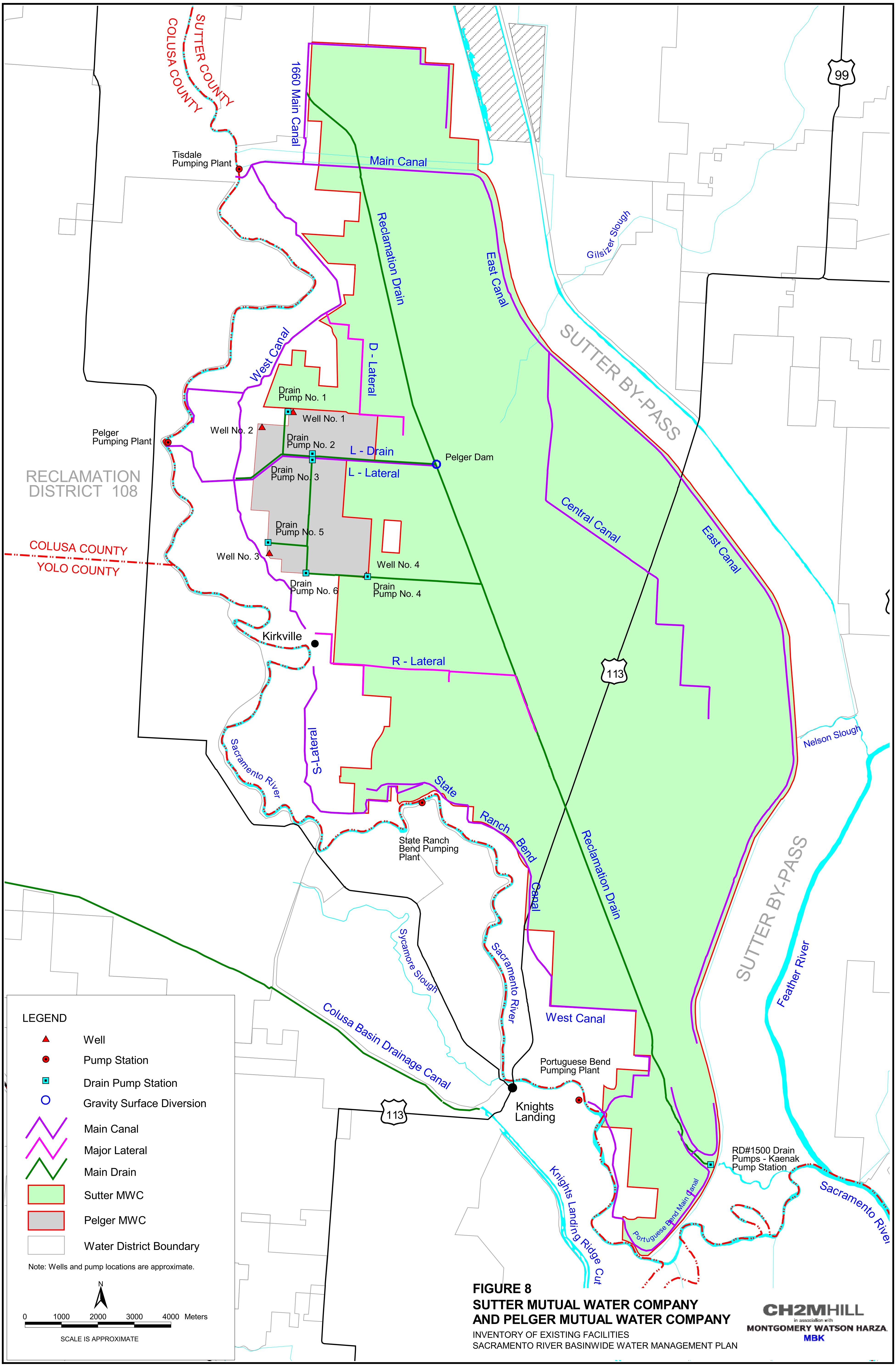

FIGURE 8
SUTTER MUTUAL WATER COMPANY AND PELGER MUTUAL WATER COMPANY
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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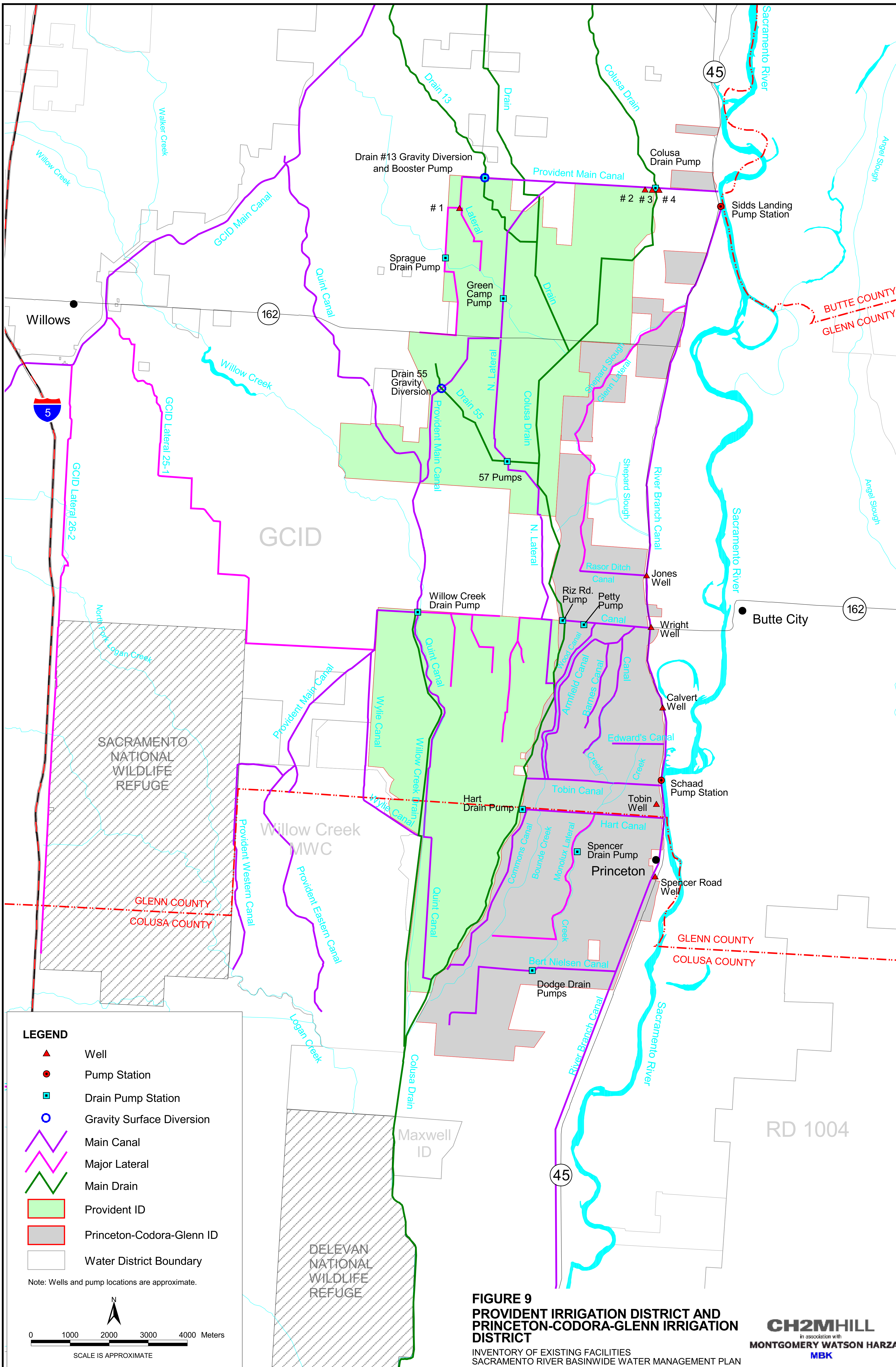

FIGURE 9
PROVIDENT IRRIGATION DISTRICT AND PRINCETON-CODORA-GLENN IRRIGATION DISTRICT
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

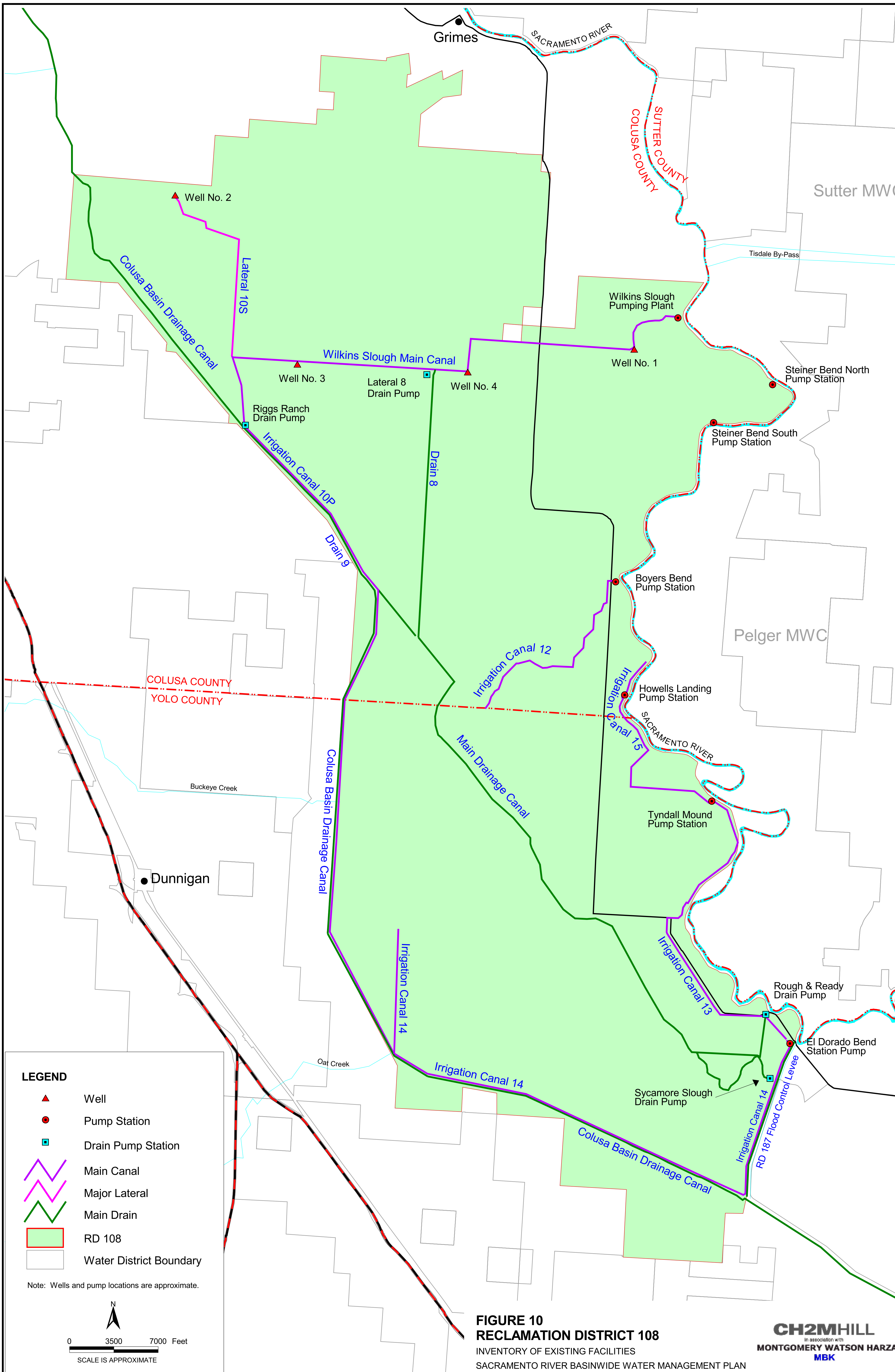

FIGURE 10
RECLAMATION DISTRICT 108
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

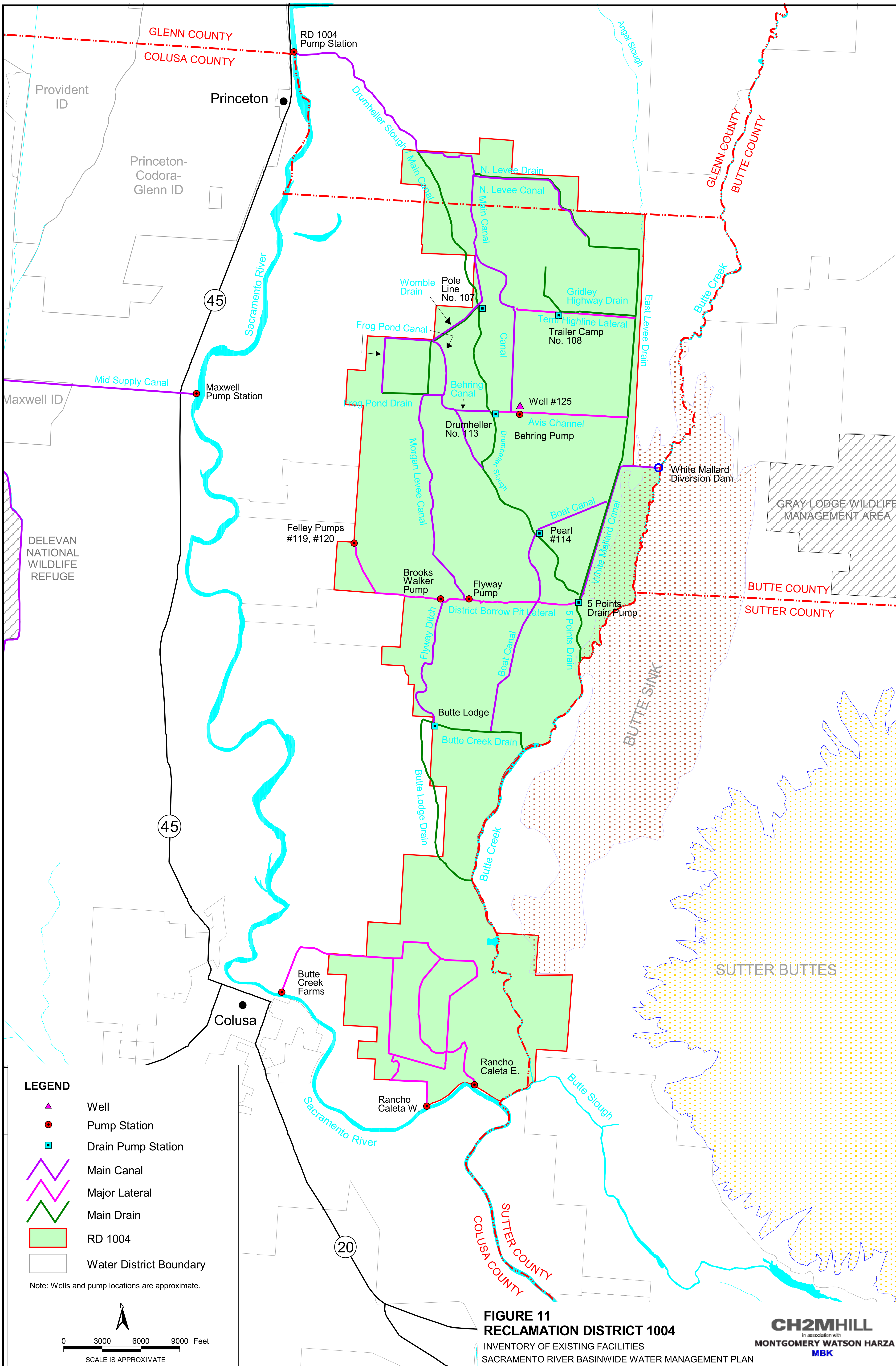

FIGURE 11
RECLAMATION DISTRICT 1004
INVENTORY OF EXISTING FACILITIES
SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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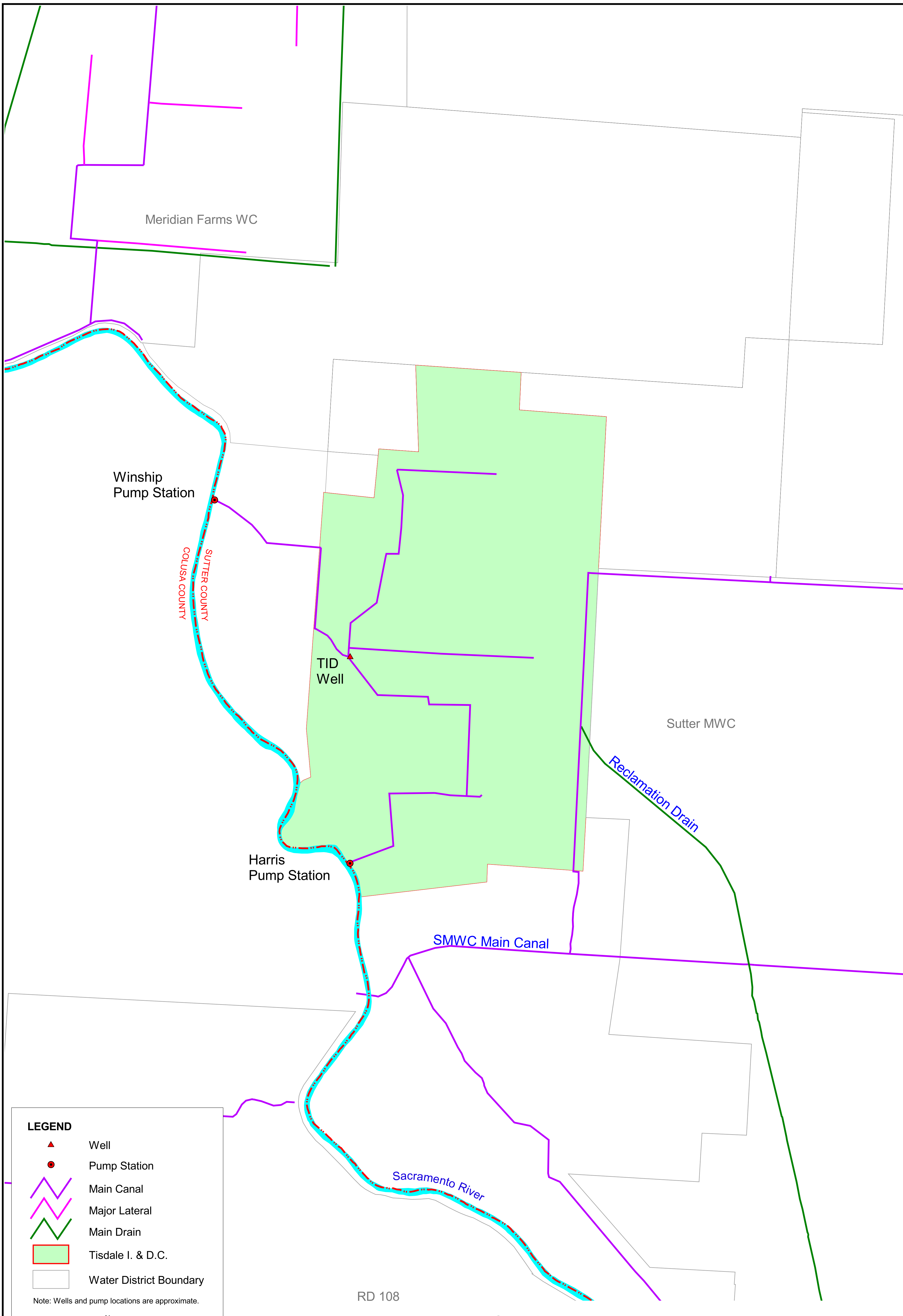

FIGURE 12

TISDALE IRRIGATION AND DRAINAGE COMPANY

INVENTORY OF EXISTING FACILITIES

SACRAMENTO RIVER BASINWIDE WATER MANAGEMENT PLAN

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Appendix E
Rules and Regulations

Anderson-Cottonwood Irrigation District

RULES AND REGULATIONS

Of the

ANDERSON-COTTONWOOD IRRIGATION DISRICT

Governing the Distribution and Use of Water

Adopted March 26, 1918.
Modified: June 3, 1952
January 16, 1986
March 16, 1993
March 11, 2004

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RULES AND REGULATIONS

INTRODUCTION

The Anderson-Cottonwood Irrigation District is government agency acting under and by virtue of Division 11 of the California Water Code. It is governed by a Board of Directors that is elected by the voters of the District. The District operates for the sole benefit of the lands and the people situated within the District boundaries. The benefits people within the District derive from the District will be measured by the extent to which the people within the District and the District's employees and Board of Directors cooperate to make the District a success.

These rules and regulations are adopted pursuant to California Water Code Section 22257 to effect an orderly and equitable distribution of water within the District, and a procedure for operation, maintenance, repair and replacement of District facilities.

The District office is located at 2810 Silver Street, Anderson, California, 96007. The regular meetings of the Board of Directors are on the second Thursday of each month, beginning at 6 p.m.

The records of the District are open to the public for inspection during office hours, subject to certain confidentiality limits. Landowners and water users may avail themselves of this source of information.

RULE 1. COMPLIANCE WITH RULES

Compliance with each and all of the following rules shall be a condition precedent to the delivery of water to any irrigator. Such condition shall be acknowledged as part of the Application and Agreement for service as indicated by the customer's signature theron. In case a specific penalty is not provided herein for violation of any rule, then and in that event, if any irrigator fails to comply with any of the Rules or any part therof, the water deliveries may be suspended from such irrigator at any time until the violation is remedied to the satisfaction of the District's General Manager.

RULE 2. MANAGEMENT

The operation and maintenance of the canals and works of the District shall be under the management of the District's General Manager. Only persons authorized by the General Manager may operate any part of the Districts irrigation facilities.

The General Manager will employ such ditchtenders and other personnel as may be authorized by the Board for the operation and maintenance of the system.

RULE 3. APPLICATION AND AGREEMENT FOR WATER SERVICE

Annually, on or before March 15th of each year, each irrigator shall file with the District office, a written application and agreement on forms supplied by the District, specifying the number of acres to be irrigated. All acreage to be irrigated shall be applied and paid for in advance at the beginning of the irrigation season. Failure to file an Application and Agreement and the appropriate water service charges by the specified due date may result in temporary or permanent denial of water deliveries. The District reserves the right to measure irrigated acreage for verification purposes.

RULE 4. CHARGES FOR WATER SERVICE

The rates and charges for irrigation water service will be fixed each year before the application due date, and the date for payment of the same shall be determined each year by order of the Board.

The rates and terms of payment for water for non-irrigation purposes shall be determined by the Board from time to time in instances where such use is permitted by Board order.

RULE 5. WATER SERVICE BILLINGS

Water users who choose to use the two installment payment option may be mailed a reminder approximately 30 days prior to the due date.

RULE 6. UNPAID CHARGES AND REFUSAL OF SERVICE

All charges for water service remaining unpaid on December 31st of each year in which irrigation water was used will be subject to a lien being filed at the County Recorder's office against the land upon which the water was used.

As provided for by Sections 25806 and 25807 of the Water Code of the State of California, unpaid water charges and penalties may be included on the County property tax bill by the County Auditor in the following tax year.

The District reserves the right to refuse or to discontinue service to any customer who is in default in the payment of water charges, and to any land upon which water charges are delinquent, and until such delinquent charges and penalties have been paid in full.

If the District finds it necessary to temporarily or permanently terminate irrigation service to any property for violation of any of the rules set forth herein, there will be no credit given for water not taken as a result of that termination.

RULE 7. CONTROL OF WORKS

No gate, takeout, siphon, or other structure or device shall be installed or placed in any facilities of the District except with the written consent of the General Manager and then only in the manner directed by him. No persons shall interfere with any facilities of the District without permission of the General Manger or his authorized representative.

RULE 8. POINT OF DELIVERY

Water will be delivered to landowners at a convenient point on the existing District facilities, the exact point to be determined by the General Manager. The District is not obligated to construct any extensions to its existing conduits. A landowner desiring new service must pay for the construction of an adequate take-out box in the District's existing facility. The landowner will be responsible for construction of facilities to transport water from the District facilities to his land.

RULE 9. ROTATION AND APPORTIONMENT

Water will be furnished in rotation to each irrigator. Ditchtenders will endeavor to give advance notice, personally or through others, to irrigators if the approximate time their rotation will start. Any irrigator not taking water when his turn arrives may forfeit his right during that rotation. In the event of shortages, the District will endeavor to equitably apportion the available water supply.

RULE 10. UNAUTHORIZED TAKING OF WATER

Persons interfering with the regulation or delivery of water in the facilities of the District are subject to prosecution. If any person takes water without permission of the General Manager or ditchtender, shall not only be subject to criminal prosecution, but may also forfeit the right to water on the next rotation, Flagrant or repeated unauthorized taking of water may result in the termination of service to the irrigator for the remainder of that year. In the event of either temporary or permanent termination of service, no refunds of water service charges will be granted.

RULE 11. RECAPTURE OF WATER

All water introduced into the District by the District facilities remains District water and is subject to rediversion and reuse by the District for the benefit of its customers. All such water, whether drainage or seepage water, intercepted and put to beneficial use will be charged for at the rates established by the District.

RULE 12. WATER USE

Water must be used continuously by the irrigator throughout the period of delivery. If water is wasted, or inefficiently or improperly used the General Manager may refuse further delivery of water until the cause of waste or inefficient or improper use is removed. The General Manager may also levy appropriate monetary penalties for waste or inefficient or improper use.

The District will endeavor to deliver a sufficient flow of water for a period of time that is adequate to efficiently irrigate land within the District.

RULE 13. PRIVATE IRRIGATION FACILITIES

Before water is delivered to a private or non-District irrigation facility, it shall be in proper condition to receive and convey water efficiently. All such facilities must be kept free from weeds and other obstructions to flow. Failure to comply with this rule will be sufficient cause for refusal to deliver water or to suspend deliveries to such facilities.

Water occurring on land due to improper maintenance of private irrigation facilities will be charged to the owner of that land. Written notice will be sent to the landowner receiving the water advising of the need to correct the maintenance problem. If no response or action is taken by the landowner to correct the improperly maintained facility on his land, a charge and penalties may be levied against the land by the District.

RULE 14. ON-FARM IRRIGATION AND DRAINAGE FACILITIES

Irrigators will be required at all times to keep their ditches and facilities for conveying and distributing water on their property in good condition so that water can be used without undue loss or waste of time, and without damage to other lands. Lands must be leveled and prepared so that water can be distributed without waste and landowners shall construct adequate drainage facilities so that adjacent land will not be damaged. The General Manager may refuse to deliver water to an irrigator whose ditches and structures are in such condition or whose land is prepared so that water cannot be distributed efficiently.

RULE 15. ACCESS TO LAND

The agents of the District will have free access at all times to the property being supplied with water from the District's system for the purpose of examining the lands irrigated, the flow of water thereon, the District's irrigation facilities, and any private canals, ditches or drainage facilities.

RULE 16. OBSTRUCTIONS OF DISTRICT RIGHTS OF WAY

No building or structure shall be constructed, and no trees, vines, or bushes shall be planted upon District rights of way unless specifically permitted by the General Manager. Cross fences on District rights of way shall be constructed in the manner directed by the General Manager with gates to permit passage along canal banks by ditch- tenders and District equipment and to permit maintenance work to be done, and in a manner that will not interfere with the flow of water.

Any obstructions on District rights of way interfering with District operation and maintenance activities may be removed by the District without notice and the cost of removal may be charged to the landowner.

RULE 17. DAMAGE TO DISTRICT FACILITIES

The cost of repair for any damage to District facilities caused by any person or by livestock may be charged to the responsible party including the owner of the livestock or the owner of the land.

RULE 18. NUISANCES

No tree or vine pruning, brush, weeds, grass, rubbish, swill, garbage, manure, or refuse, or dead animal matter from any barnyard, stable, dairy, or hog pen, or other material or substance that will become offensive to the senses or injurious to health or injuriously affect the quality of water, or obstruct the flow of water or result in the scattering of seeds or noxious weeds, plants, or grasses, shall be placed or dumped in any facility of the District or be placed or left so as to roll, slide, flow, or be washed, or blown into any such facility. Any violation of this rule will subject the offender to prosecution. All employees of the District are especially urged to cooperate in its enforcement.

Installation of septic tanks, water closets, or privies, in a location which would result in pollution of the water in a facility of the District is a misdemeanor.

Unauthorized or unapproved drainage of imported water, including storm water runoff, into District facilities is prohibited.

RULE 19. NON-LIABLITY FOR DAMAGES

Neither the District, its officers or employees, will be liable for any damage of any kind or nature resulting directly or indirectly from any facilities not owned by the District or the water flowing therein, or by reason of lack of capacity therein or for the negligent, wasteful, or other use or handling of water by users there of.

All water furnished by the District flows through many miles of open ditches and is therefore subject to pollution, shortages, fluctuation in flow, and interruption in service. Ditchtenders are forbidden to make any agreements binding the District to serve an uninterrupted constant supply of water. All water furnished by the District will be on the basis of irrigation

deliveries and every user putting the water to other uses does so at his own risk and by doing so assumes all liability for, and agrees to hold the District and its officers and employees free and harmless from liability and damages that may occur as a result of the defective water quality, shortages, excess flow, fluctuation in flow, and interruptions in service.

Pumping of District water by users is done at the user's risk and the District, its officers and employees assumes no liability for damages to pumping equipment or other damages as a result of turbulent water, or shortage or excess of water or other causes.

Nothing contained in these rules shall be construed as an assumption of liability on the part of the District, its Directors, officers, or employees for any damages occasioned through the improper construction, maintenance or use of District facilities, or the waste of water, or by permitting the flow of water, or turning water in any facility, or to any land.

The District assumes no responsibility or liability for the rate of flow of water to landowners who install conduits, open ditches, or take-outs with less capacity than previously available to the land under irrigation. It is the responsibility of the water users and landowner to ensure proper size of the pipeline, conduit, open ditch, or take-out to continue water capacity as previously received by land under irrigation.

Glenn-Colusa Irrigation District

RULES AND REGULATIONS GOVERNING THE USE AND DISTRIBUTION OF WATER WITHIN THE GLENN-COLUSA IRRIGATION DISTRICT

ADOPTED May 18, 1995

PREAMBLE

These Rules and Regulations have been adopted by the Board of Directors under the authority of the California Water Code, and are a part of the law governing this District, and its landowners and water users. These Rules and Regulations have been adopted to ensure the orderly, efficient and equitable distribution, use and conservation of the District's water resources.

This booklet is available for free distribution.

INDEX

DEFINITIONS

"DISTRICT"
means the Glenn-Colusa Irrigation District.

"BOARD"
means the Board of Directors of the District.

"DISTRICT MANAGER"
means the District Manager appointed by the Board.

"WORKS"
includes structures, dams, wells, conduits, pumps, power plants and all lines, telephone lines and their appurtenances.

"CONDUITS"
includes canal, laterals, ditches, drains, flumes, pipes, measuring and control devices therein and their appurtenances.

"OPERATE"
includes use, maintain and repair.

"CONSUMER"
includes water user or user of other services of the District.

"WITHIN DISTRICT"
refers to land legally included within the District boundaries.

"OUTSIDE DISTRICT"
refers to land not within the District boundaries.

"RULES"
includes regulations.

"CHARGES"
include water tolls and rates and any indebtedness for other service rendered by the District for which a charge is made. See Rate Schedule available in the District office.

"APPLICATION"
means the annual written application for water referred to in Rule 12.

"BOOSTER PLANTS"

means pumping plants lifting water from District conduits or Reclamation District 2047 drains within the District, into private fields, private conduits or improvement district conduits or conduits held in trust for improvement district. The term does not include the District pumping plants operated by it to pump water from drains into the gravity system.

Rule 1:
WATER SERVICE SEASON

Normally, the District' facilities will be in service between April 1 and November 1 of each year. The District's facilities will not usually be in service for the remainder of each year, in order to protect the facilities, perform maintenance work and pass winter runoff.

Rule 2:
WATER USE

The District was organized for the purpose of supplying irrigation water services for farm crops. The water quality of the District's water supply, and District facilities are not always suitable for domestic uses, for commercial production of fish and other aquaculture uses, or for industrial/commercial purposes.

The District may serve water for flooding of duck ponds, but only when such service will not, in the opinion of the District Manager, interfere with the agricultural operations of other landowners, though seepage or overflow from conduits or the subject duck ponds.

Any service for purposes other than growing of agricultural corps and flooding of duck ponds will only be provided upon consideration of and approval by the Board.

Rule 3:
CONTROL OF SYSTEM

The operation of the system and works of the District shall be under the exclusive management and control of the District Manager and no other person except employees and assistants authorized by the District Manager shall have any right to operate or interfere with said system and works in any manner. The District Manager shall have general charge, responsibility and control over all property of the District.

Rule 4:
DISTRICT EMPLOYEES

The District Manager shall employ such assistants and other employees deemed necessary for the proper operation of the system, subject to the approval of the Board and at rates of compensation fixed by the Board. The District Manager shall delegate authority at the District Manager's discretion.

All persons employed in the operation or maintenance of the distribution system shall be under the District Manager's direction. An organization chart depicting the chain of responsibility is set forth in Appendix A.

Each water operations operator shall distribute the water fairly, equitably and impartially to all persons entitled to water service, and shall apply these rules and regulations without favor. It is the specific duty of each employee to maintain cordial relations with all landowners and water users in the District. Every consumer is entitled to equitable, courteous and prompt service. Every employee is charged with the duty and responsibility of cooperating with the consumers and the Board in a sincere effort to render as satisfactory service as can reasonably by attained. Every consumer has a right to such service, and every employee of the District is enjoined to maintain and execute this policy.

Water user complaints shall first be referred to the responsible water operations worker or other field personnel. If such complaints are not satisfactorily settled by said personnel or their supervisors, they should be submitted to the District Manager. Final appeal may be made to the Board.

Rule 5:
OWNERSHIP OF WATER

All surface water within the District an all groundwater purchased by the District is the property of the District and is subject to diversion and use by the District. No landowner or consumer acquires any proprietary right in the surface water by reason of such use, nor does such landowner or consumer acquire any right to resell the water purchased or used, or the right to use it on premises or for a purpose other than for which it was applied and as stated in the application. The district expressly asserts the right to recapture, reuse and resell all surface water that passes from the premises described in the application as the place of use, and asserts its right to use all surface waters and groundwater purchased by the District within the District.

Rule 5.1
UNAUTHORIZED USE OF DISTRICT WATER

(a) Lands Outside the District: Landowners or consumers may not use District water on lands outside the District when the corresponding water application was solely for land located within the District. This prohibition applies irrespective of whether such use on outside lands is accomplished by routing the water though a conduit, by firs flowing the water across land within the District, by recapturing the water from drains, or otherwise, except as provided for below in subsection (c). If an unauthorized use of District water occurs on outside lands, the District may refuse service to the land within the District, until (1) all charges for water used on the outside lands are paid, and (2) the consumers or landowners make such physical changes in their fields or irrigation systems as the District Manager deems necessary, to prevent future uses of District water on outside lands.

(b) Lands within the District: Landowners and consumers may not divert, intercept, impound, or otherwise use District water on any lands within the District, without filing an application for such water pursuant to Rule 12, or otherwise executing an express written agreement with the District for the use of such water. This prohibition applies irrespective of whether the water is diverted from a conduit or lateral, or taken from or impounded in a natural channel or drain, or whether it is waste, spill, seepage, runoff or other water, except as provided for below in subsection (c).

(c) Unanticipated/Unforeseen Causes: If the District Manager determines that the unauthorized uses of water described above in subsections (a) and (b) occurred solely to causes which could not be foreseen or anticipated, then no violation of these subsections shall be deemed to occur.

(d) Notice of Violation: Notice of a violation of Rule 5.1 shall be promptly provided by the District to the responsible landowner(s). The District will attempt to notify the landowner(s) by telephone so that the violation can be corrected immediately, and further violations avoided. In addition, written notice will be mailed to the landowner(s) and/or attached to the landowner's delivery gate, as soon as possible after the violation is observed.

(e) Enforcement: To enforce Rule 5.1 and prevent unauthorized uses of District water, the District may, in the District Manager's discretion, impose any or all of the following conditions:

(1) Charge and collect as part of the water charge for any unauthorized use of water, a charge equal to three times the regularly established District water charge for the crops growing on the subject lands. This charge shall be based upon the full irrigation season rate for the crops involved, and shall not be pro rated;

(2) Charge and collect an additional ten percent (10%) charge on the amount assessed pursuant to subsection (e) (1), for failure to submit an application for water fro the subject lands;

(3) If the subject lands are irrigated with groundwater, the District may require the delivery to the District, by well operations, of the amount of water which the District estimates was not pumped during the relevant time period, with an additional ten percent for losses. If there is insufficient pumping capability or the District is unable to use the pumped replacement water during the irrigation season when the violation occurred, the pumped replacement water shall be delivered at the beginning of the following irrigation season;

(4) Place the subject lands on up to five years of probation for continuing District water use. Probationary conditions may include periodic inspections of the subject lands by

District personnel, to ensure strict compliance with all District rules and regulations. The cost of such inspections shall be borne by the landowner(s) of the subject lands;

(5) Refer the matter and all investigative materials developed by the District to the district Attorney and/or other law enforcement authorities; and

(6) Pursue any form of civil or administrative proceeding to enforce the District's Rules and Regulations and/or to recover any losses and damages resulting from an unauthorized us of District water.

(f) Notice of Enforcement Conditions: Written notice of the enforcement conditions imposed pursuant to subsection (e) shall be delivered by certified mail to landowner(s) of the subject lands. Any charges assessed pursuant to subsections (e) (1) and (2) must be payable within ten (10) days of the billing date. Failure to timely pay such charges shall result in an additional charge of ten percent (10%) on the amount charged, and may result in the District's termination of water deliveries to the landowner(s).

(g) Payment Under Protest: Payment under protest of any charges assessed pursuant to Rule 5.1 will be permitted, however, the Board of Directors may elect not to hear such protests before the end of the irrigation season. Any protests must be received promptly, in writing, no later than thirty (30) days after the mailing of the District's notice of enforcement conditions. All protest must include a detailed written account of the alleged violation of Rule 5.1, and any reasons why the enforcement conditions should not be imposed. Protesting or objecting parties are reminded that because efficient water use is so critical to the ability of the District to facilitate maximum planing under existing delivery constraints, the board will strictly enforce its rules and regulations prohibiting unauthorized uses of District water.

Rule 6
TIME OF FIXING RATES OF TOLLS AND CHARGES

The rates for irrigation water service and other charges authorized by Section 22280 et seq. Of the Water Code, will be fixed by the Board each year before the water application date. The date or dates of payment of said rates and charges authorized and fixed pursuant to Water Code section 22280 shall become due and payable as of the date set each year by the Board. If such charges become delinquent, they may be collected pursuant to Water code section 22284, and they will not be pro-rated by the District.

The rates and terms of payment for water for Board approved non-agricultural purposes shall be determined by the board as necessary.

The District may charge higher rites for water service to any lands that are not subject to assessment by the District, than is charged for similar service to lands which are within the District.

Rule 7
UNPAID TOLLS AND REFUSAL OF SERVICE

All charges for service remaining unpaid on the last business day in September will be added to and become a part of the annual assessment levied by the District as provided for by Sections 25806 and 25807 of the Water Code.

The District may require full payment to accompany new water applications for service to lands on which delinquent assessments, that include unpaid water charges, are outstanding at the time the application is made.

District reserves the right to refuse or discontinue service to any consumer who is in default I the payment of District charges, including, but not limited to assessments, standby charges and water charges, and to any land on which such charges are delinquent, unless and until such defaulted payment shall have been paid in full.

If less than the full amount of unpaid water charges is paid by a consumer who irrigates several parcels of land, the District reserves the right to determine which parcels shall have the payment applied to it.

This rule shall be effective against all applicants for water service to lands which are delinquent, regardless of whether the applicant is the same person who owned or farmed the land when the delinquent water charges were incurred.

Rule 8
DELINQUENT PAYMENTS

All charges shall become delinquent fifteen (15) days after the same become due and payable. If not paid to such delinquency, there shall be added thereto, and become a part of such charges, and be collect by the District, an interest charge of one and one-half percent (1.5%) per month on all delinquent payments. Such interest charge shall commence at the date of such delinquency and shall be compounded until paid, or to the time the unpaid and delinquent charges are added to the annual assessment of the District as provided by the Water Code.

Rule 9
ACREAGE SURVEYS

The District shall have the right to conduct a survey to determine the acreage on which water was used, allowed to stand, and over which it was permitted to flow or drain.

The charges for water will be based on the gross acreage covered with water, regardless of acreage actually planted.

Rule 10
ACKNOWLEDGMENTS

Whenever the District staff deems it necessary, a landowner or water user may be requested to acknowledge the amount of acreage planted and irrigated. The District may by written notice submit an acknowledgment for signature to the landowner, by mailing to the corresponding address listed in the assessor's records. Failure of the landowner or water user to object in writing within fifteen (15) days of the date of mailing the acknowledgment shall be deemed an acceptance of the acknowledgment for all purposes.

Rule 11
ABANDONED USE OF WATER

Any person desiring to abandon any use of water shall deliver to the District a WRITTEN notice of such intention, and shall concurrently tender full payment of all remain installments of the water charge.

Rule 12
APPLICTIONS FOR WATER

On or before the last business day in March or such other date as the Board may designate, each landowner and tenant farming land within the District shall file with the District, at the District office in Willows, an application for water. This water application shall be submitted on a form provided by the District. The Water application shall specify (1) the crops, and the corresponding acreage of each crop, which the applicant intends to irrigate, (2) the name of the owner of the land, (3) the name of tenant or tenants, (4) the location of acreage for which water is requested, and (5) such other matters as the Board may require. Water shall not be used for any purpose other than as specified for receipt of applications shall be accepted unless special action of the Board authorizing acceptance occurs.

Where there is more than one user on a private conduit, the applicant, by submitting said water application, grants a right to the District to control such private meters, measuring devices, delivery gates or other structures in any such private conduit, as necessary for the distribution and measurement of the water to the several users. The applicant grants a further right to the District to install any such necessary devices, gates and structures. The water application shall authorize the District's agents to enter the applicants' land for the purpose of measuring the area irrigated.

A penalty of five (5%) percent, or a greater amount as set by the Board, shall be added to the water charges on any land seeking to utilize water and for which an application (along with all other submittals required by the application terms) was not received at the District office prior to the last day for submittal.

A penalty of ten (10%) percent shall be added to the water charges on any land using water in any year in which an application for such water has not been previously filed. The provision shall not apply to minor adjustments for acreage planted in a field for which an application was filed.

Rule 13
DELIVERY OF WATER

All consumer requests for water must be received at the District's office, or by the responsible water operations worker, at least three days before the water is needed by the consumer.

No guarantee can be made as to when the water can be delivered, particularly during the rice flooding periods; however, every effort will be made to schedule deliveries to all applicants as equitably and rapidly as possible after the request is received.

All shut-off requests must be received at the District office, or by the responsible water operations worker, not later than the day before such shut-off is desired. When service is desired for shorter periods than one day, the shut-off request must accompany the request for service.

If any water users shut off their water without first providing the above notice, such water users shall be liable to downstream water users for all damages caused by the increased flow of water upon the downstream users' lands.

Water must be used continuously by the user throughout the period of delivery, including both day and night.

Where deemed desirable by the District General Manager, deliveries will be made on a rotation basis.

The District reserved the right to measure deliveries to any and all consumers.

Rule 14
APPORTIONMENT OF WATER

In the event of water shortage or water delivery constraints, the District will endeavor to equitably apportion the available District water to the District land entitled thereto. District landowner(s) are advised that drain water in the District is considered water supplied by the District, and any such water recaptured by the landowner(s) or user(s) may not be used to increase irrigated acreage.

Rule 14.1
ESTABLISHNG CROP SPECFIC WATER REQUIREMENTS

The Board may establish reasonable average annual water requirements for the different types of irrigated crops grown in the District. Notice of a meeting to consider the adoption of the proposed schedule of crop specific water requirements shall be published in a Glenn County and Colusa County newspaper. The notice shall be published at least seven (7) days prior to the date of the hearing. The schedule adopted may be continued in subsequent years as authorized by order of the Board.

Rule 14.2
APPORTIONING WATER VIA PRIMARY AND SECONDARY APPLICATIONS

In years in which the Board concludes that the District's water supply will be inadequate to serve all lands entitled to service from the District, the District will estimate the total water supply available for the irrigation season, and after deducting estimated canal losses, apportion the balance to each District landowner in accordance with California Water Code section 22250 and 22251. To accomplish this apportionment, the District will accept primary applications for acreages of crops for which the landowner's apportioned water share will bring appurtenant crops to maturity. All additional acreage applied for will be placed on a secondary application list. On expiration of the time to submit primary water applications, if the total estimated water required to serve the primary application is less than the total estimated water available, the excess shall be equitably allocated to secondary applications at the discretion of the Board.

Rule 14.3
LANDS PLANTED WITH BOTH PERMANENT AND ANNUAL CROPS

If a landowner has land planted both with permanent crops and new plantings or annual crops, the water requirements of the land planted to permanent crops shall be given preference in any water supply apportionment, unless the landowner indicates on the water application that no water will be supplied to a portion of land planted with permanent crops, and the landowner prepares the subject land to prevent the flow of water thereto.

Rule 14.4
ENFORCEMENT OF APPORTIONMENT

To enforce Rules 14.0 through 14.3, the District may do any or all of the following:

a. Refuse to serve land irrespective of whether it is on the primary application list, until such land has been prepared to prevent the flow of water to excess acreage.

b. Shut off or reduce the flow of water to any landowner or tenant irrigating excess acreage or wasting water. Draining rice fields or spilling to lower levels in rice checks shall be deemed a waste of water, unless adequate advance notice is given to the District, to permit reduction of inflow into the field and substantial lowering of the water in the checks prior to the start of the draining or spilling.

c. Charge and collect as part of the water charge, a penalty equal to three time the regularly established District water charge for the crops growing on the excess lands. This charge shall be based upon the full irrigation season rate for the crops involved, and shall not be prorated.

d. Measure water deliveries to land that in the opinion of the Board will require more water than the landowner's share will supply, notwithstanding the deliveries to other land are not measured, and turn off service when the landowner's share has been delivered. The landowner's share shall be determined as provided in Rule 14.2.

e. Land not on the primary application list may be irrigated with water pumped from private wells, provided that the groundwater is not mingled with District supplied water in ditches or in the field. If such mingling occurs, the entire water supply shall be deemed to be supplied by the District, unless a written agreement between the District and landowner is executed prior to the mingling, and such agreement assures the District of the amount, adequacy, and dependability of the water to be supplied form private wells.

Rule 15
CONDITION OF PRIVATE CONDUITS

All private conduits must be kept free from weeds and other obstructions, and shall be of sufficient capacity and properly constructed and maintained to carry the flow of water applied for without danger of breaks, overflow or undue seepage. The District General Manager may discontinue the delivery of water to any private conduits not meeting the above requirements, and may require such conduits to be cleaned, repaired or reconstructed before water is turned into them. A water user's failure to comply with such directives by the District Manager shall relieve the District of any liability or responsibility for the discontinuation of water deliveries.

Nothing herein shall be construed as an assumption of liability on the part of the District, its directors, officers, agents or employees for any damage occasioned through the improper construction, maintenance or use of any private conduit or by reason of permitting the flow of water or turning water therein.

The District will not maintain or operate private conduits. The owners of and water users from private conduits shall be solely responsible for their maintenance and operation. Such owners and water users indemnify and hold the District harmless from any claims or liability arising from the conduct of water in their private conduits.

Rule 16
WASTE OF WATER

If, in the opinion of the General Manager, a consumer is wasting water, either willfully, carelessly, negligently or on account of defective private conduits, the District may refuse the delivery of water until the wasteful conditions are remedied, or the District may reduce the water inflow into the consumer's fields to a flow that would be reasonable if such wasteful conditions were remedied. Wasteful water use practices include, but are not limited to, (1) using water on roads, vacant land, or land previously irrigated, (2) flooding any portions of a consumer's land to an unreasonable depth or using an unreasonable amount of water in order to irrigate other portions of such land, (3) using water on land that has been improperly prepared for the economical use of water, and (4) allowing an unnecessary amount of water to escape form any tailgate.

The District reserves the right to refuse delivery of water when, in the opinion of the District Manager, the proposed use, or method of use, will require excessive quantities of water which constitute waste.

Rule 17
BOOSTER PLANTS

All expenses of installation, maintenance and cooperation of, and power for booster plaints shall be borne by the consumers obtaining water through such lifts. Provided however, that the District, its officers, agents and employees shall retain authority over the use of the pumps and equipment in the pumping of such water.

Rule 18
GATES, STRUCTURES AND MAIN CANAL

No opening shall be made or structures placed in any District conduits without special written permission of the District Manager. All such structures in the District conduits must be constructed according to the requirements and under the supervision of the District, and at the expense of the water user, and must not be changed without the permission of the District Manager.

A requested change in point of water delivery, or for an additional or separate point of delivery will only be made if approved by the District Manager and at the landowner's expense. Any other structures, construction or conduits, which the District Manager determines are necessary to make the requested change functional, shall also be paid by the landowner.

Any works constructed in the District's water system at the landowner's expense shall, at the option of the District, become the property of the District.

Rule 19
CONTRACTS FOR DISTRICT SERVICES

In all cases where the landowner or water user desires to have work performed by the District, and the District Manager approves of the same, an estimate of the const will be prepared and submitted to the landowner or water user and, if the estimate is approved, the landowner or water user must sign a written agreement on a form prepared by the District. This form shall acknowledge that the landowner or water user agrees to pay for the work, and further agrees that the cost, if not paid, may be added to the District assessment on the landowner's or water user's land. The work will be done at the convenience of the District.

Rule 20
DAMAGE TO DISTRICT WORDS AND RIGHTS-OF-WAY

Any person who (1) permits any equipment, livestock, poultry or waterfowl to damage or injure any works of the District, (2) damages, injures or destroys, by burning or otherwise, any such works, (3) deposits any rubbish therein or thereon such works, or (4) erects signs, fences or other structures on District rights-of-way, shall pay to the District, all expenses incurred in repairing the damage, or removing the rubbish, signs, fences or structures, including the reasonable value of staff time and attorneys fees expended in enforcing this provision.

Rule 21
CANAL BANK ROADS

District canal bank roads are maintained for the use of the authorized agents, employees, and officials of the District, in the discharge of their official duties. All other uses of the District canal banks roads is at the sole risk of the user. Use of such roads by vehicles not owned by the District is prohibited where District singes, gates, chains or other barricades so indicate. Public use of canal bank roads without written permission of the District Manager may also be prohibited during certain periods of the year. Signs will be posted or other notice provided indicating any canal bank roads subject to such restrictions.

Rule 22
ENFORCEMENT OF RULES

Failure of refusal of any landowner or water user to comply with these Rules and Regulations, or any interference by any landowner or water user, or their servants or employees, with the rights, duties or obligations of the District, or its employees, shall entitle the District to terminate water service to the lands of such owner or user until the landowner or water user fully complies with all requirements of these Rules and Regulations.

Rule 23
NON-LIABILITY OF DISTRICT

(a) Private Conduits. The District will not be liable for any damage of any kind or nature resulting directly or indirectly from any private conduit, or the water flowing therein, or by reason of lack of capacity therein, or for negligent, wasteful or other use or handling of water by the consumers there from.

(b) Delivery of Water. Most of the water furnished by the District is pumped, flows through many males of open ditches, and is subject to pollution, shortages, fluctuation in flow, and interruption in service. District employees shall not and are not authorized to make any agreements binding the District to serve an uninterrupted, constant supply of water, or guaranteeing a certain quality of water. All water furnished by the District will be on the basis of irrigation deliveries; consumers putting District water to other uses do so at their own wish, and assume all liability for, and agree to hold the District and its directors' officers, agents and employees free and harmless from, liability and damages that may occur as a result of defective water quality, water shortages, fluctuation in flow and interruptions in service. The District sells water as a commodity only and not as a guaranteed service. The District will not be liable for defective quality of water, shortage of water, either temporary or permanent, or for failure to deliver water.

(c) Pumping. Pumping by consumers of District water is done at the consumer's risk, and the District assumes no liability for damages to pumping equipment or other damages resulting from turbulent water, shortage or exce3ss of water, or other causes, including fluctuations in the amount or level of water. It shall be the duty of the landowner or water user to provide appropriate devices to protect pumps from damage.

Rule 24
DISTRICT CONDUITS ARE NOT FOR RECREATION OR OTHER UNATHORIZED USES

The District's conduits shall be used solely for the purpose of conveying water for use on land, and for conveying drainage water away from the land. The use of District conduits for recreation or other unauthorized purposes is prohibited.

Landowners and water users are urged to prevent the use of District conduits and their banks for recreation, swimming, play or other unauthorized purposes. The water in many of the District's conduits is cold, swift and deep, and the conduits span so many miles, that District detection of their use for recreation is impossible.

Rule 25
DIVISION OF LAND

The District shall be provided notice by landowners of any proposed divisions of land within the District. The District shall specify the facilities which shall be installed at the landowners' expense to provide continued water service and drainage, without additional costs to the District, to the parcels formed by the division. The District will refuse service to each and every parcel formed by a division unless he District's requirements have been fully performed.

Rule 26
DRAINAGE MAINTENANCE

Pursuant to the District's Drainage Maintenance Policy adopted by the Board of Directors on May 5, 1994, the District shall perform drainage maintenance within the District as follows:

1. The District has no obligation or duty to maintain or clean certain drains within the District because the District has been relieved of such responsibilities by contract, or by annexation, consolidation, detachment or inclusion proceedings.

2. The District will clean and maintain, as the District deems necessary to accommodate reasonable surface drainage of District supplied irrigation water, all drains within the District, other than those described above, which meet one or more of the following criteria:

A. A deed, easement, or agreement if filed in the District office, and evidences that the drain is a District right-of-way or obligation.

B. The drain is depicted on the District's right-of-way map as a maintenance obligation of the District.

C. That portion of any drain within the District's boundaries the meet both of the following conditions:

(1) drains two or more parcels of land in separate ownerships.
(2) drains more than 160 acres.

3. The District will maintain only those road crossings and bridges which are over drains that the District has contracted to maintain, or to the extent deemed necessary by the District for District use.

Rule 27
WATER CONSRVATION

All landowners and water users within the District are subject to the special water conservation rules adopted pursuant to the District's Water Conservation Policy in effect for the given irrigation season. Copies of the District's Water Conservation Policy and special water conservation rules thereto are available upon request, and must be reviewed by all water users prior to irrigating.

Rule 28
RULES AND REGULATIONS INCORPORTATE DIN WATER APPLICATIONS

These rules and regulations are incorporate din the water applications of the District as a part of that contract, as if set forth in full therein. If it is necessary for the District to commence legal action to enforce these rules and re3gulations, the District shall be entitled to recover the reasonable value of staff time spent in enforcing the rules and regulations, and the reasonable value of attorney services incurred, as well as all other costs incurred by the District.

Rule 29
CONJUNCTIVE USE PROGRAM

The District may elect to continue its voluntary conjunctive use program with private groundwater well owners within the District. When deemed necessary by the Board, the District may implement a conjunctive use program. The conjunctive use program will be administered through voluntary written well agreements executed by the District and individual well owners.

APPENDIX B

"IRRIGATION DISTRICT LAW" (Excerpts)
(California Water Code)

Section 21385
"The board except as otherwise specifically provided has the power and it shall be its duty to manage and conduct the business and affairs of the district."

Section 22229
"A district may enter upon any land to make surveys and determine the location of or its necessary works on any land which may be deemed best for their location."

Section 25806
"In case any charges for water and other services or either remain unpaid at the time specified for the delivery of the assessment book to the collector, the amount of the unpaid charges may be added to and become a part of the annual assessment levied upon the land upon which the water for which the charges are unpaid was used and upon the land subject to the charges for any other district services and shall constitute a lien on that land."

Section 25807
"If the annual district assessment is payable in two installments the unpaid charges may be added to and become a part of the first installment."

Section 22255
"When its board deems it in the best interest of the district, the district may regulate the amount of water used to irrigate crops within the district when seepage from the irrigation would damage adjacent land inside or outside of the district or may require as a condition precedent to the delivery of water the construction of adequate drainage facilities to prevent damage to the adjacent land. Whenever the board finds, with respect to land for which there is no existing system for the application of water for the irrigation thereof, that the character of the soil or elevation of the land to be supplied water from the district water supply is such that the application of such water thereto by flooding is likely to require the use of excess quantities of water or to create a hazardous seepage or drainage problem. The board may limit the application of such water to that land to application through overhead sprinkling systems so designed and operated to prevent the use of excess quantities of water, or the creation of a hazardous seepage or drainage problem."

Section 22257
"Each district shall establish equitable rules for the distribution and use of water, which shall be printed in convenient form for distribution in the district. A district may refuse to deliver water through a ditch which is not clean or not in suitable condition to

prevent waste of water and may determine through which of two or more available ditches it will deliver water.

A district may close a defective gate in a community water distribution system used for irrigation purposes and may refuse to deliver water through the defective gate if the landowner fails to repair the gate or outlet to the satisfaction of the district within a reasonable time after receipt of notice from the board through its authorized water superintendent, District Manager or water operator to repair the gate or outlet..."

Section 22282.1
"A district may refuse service to any land if outstanding charges for services already rendered such land have not been paid within a reasonable time."

APPENCIX C

LAWS OF THE STATE OF CALIFORNIA RELATED TO THE CALIFORNIA WATER CODE

Water, Ditches, etc., Penalty for Trespass or Interference With

Penal Code Section 592(a): "Every person who shall, without authority of the owner or managing agent, and with intent to defraud, take water from any canal, ditch, flume, or reservoir used for the purpose of holding or conveying water for manufacturing, agricultural, mining, irrigation, or generation of power, or domestic uses, or who shall without like authority, raise, lower or otherwise disturb any gate or other apparatus thereof, used for the control or measurement of water, or who shall empty or place, or cause to be emptied or placed, into any such canal, ditch, flume, or reservoir any rubbish, filth or obstruction to the free flow of water is guilty of a misdemeanor."

Penal Code Section 607: "Every person who willfully and maliciously cuts, breaks, injures or destroys, or who, without the authority of the owners of managing agent, operates any gate or control of any bridge, dam, canal, flume, aqueduct, levee, embankment, reservoir, or other structure erected . . . to store or conduct water for . . . reclamation, or agricultural purposes . . . or any embankment necessary to the same, or either of them, or willfully or maliciously makes, or causes to be made any aperture or plows up the bottom or sides in the dame, canal, flume, aqueduct, reservoir, embankment, levee, or structure, with intent to injure or destroy the same . . . is guilty of vandalism under Section 594 . . . ."

Levees, Banks of Waterways and Pipeline Rights-of-Way

Section 21116 Vehicle Code: (a) No person shall drive any motor vehicle upon a roadway located on a levee, canal bank, natural watercourse bank, or pipeline right-of-way if the responsibility for maintenance of the levee, canal bank, natural watercourse bank, or pipeline right-of-way is vested in the state or in a reclamation, levee, drainage, water or irrigation district, or other local agency, unless such person has received permission to drive upon such roadway from the agency responsible for such maintenance, or unless such roadway has been dedicated as a public right-of-way.

(b) For this section to be applicable to a particular levee, canal bank, natural watercourse bank, or pipeline right-of-way, the state or other agency having responsibility for maintenance of the levee, canal bank, natural watercourse bank, or pipeline right-of-way, shall erect or place appropriate signs giving notice that permission is required to be obtained to drive a motor vehicle thereon and giving notice of any special conditions or regulations that are imposed pursuant to this section and shall prepare and keep available at the principal office of the state agency or other agency affected or of the board of such agency, for examination by all interested person, a written statement, in conformity with the existing rights of such agency to control access to the roadway, describing the nature of the vehicles, if any, to which such permission might be granted and the conditions, regulations, and procedure for the acquisition of such permission adopted pursuant to this section.

APPENDIX D
WATER DATA

1 Acre Foot Supplies a Family of 5 for 1 Year
1 Acre Foot is 1 Acre Flooded 1 Foot Deep
1 Acre Foot = 325,900 Gallons
1 Acre Foot = 43,560 Cubic Feet
1 Cubic Foot = 7.48 Gallons (62½ lbs.)
1 Cubic Foot per Second (CFS) = 450 Gallons per Minute
For 24 Hours = 1.983 Acre Feet
1 CFS = 646,317 Gallons per Day
200 CFS = 90,000 Gallons per Minute
1,000,000 Gallons = 3.07 Acre Feet

GLENN-COLUSA IRRIGATION DISTRICT
STATISTACLA DATA

Main Canal Capacity	3,000 CFS
Main Canal Length	65 Miles
Lateral, Total Length	420 Miles
Total District Acres	175,000
Irrigable Acres	137,000*
Sacramento River Water Rights	720,000 acre-feet
CVP Water USBR	105,000 acre-feet
Drainage Water Recapture (1979)	220,000 acre-feet

*Does not include Wildlife Refuges

MAIN CANAL ELEVATION
U.S.C. & G.S.

	Mile	Operating	Maximum
141.90	7.23	Stony Gates	140.20
39.20	12.91	Glenn Camp	138.00
137.50	17.68	Willard	137.3
134.80	21.75	Tuttle	134.15
132.80	24.00	Walker Check	132.50
130.50	26.21	Willows	130.20
128.20	31.45	Spooner	127.90
128.20	34.49	Norman	125.90
124.00	41.34	Funks Slough	123.20
122.00	44.95	Stone Corral	121.50
119.60	48.74	Abel	119.30
118.00	49.95	Lurline	117.60
116.10	53.70	Freshwater	115.90
114.50	56.45	Salt Creek	114.20
111.50	60.87	Zumwalt	111.20
68.00	64.96	Lateral 64.1	67.50

Provident Irrigation District

PROVIDENT IRRIGATION DISTRICT
Rules for Distribution and Use of Water
Adopted July 9, 2002

The Board of Directors of Provident Irrigation District have adopted these Rules and Regulations under authority of the provisions of California Water Code Section 22257, that provides for a district to establish and distribute a set of equitable rules for the distribution and use of water.

Rule 1. Control of System

The maintenance, and operation of the canals, drains and works of the District shall be under the exclusive management and control of the District Manager, appointed by the Board of Directors and no other person, except his employees and assistants shall have any right to interfere with said canals, drains and works in any manner, except in case of an order from the Board of Directors.

Rule 2. Ditchtenders and Other Employees

The District Manager will employ such ditchtenders and other assistants as he may deem necessary for the proper operation of the system subject to the approval of the Board of Directors. Each ditchtender shall have charge of his respective Section, and shall be responsible to the District Manager. From the rulings and the action of the ditchtender an appeal may be made to the District Manager. From the action of the District Manager an appeal may be made to the Board of Directors at any meeting of such Board.

Rule 3. Distribution of Water

All waters shall be apportioned ratably to each landowner upon the basis of the ratio which the last assessment against his land for District purposes bears to the whole sum assessed upon the lands of the District, or in such other manner as is allowed by law, to such landowners making application therefor, and making payments of the tolls and charges fixed by the Board. Upon failure of any landowner to make application for water, the water that would otherwise be allotted to such landowner may be alloted by the District to other landowners who make application therefor.

Any landowner may make application for additional water over and above the amount to which he is entitled under his assessment and if such application cannot be granted for the full amount applied for, such water as may be available shall be pro-rated between such applications in proportion to their said assessments in the District.

Rule 4. Application for Water

At such time as may be ordered by resolution of the Board of Directors, each landowner or tenant shall file an application for water on a form provided by the District, setting forth the crops and acreage of each he is intending to irrigate. The application shall further contain the name of the owner of the land to be farmed, name of the tenant or tenants, acreage to be farmed within the District, amount and location of acreage for which the water is required and such other matters as the Board of Directors may desire. By making said application the applicant grants a right to the District for the irrigation season to control all ditches and laterals, and to install, maintain, control and regulate all meters, measuring devices, delivery gates or other structures in any ditch, canal or lateral necessary and on which the District does not otherwise have such rights, for the distribution, measurement and control of water, and to go upon the applicant's land for the purpose of measuring the area irrigated.

Any land that is farmed by a tenant is subject to the imposition of a claim by the District for any unpaid District rates, charges or assessments.

Rule 5. Delivery of Water

All orders for delivery or for shut-off of water must be made to the District's office by 2:00 p.m. on the day prior to the desired delivery or shut-off. The District will attempt to make delivery the same day, or by the next day for orders received after 2:00 p.m. The District's distribution system, however, is not designed to provide full service to every landowner simultaneously. Therefore, there may be times when water deliveries must be rotated, and that rotation will be imposed as equitably as possible by the District Manager. The District shall not be responsible for loss or damages incurred by reason of delays or interruptions in delivery of water service.

Water must be used continuously by the water user throughout the period of delivery, both day and night.

The District shall deliver no water unless proof of payment therefore required by these Rules and Regulations is made.

Rule 6. Measurements and Measuring Devices

The District shall be entitled to place such meters or other measuring devices, turnouts, gates, or other structures in the ditches, canals and laterals as it may consider necessary or proper.

Rule 7. Time for Fixing Rates of Tolls and Charges

The rates of tolls and charges for the use of water and other purposes may be fixed and determined annually by the Board of Directors. The rates of tolls and charges are payable at the District office.

If an applicant requests only a single irrigation, the entire amount of tolls and charges shall be paid before water is delivered. Should an applicant require a subsequent irrigation, the entire amount of tolls and charges for that subsequent irrigation shall be paid before water is delivered. Where more that one irrigation or continuous irrigation (such as for rice) during a season will be required, the applicant shall pay a minimum of one-fourth of the tolls and charges upon filing his application and before water delivery is commenced. The remainder of the tolls and charges shall be paid, one-fourth each, on or before the first day of June, July and August.

All water tolls and charges shall become delinquent fifteen days after the same are due and payable. If not paid prior to such delinquency, an interest charge of 1 ½% per month shall be added. If delinquent water tolls and charges are not fully paid on or before the last Monday of December, an additional 10% penalty shall be added thereto and shall be and become part of such tolls and charges, in addition to the interest on delinquent payments, and such penalty will also bear interest thereafter.

In addition to any other rights under law, the District may secure any unpaid tolls and charges in accordance with California Water Code Section 25806, that allows, in the District's discretion, for such charges to be added to the next assessment on the land, or to be secured by the filing of a certificate of lien in the office of the county recorder of any county. Landowners should understand that one or more of these processes could ultimately result in their loss of title to their land.

If any applicant for or user of water or the land upon which the water is to be used is fifteen or more days delinquent in the payment of any District tolls or charges, or any installments thereof, water delivery to such applicant or land shall be refused or discontinued until such tolls or charges or installments thereof, plus interest and penalties as provided for in these Rules and Regulations, are paid. If water service has commenced for the irrigation season, but is to be discontinued under the terms of this Rule, the landowner, and tenant, if any, who signed the application for water for the year, will first be afforded the right to a hearing before the District Manager or Board of Directors, as set forth in a written notice to be given to the landowner and tenant. Addition of delinquent water toll or tolls to the assessment against the lands using such water shall not be considered as payment thereof. The District's option to discontinue water service is in addition to all other rights of enforcing payment of District tolls and charges, and shall not be construed as limiting the rights of the District to otherwise enforce collection of its tolls and charges.

If at any time during an irrigation season, a landowner or water user has been more than thirty days delinquent in the payment of district tolls or charges, the District will require that one hundred percent of the following irrigation season's estimated water tolls and charges for the land on which the prior year's tolls or charges were delinquent be deposited at the time an application for water service is filed for that subsequent irrigation season.

Rule 8. District Owned Property

The lands owned or controlled by the District may be leased or rented under such terms and conditions as may be prescribed and ordered by the Board of Directors from time to time; provided however, that unless different rules, regulations and rates are fixed, then these rules, regulations and rates shall apply to water service to be delivered to such District-owned land.

Rule 9. Acreage Surveys

If the District finds it necessary to survey land for the purpose of determining the acreage planted and for which water was delivered, it will include all lands within the exterior boundaries of the area on which water has been allowed to stand, or use such other standards for measurement as are commonly used in the area in which the land is situated.

Rule 10. Abandoned Use of Water

Whenever the use of water is abandoned on any lands, such lands shall be required to pay the full installments of water tolls and charges due and payable at the time the District receives notice of such abandonment.

Rule 11. Condition of Ditches

Upon the application of a landowner or water user for the delivery of water, it shall be the duty of the District Manager to certify whether or not the applicant's ditches are in proper condition to receive water.

As provided in California Water Code Section 22257, all ditches must be kept free from weeds and other obstructions and shall be of sufficient capacity and properly constructed and maintained so as to carry water without danger of serious breaks or waste, and if not so unobstructed, constructed and maintained the District Manager may shut off delivery of water thereto. The District Manager will examine all ditches and may order them to be cleaned, repaired or reconstructed if necessary, before water is turned in. Refusal to comply with this rule will be sufficient cause for refusal to turn in water. Nothing herein shall be construed as an assumption of liability on the part of the District, its Directors, officers or employees for any damages occasioned through the improper construction, maintenance or use of any ditch or ditches or by reason of permitting the flow of water or turning water therein.

Rule 12. Waste of Water

Any landowner or water user wasting water either wilfully, carelessly, or on account of defective ditches will be refused the use of water until such conditions are remedied. Without limiting the foregoing, the District and its Board of Directors reserve the right to refuse or to limit delivery of water to any lands when it appears to the satisfaction of the Board of Directors that its proposed use, or method of use, will require such excessive quantities of water as will constitute waste or will damage adjacent land by seepage.

When it appears to the satisfaction of the Board of Directors that service of water to certain lands will probably result in seepage damage to adjacent lands the Board may require as a condition precedent to the delivery of water a written guarantee on the part of the landowner desiring service that he will protect the District and hold it free and harmless from liability for any such damage.

Rule 13. Shortage of Water

When, through lack of water, lack of ditch capacity, or for any other reason, it is not possible to deliver throughout the District or any portion thereof the full supply of water required by the water users, such supply as can be delivered will be equitably pro-rated until such time as delivery of a full supply can be given. A pro-rata delivery means a simultaneous flow available at a point nearest the District system for the use of each and every landowner or water user in as nearly an exact proportion as can be determined of the total amount available or that can be delivered, based on the individual's right to receive water as fixed by acreage, crop to be irrigated, ditch capacity, or otherwise. The method may be applied to all, or a part of the system.

Rule14. Use of Laterals and Distribution Ditches

No District owned or operated lateral shall be used as a distribution ditch to directly irrigate alfalfa, clover, corn or similar strip check grown crop.

Rule 15. Complaints

All complaints as to service, lack of water, or other unsatisfactory conditions should be made immediately, in writing, addressed to the District office.

Rule 16. Access to Land and Ditches

The District and its agents shall have free access at all times to all lands irrigated from the canal system and to all canals, laterals and ditches for the purpose of inspection, examination, measurements, surveys or other necessary purposes of the District, with the right of installation, maintenance, control and regulation of all meters or other measuring devices, gates, turnouts, or other structures necessary or proper for the measurement and distribution of water.

The District assumes no liability for damages to persons or property occasioned through defective ditches, laterals, meters or measuring devices.

Rule 17. Use of District Right-of-Way

No trees or crops shall be planted on any District right-of-way, and all such trees or crops growing therein shall belong absolutely to the District. The District Manager may, upon such terms and conditions as he deems appropriate, grant permission in writing for annual crops to be planted in a District right-of-way. Such plantings shall be entirely at the risk of the landowner or tenant planting such crops.

Rule 18. Obstructions on Right-of-Way

No fences or other obstructions shall be placed across, upon or along any canal bank or District right-of-way without the written permission of the Board of Directors, subject to such conditions as the Board deems appropriate. Any obstructions placed without permission as herein required shall be removed by the District and the expense of such removal shall be assessed against the landowner.

Rule 19. Drains

Before allowing water to drain or waste into the drains constructed by the District, all landowners and water users must construct, install and maintain all necessary structures so as to protect such drains from erosion and damage. Such work must be done to the satisfaction of the District Manager.

Each landowner shall construct and maintain adequate drainage facilities to prevent damage to adjacent land.

Rule 20. Gates, Structures and Main Canal

No opening shall be made or structures placed in or on any District right-of-way, nor shall anyone alter District facilities without the written permission of the District Manager. All such structures or alterations must be constructed according to requirements of the District, at the expense of the landowner or water user, must be maintained in a condition satisfactory to the District Manager and must not be changed without the written permission of the District Manager.

If a landowner or water user desires to have work done at his expense by the District, the District will prepare an estimate in advance if the landowner or water user requests it. The total cost of all work shall be paid within 30 days of completion of the project.

Rule 21. Damage to Laterals

Any person causing damage to or permitting livestock to cause damage to any District right of way or facilities shall be required to reimburse this District for all expense incurred in repairing the same.

Rule 22. Enforcement of Rules

Refusal to comply with the requirements, any violations of any of these Rules and Regulations, or any interference with the proper discharge of the duties of any person employed by the District, shall be considered sufficient cause for shutting off the water, and water will not again be furnished until in the opinion of the District Manager full compliance has been made with all requirements herein set forth.

Rule 23. Non-Liability of District

The District will not be liable for any damage of any kind or nature resulting directly or indirectly to any private ditch or the water flowing therein or by reason of lack of capacity therein, or for negligent, wasteful or other use or handling of water by the users thereof. The District's responsibility shall absolutely cease when the water leaves the District's facilities, and the District will not be liable for shortage of water, either temporary or permanent, failure to deliver such water, or for the quality thereof.

Rule 24. Presumption of Knowledge by Landowners

All landowners in the District shall be conclusively presumed to have knowledge of these Rules and Regulations, of the provisions of the California Irrigation District Law, and of all proceedings had, and all orders and decisions made and entered in the District's records, including those already appearing therein and those that may hereafter be entered therein; and all such landowners are bound by them.

Rule 25. Borrowing Equipment

Tools or equipment will not be loaned unless the borrower first secures a properly signed order for same at the District office.

Rule 26. Rebates

Refunds or rebates for water applied for but not used will only be considered in the discretion of the Board of Directors and none will be granted unless application therefore is made within the current year during which payment was made.

The foregoing Rules and Regulations were adopted July 9, 2002, superceding all former Rules and Regulations.

Princeton-Codora-Glenn Irrigation District

BY-LAWS

RULES

AND

REGULATIONS

Princeton-Codora-Glenn Irrigation District

PRINCETON, CALIFORNIA

By-Laws, Rules and Regulations

PRINCETON-CODORA-GLENN
IRRIGATION DISTRICT

These rules and regulations were adopted by resolution of the Board of Directors of the Princeton-Codora-Glenn Irrigation District, under authority of the provisions of Section 22257 of the Water Code, which reads as follows: "Each district shall establish equitable rules for the distribution and use of water, which shall be printed in convenient form for distribution to the District."

Rule 1—Control of System

The maintenance and operation of the canals, drains and works of the District shall be under the exclusive management and control of the Superintendent, appointed by the Board of Directors, and no other person, except his employees and assistants shall have any right to interfere with said canals, drains and works in any manner, except in case of an order from the Board of Directors.

Rule 2—Ditchtenders and Other Employees

The superintendent will employ such ditchtenders and other assistants as he may deem necessary for the proper operation of the system, subject to the approval of the Board of Directors. Each ditchtender shall have charge of his respective Section, and shall be responsible to the Superintendent. From the rulings and the action of the ditchtender an appeal may be made to the Superintendent. From the action of the Superintendent an appeal may be made to the Board of Directors at any meeting of such Board.

Rule 3—Distribution of Water.

All waters shall be apportioned ratably to each landowner upon the basis of the ratio which the last assessment against his land for District purposes bears to the whole sum assessed upon the lands of the District, upon such landowners making application therefor, and making payments of the tolls and charges fixed by the Board; provided, however, that the Board of Directors may in its discretion refuse to furnish water to any or all lands to which the District has taken and holds title by virtue of Collectors deeds. Upon failure of any landowner to make application for water or pay tolls and charges the water belonging to such landowner may be alloted by the District to other landowners offering to make the required payments therefor.

Any landowner may make application for additional water over and above the amount to which he is entitled under his assessment and if such application cannot be granted for the full amount applied for, such water as may be available shall be pro-rated between such applications in proportion to their said assessments in the District.

Rule 4—Application for Water

Between the first day of March and the fifteenth day of April of each year, or such additional time as may be ordered by resolution of the Board of Directors, each landowner or tenant farming land within the District is required to file with the Secretary of the Board of Directors a statemcent and application for water on a form provided by the District, setting forth the crops and acreage of each he is intending to irrigate, and which statement and application shall further contain the name of the owner of the land to be farmed, name of the tenant or tenants, acreage to be farmed within the District, amount and locatioin of acreage for which the water is required and such other matters as the Board of Directors may desire. By making said application the applicant grants a right to the District to control all ditches and laterals, and to install, maintain, control and regulate all meters, measuring devises, delivery gates or other structures in any ditch, canal or lateral necessary for the distribution, measurement and control of water, and to go upon the applicants land for the purpose of measuring the area irrigated.

If any landowner whose land is being farmed by a tenant, does not wish to have unpaid water tolls for water delivered to his land added to his assessments, he must between the 1st day of March and the 15th day of April of each year notify the Secretary of the Board of Directors in writing of such desire. Said notice must state the landowner does not wish his lands to be liable for the water bill of the tenant or tenants farming the land, giving the name of the tenant or tenants and a description of the land or lands to be farmed by said tenant or tenants and that if any water tolls or installments therefor are not paid at the time the same become due, then the irrigation district shall discontinue the service of water to such lands and that the landowner assumes all liability arising through the discontinuance of such water service.

Rule 5—Delivery of Water.

All requests for water service must be made in writing and must be delivered at the District's office at least three days before the water is needed. Effort will be made to make delivery in less than three days, and where possible, delivery will be made within twenty-four hours.

All shut-off orders must be sent to the District office or given to the ditchtender not later than 5 o'clock P. M. on the day before shut-off is desired. When service is desired for shorter periods than one day the shut-off order must accompany the request for service.

Water must be used continuously by the water user throughout the period of delivery, both day and night.

No water shall be delivered by agents or employees of this district unless the request is accompanied by a reciept issued by the District showing that payments therefor, then required by these rules and regulations to be made have been paid.

Rule 6—Measurements and Measuring Devices.

The District shall be entitled to place such meters, or other measuring devices, turnouts, gates, or other structures in such of the ditches, canals and laterals, as it may consider necessary or proper.

Rule 7—Time of Fixing Rates of Tolls and Charges.

The rates of tolls and charges for the use of water may be fixed and determined annually by the Board of Directors between the first day of March and the first day of May of each year. The rates of tolls and charges are payable at the office of the District in Princeton, California.

The tolls and charges of irrigating lands, where but a single irrigation for the season is required, shall be payable at the time of application for water service for such purpose and before water is served.

Where more than one irrigation is required, one fifth of the charge for water is payable upon making of application for water and before service is made of any water to lands desiring the same; one-fifth of the charge for water is payable on or before the first day of May, June, July and August.

All water tolls and charges shall become delinquent fifteen days after the same become due and payable and, if not paid prior to such delinquency there shall be added thereto, and become and be a part of such tolls and charges and be collected by the District, an interest charge of one percent (1%) per month on all delinquent payments due for such tolls and charges, such interest charge to commence at the date of such delinquency and continue until paid or to the time when said unpaid and delinquent tolls and charges are added to the annual assessment of the District, as provided by "the Irrigation District Law."

All such tolls and charges remaining unpaid at the time specified for the delivery of the assessment book to the Collector of the District will be added to and become a part of the first installment of the annual assessment levied by the District, as provided for by "the Irrigation District Law."

PROVIDED, HOWEVER, that security for the payment of water tolls and charges may be accepted by this District. If delinquent water tolls and charges are not added to said assessment and if such water tolls and charges are not paid on or before the last Monday of December, 10% shall be added thereto and shall be and become a part, in addition to the hereinbefore mentioned interest to be charged on delinquent payments, of such tolls and charges.

PROVIDED FURTHER, HOWEVER, that if any applicant for or user of water not owning land free from delinquent assessments or installments of assessment of this District upon which lands the water is to be used is fifteen or more

days delinquent in the payment of his or its water toll or tolls or any installments thereof, water delivery to such applicant shall be refused or discontinued until such water toll or tolls or installments thereof is paid plus interest and penalties as provided for in these By-Laws, Rules and Regulations. Addition of delinquent water toll or tolls to the assessment against the lands using such water shall not be considered as payment thereof. The right to discontinue water service is in addition to all other rights of enforcing payment of water tolls and shall not be construed as limiting the rights of the Irrigation District to otherwise enforce collection of water tolls.

Rule 8—District Owned Property.

The lands owned or controlled by the District may be leased or rented under such terms and conditions, and requirements as to payment for water as may be prescribed and ordered by the Board of Directors from time to time: PROVIDED HOWEVER, that unless different rules, regulations and rates are fixed, then these rules, regulations and rates shall apply.

Rule 9—Acreage Surveys.

If the District finds it necessary to survey land for the purpose of determining the acreage planted and for which water was delivered, it will include all lands within the exterior boundaries of the area on which water has been allowed to stand.

Rule 10—Abandoned Use of Water.

Whenever the use of water is abandoned on any lands, such lands shall be required to pay in the full installments of water tolls and charges due and payable at the time the District is given written notice of such abandonment.

Rule 11—Condition of Ditches.

Upon the application of a landowner or water user for the delivery of water, it shall be the duty of the Superintendent to certify whether or not the applicant's ditches are in proper condition to receive water.

All ditches must be kept free from weeds and other obstructions and shall be of sufficient capacity and properly constructed and maintained so as to carry water without danger of serious breaks or undue seepage, and if not so unobstructed, constructed and maintained the Superintendent may shut off delivery of water thereto. The Superintendent is required to examine all ditches and may order them to be cleaned, repaired or reconstructed if necessary, before water is turned in. Refusal to comply with this rule will be sufficient cause for refusal to turn in water. Nothing herein shall be construed as an assumption of liability on the part of the District, its Directors, Officers or Employes for any damages occasioned through the improper construction maintenance or use of any ditch or ditches or by reason of permitting the flow of water or turning water therein.

Rule 12—Waste of Water.

Any consumer wasting water on roads, or vacant land, or land previously irrigated either wilfully, carelessly, or on account of defective ditches, or who shall flood certain portions or the land to an unreasonable depth, or use an unreasonable amount of water in order to properly irrigate other portions or whose land has been improperly checked for the economical use of water or allows an unnecessary amount of water to escape from any tailgate, will be refused the use of water until such conditions are remedied.

The District and its Board of Directors reserve the right to refuse or to limit delivery of water to any lands when it appears to the satisfaction of the Board of Directors, that its proposed use, or method of use, will require such excessive quantities of water, as will constitute waste or will damage adjacent land by seepage.

When it appears to the satisfaction of the Board of Directors that service of water to certain lands will probably result in seepage damage to adjacent lands the board may refuse as a condition precedent to the delivery of water a written guarantee on the part of the landowner desiring service that he will protect the District and hold it free and harmless from liability for any such damage.

Rule 13—Shortage of Water.

When, through lack of water, lack of ditch capacity, or for any other reason, it is not possible to deliver throughout the District or any portion thereof, the full supply of water required by the water users, such supply as can be delivered will be pro rated until such time as delilvery of a full supply can be given. A pro rata delivery means a simultaneous flow available at a point nearest the district system for the use of each and every consumer in as nearly an exact proportion as can be determined of the total amount available or that can be delivered, based on the individual's right to receive water as fixed by acreage, crop to be irrigated ditch capacity, or otherwise. The method may be applied to all, or a part of the system.

Rule 14—Use of Laterals and Distribution Ditches.

No District owned or operated lateral shall be used as a distribution ditch to irrigate alfalfa, clover, corn or similar strip check grown crop.

Rule 15—Complaints.

All complaints as to service, lack of water, or other unsatisfactory conditions should be made immediately, in writing, addressed to the office of the District, at Princeton, California.

Rule 16—Access to Land and Ditches.

The authorized ditchtenders and other agents of the District shall have free access at all times to all lands irrigated from the canal system and to all canals, laterals and ditches for the purpose of inspection, examination, measurements, surveys or other necessary purposes of the District, with the right of installation, maintenances, control and regulation of all meters or other measuring devices, gates, turnouts, or other structures necessary or proper for the measurement and distribution of water.

Said District assumes no liability for damages to persons or property occasion through defective ditches, laterals, meters or measuring devices.

Rule 17—Use of District Right-of-Way.

No trees, alfalfa or other crops shall be planted on the right-of-way of any District Canal and all such crops growing on such right of way shall belong absolutely to the District. Permission, however, may be granted by the Superintendent under such restriction as he may deem expedient, to raise annual crops therein.

Rule 18—Obstructions on Right-of-Way.

No fences or other obstructions shall be placed across or upon or along any canal bank or right-of-way of any canal or ditch belonging to the District without the special written permission of the Board of Directors. Whenever such special permission shall be granted it shall always be with the distinct understanding that proper openings of passage ways for tractors and equipment shall be provided.

Any obstructions placed without permission as herein required shall be removed by the District and the expense of such removal shall be assessed against the landowner.

Rule 19—Drains.

Before allowing water to drain or waste into the drains constructed by the District, all landowners and water users must construct, install and maintain all necessary structures so as to protect such drains from erosion and damage. Such work to be done to the satisfaction of the District Superintendent.

Each landowner shall construct and maintain adequate drainage facilities to prevent damage to adjacent land.

Rule 20—Gates, Structures and Main Canal.

No opening shall be made or structures placed in any District Canals or Laterals or Canal Banks without special written permission of the Superintendent. All such structures in the District Canals, Laterals and Canal Banks must be constructed according to requirements of the District, and at the expense of the water user, and must be maintained in a condition satisfactory to the Superintendent and must not be changed without the permission of the Superintendent.

In all cases where the landowner or water user desires to have work done at his expense by the District, an estimate will be prepared and if the construction by District forces and equipment is approved, the person making application will deposit in advance with the District the amount of the estimated costs. If the work costs less than the amount desposited the difference will be returned by the District. If the work costs more than the estimate the person making the deposit will be required to pay the difference to the District.

Rule 21—Damage to Laterals.

Any person causing damage to or permitting livestock to cause damage to any ditches or ditch banks of the District shall be required to reimburse this District for all expense incurred in repairing the same.

Rule 22—Enforcement of Rules.

Refusal to comply with these requirements or any transgressions of any of the foregoing rules or regulations or any interference with the proper discharge of the duties of any person employed by the District, shall be considered sufficient cause for shutting off the water, and water will not again be furnished until in the opinion of the Superintendent full compliance has been made with all requirements herein set forth.

Rule 23—Non-Liability of District.

The District will not be liable for any damage of any kind or nature resulting directly or indirectly from any private ditch or the water flowing therein or by reason of lack of capacity therein, or for negligent, wasteful or other use or handling of water by the users thereof, but its responsibility shall absolutely cease when the water leaves the main canal of the District; nor will the District be liable for shortage of water, either temporary or permanent, or failure to deliver such water.

Rule 24—Presumption of Knowledge by Landowners.

All landowners in the District shall be conclusively presumed to have knowledge of these rules and regulations, of the provisions of "the Irrigation District Law", and of all proceedings had, and all orders and decisions, made and entered in the proper minute book, or record, including those already appearing therein and those that may hereafter be entered therein; and all such landowners are bound by them.

Rule 25—Borrowing Equipment.

Tools or equipment will not be loaned unless the borrower first secures a properly signed order for same at the office.

Rule 26—Rebates.

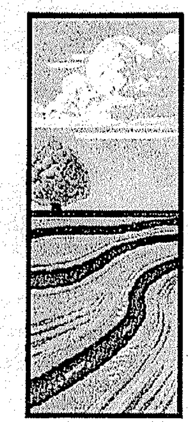
Refunds or rebates for water applied for but not used will only be considered in the discretion of the Board of Directors and none will be granted unless application therefore is made within the current year during which payment was made.

The foregoing By-Laws, Rules and Regulations were adopted March 15, 1951, superceding all former By-Laws, Rules and Regulations.

Reclamation District No. 108

RULES AND REGULATIONS

COVERING THE DISTRIBUTION OF WATER



RECLAMATION DISTRICT

108

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RULES AND REGULATIONS

COVERING THE DISTRIBUTION OF WATER

IN

RECLAMATION DISTRICT NO. 108

AND FIXING CHARGES AND RATES FOR THE SAME

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ADOPTED NOVEMBER 8, 1989

Pursuant to Section 50911 (a) of the Water Code of the State of California

Headquarters on Wilson Road at Wilkins Slough

P.O. Box 50
Grimes, California 95950
(916) 437-2221

RULES AND REGULATIONS

GOVERNING THE DISTRIBUTION OF WATER IN

RECLAMATION DISTRICT NO. 108

AND
FIXING CHARGES FOR THE SAME

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RULE 1 — CONTROL OF SYSTEM

The operation of all irrigation works owned or operated by Reclamation District No. 108 shall be under the exclusive management and control of the Manager of the District. No other person shall have any right to operate or interfere in any manner with said irrigation works, except for duly appointed assistants of the Manager or when specifically authorized by resolution of the Board of Trustees of the District.

RULE 2 — EMPLOYEES

Subject to the approval of the Board of Trustees, the Manager shall employ such assistants as may be necessary for the proper operation and maintenance of the irrigation works of the District. In such operation and maintenance, all employees shall be guided by these Rules and Regulations and by such technical and other instructions and advice as may be given by the Engineer of the District for the purpose of carrying out the policies of the Board of Trustees and providing efficient and economical service.

RULE 3 — DISTRIBUTION OF WATER

The District will deliver water into the various irrigation canals and laterals included in its adopted project at such levels as are feasible and practicable with the facilities existing at the time these Rules and Regulations are made effective and such other facilities as may thereafter be added by resolution of the Board of Trustees. Except as hereinafter provided in case of a shortage of water or in case of noncompliance with these Rules and Regulations, water will be delivered into the irrigation canals and laterals in sufficient quantity to meet the reasonable needs of all qualified irrigators.

RULE 4.—APPLICATIONS FOR WATER

Prior to the first delivery of water to each tract of land each season and prior to the pumping of any water from the works of the District to lands not susceptible to gravity irrigation, an application for water shall be filed with the Manager or authorized assistant on a form provided by the District. All applications shall be signed by and shall show the name and address of the party (applicant) to be billed for irrigation service, and such other information as the Manager may require from time to time.

In all instances, the landowner shall be responsible for all charges for water used upon his or her land and, when the application for water is made by a tenant, the applicant, and all other tenants making use of such water, shall be jointly and severally liable with the landowner for all water charges.

RULE 5—CHARGES FOR WATER

The Board annually shall adopt a schedule of rates to be charged by the District for irrigation water service.

RULE 6—TIME OF PAYMENT

Payment of the seasonal charge for the irrigation of each tract of rice shall be made in three equal installments; the first prior to the initial delivery of water to the tract, the second on or before the first day of July and the third on or before the fifteenth day of August.

Payment of the charges for water for each irrigation of lands and crops utilizing a single irrigation or a series of separate irrigations during the season shall be made not later than the start of each separate irrigation.

For special cases, payment of the seasonal charge for water shall be made in such installments of such amounts as the Manager may determine to be necessary in each case so as to insure that all water so delivered is paid for in advance.

If any installment is not paid by the due date set forth above, it shall be considered delinquent and a penalty of five percent (5%) shall be added to the balance. There shall also be added at the end of each thirty (30) day period following date of delinquency, interest at the rate of one percent (1%) on the delinquent principal amount until the full amount including principal, penalty and interest is paid. The District may in addition thereto, immediately discontinue the delivery of water and refuse further delivery of water for the irrigation of said land until charges are paid in full.

RULE 7—SHORTAGE OF WATER

Whenever a general shortage of water appears imminent, the Board of Trustees shall so find by resolution duly passed and recorded in its minutes. The resolution shall incorporate special rules and regulations to cover the distribution of the available water supply during the period of the shortage. In the event of temporary, local or similar shortages, the Manager is authorized to place in effect such variations in service as in his judgment the occasion requires.

RULE 8—WASTE OF WATER

Any water user who deliberately, carelessly or otherwise wastes water on roads, vacant land or land previously irrigated or who floods certain portions of the land to an unreasonable depth or who uses an unreasonable amount of water in order to irrigate properly other portions or who irrigates land which has been improperly checked for the economical use of water or who allows an unnecessary amount of water to escape from any field will be refused the use of water until such conditions are remedied or will have his use curtailed by the amount of waste, as the Manager may determine.

The District reserves the right to refuse delivery of water to any lands when it appears to the satisfaction of the Manager that its proposed use or method of use would require such excessive quantities of water as would constitute waste.

RULE 9—MEASUREMENT OF WATER

The Manager and his assistants shall be entitled to place meters or other measuring devices in such canals, laterals, ditches and pipe lines as may be considered necessary or proper, whether such canals, laterals, ditches and pipe lines are owned by the District or by the landowner.

RULE 10—DETERMINATION OF ACREAGE IRRIGATED

The District will survey each tract of land for the purpose of determining the acreage to be paid for and will include all land within the exterior boundaries of the land area upon which water is allowed to stand. If any such survey shows a change in the acreage, the effect thereof will be included in all subsequent bills.

RULE 11—ACCESS TO LAND

The Manager, his assistants and all other employees of the District shall have free access at all times to all canals, laterals, ditches and pipe lines and to all lands irrigated from same for the purpose of inspection, examination, measurements, surveys, control of water or other necessary purposes of the District, with the right of installation, maintenance, control and regulation of all meters or other measuring devices, gates and turnouts necessary or proper for the measurement and distribution of water.

RULE 12—CONTROL OF REGULATION STRUCTURES

Except in cases of actual emergency or to prevent imminent danger of damage to property or when specifically authorized by the Manager, no person other than the Manager or his assistants shall be authorized or permitted to turn water on or off or to change or interfere with any waste, check, head or delivery gate or the irrigation systems or with any measuring devices of the irrigation systems. All violators are subject to prosecution under Section 592 of the Penal Code of California.

RULE 13—CONDITION OF PRIVATE DITCHES

All private ditches shall be properly constructed and maintained so as to carry water without danger of serious breaks or undue seepage. The Manager is required to examine all such ditches and may order them to be cleaned, repaired or reconstructed, as he deems necessary, before water will be turned into them. Refusal to comply therewith will be sufficient cause for refusal to turn in water. Nothing herein shall be construed as an assumption of liability on the part of the District, its Trustees, officers, or employees for any damage occasioned by improper construction, maintenance or use of any private ditch or ditches or by reason of permitting the flow of water or the turning of water therein.

RULE 14—DELIVERY GATES OR TURNOUTS

All pipes and crossings shall be constructed by District personnel in accordance with District plans. They become District property and shall be maintained by the District.

All costs of new pipes and crossings shall be paid for by the Landowner. Replacement of existing pipes and crossings are at District expense.

If the Landowner requests a pipe or crossing moved he pays for the costs. During this process, if the pipe is found to be unusable, the District pays for the pipe.

Damage occurring to existing structures, such as splash board risers, turnouts, or any other District owned property, see Rule 16.

All used materials remain the property of the District.

RULE 15—RESPONSIBILITY OF THE DISTRICT

The District will not be liable for any damage resulting, directly or indirectly, from the water flowing in or from any private ditch nor for any damage which may result from the flooding of land or other property by water from fields that are being irrigated. District responsiblity will cease absolutely when the water is delivered from the canals or laterals of the District.

RULE 16—LIABILITY OF IRRIGATORS

Every water user and landowner shall be jointly and severally responsible to the District for all damage to District works by his neglect or careless or malicious acts, such repairs will be made at his expense by the District.

RULE 17—ENCROACHMENTS

No encroachment shall be permitted upon district lands, easements, rights-of-way, including irrigation and drainage ditches, by installation of any structure or other alteration of the District lands, easements or rights-of-way (excluding, in the case of district owned lands, alterations made pursuant to a lease) except upon application to the District for a permit authorizing such installation or other alterations.

RULE 18—ABATEMENT OF NUISANCE

No tree or vine prunings, brush, weeds, grass, tules, rubbish, swill, garbage, manure, refuse, dead animals, or animal matter from any barnyard, stable, dairy or hogpen, or other materials or substances that will become offensive to the senses or injurious to health or obstruct the flow of the water, or result in the scattering of seeds of noxious weeds, plants or grasses shall be placed or dumped in any canal or lateral belonging to the District, or be placed or left so as to roll, slide, flow or be washed or blown into any such canal or lateral. Any violation of this rule will subject the offender to prosecution. All employees of the District shall promptly report any violation of this rule and the water users of the District are urged to cooperate in its enforcement.

RULE 19—DRAINAGE WATER FROM SOURCE OUTSIDE DISTRICT SYSTEM

A charge will be made to cover the cost of conveying and disposing of drainage water from each tract of land situated outside the District. This charge shall be established annually by the Board of Trustees.

RULE 20—ENFORCEMENT OF RULES

Failure to comply with the requirements of any of these Rules and Regulations or violation of any of the provisions hereof or failure to pay any water toll or charge, when due, or interference with the performance of the duties of any official or employee of the District shall be sufficient cause for shutting off the water from any such offender, and water will not again be furnished until, in the opinion of the Manager, full compliance has been made with all of the requirements hereof.

RULE 21—COMPLAINTS

All complaints as to service, lack of water or other unsatisfactory conditions shall be communicated by the landowner or irrigator directly to the employee of the District in direct charge of the distribution of water. From the ruling or action of such employee recourse may be had to the Manager and from the decision of the Manager to the Board of Trustees at the next regular meeting of the Board.

RULE 22—AMENDMENTS AND OTHER CHANGES

These Rules and Regulations are subject to amendment, modification, repeal or other variation at any time or from time to time in the discretion of the Board of Trustees.

Appendix F
Sacramento Valley Water Quality Coalition Amended Monitoring and Reporting Program Plan 2006 and 2007 Monitoring Plan

Proposed Water Quality Monitoring Program for 2006:

Sacramento Valley Water Quality Coalition

In January 2005, the Sacramento Valley Water Quality Coalition commenced monitoring under its Monitoring and Reporting Program Plan (MRPP) and Quality Assurance Project Plan (QAPP) submitted to the Regional Water Quality Control Board, Central Valley Region (Regional Board) on April 1, 2004 and December 22, 2004 respectively. The Regional Board issued a Conditional Approval of the Coalition's MRPP on December 2, 2004.

The following document is the Coalition monitoring plan for 2006 and is provided as an attachment to the Coalition's amended MRRP.

MONITORING IN 2005

Monitoring conducted in 2005 under the Coalition's MRPP provides the basis for the monitoring proposed for 2006. This monitoring is briefly summarized in the following sections, along with the basis for changes implemented for the 2006 storm and irrigation season monitoring.

Core Monitoring Sites

The Coalition has collected samples and performed analyses at sixteen core sites throughout the watershed (Table 1). Consistent with conditionally approved MRPP and QAPP, monitoring was generally conducted twice during the storm season (December – March), and monthly during the irrigation season (May – October).

Table 1. SVWQC core monitoring sites, 2005

Site Index	Subwatersheds	Site Location
4	Shasta/Tehama	Burch Creek at Woodson Ave Bridge
5	ColusaBasin	Stony Creek on Hwy 45 near Rd 24
8	ColusaBasin	Rough and Ready Pumping Plant (RD 108)
11	Placer/Nevada/S.Sutter/N.Sac.	Coon Creek at Striplin Road
12	Butte/Yuba/Sutter	Butte Slough at Pass Road
13	Butte/Yuba/Sutter	Wadsworth Canal at South Butte Rd
14	Butte/Yuba/Sutter	Pine Creek at Nord Gianella Road
16	Solano/Yolo	Z Drain – Dixon RCD
17	Solano/Yolo	Toe Drain at Little Holland Tract
18	Solano/Yolo	Tule Canal at I-80
19	UpperFeatherRiver	Spanish Creek above Greenhorn Cr.
20	UpperFeatherRiver	Middle Fork Feather River at County Road A-23
21	UpperFeatherRiver	Indian Creek d/s from Indian Valley
22	Lake/Napa	McGaugh Slough at Finley Road East
25	ElDorado	North Canyon Creek
26	Sacramento/Amador	Cosumnes River at Twin Cities Rd

Exceptions to the planned monitoring frequencies documented in the MRPP and QAPP were as follows:

Toe Drain @ Little Holland Tract: Poor access conditions in storm and irrigation seasons resulted in only two samples being collected at this site throughout the year. In August, the Coalition identified a new site in the same drainage area and submitted a memo to the Regional Board specifying the reason for the change. Monitoring commenced at the new location (Shag Slough at Liberty Island Bridge) in September 2005, and are proposed to continue in 2006.

Middle Fork Feather River at County Road A-23: This site was inaccessible in January 2005 due to icy conditions. This site was successfully sampled during all other planned events.

Burch Creek at Woodson Avenue Bridge: This site was sampled for two storm events and one irrigation event (January, March and May). Following the May irrigation season sample event, flow was inadequate to sample this site. The site was checked monthly for flow after May, and was found to be dry for the remainder of the irrigation season.

Pine Creek at Nord-Gianella Road: This site was sampled for two storm events and three irrigation events (January, March, May, June and July). Following the July event, flow was inadequate to sample this site. The site was checked monthly for flow after July, and was found to be dry for the remainder of the irrigation season.

Cosumnes River at Twin Cites Road: This site was sampled for two storm events and four irrigation events: January, March, May, June, July and August. Following the August event, flow was inadequate to sample this site. The site was checked monthly for flow in September and October, and was found to be dry for the remainder of the irrigation season.

Coordinated Monitoring

The Coalition also coordinated efforts with five other programs collecting samples in priority drainage areas throughout the Sacramento Valley. Samples were collected at the sites listed in Table 2 at the frequencies specified in the Coalition's Table 7A of the MRPP. The parameters analyzed were also as specified in Table 7A.

Table 2. Coordinating program monitoring sites in 2005

Subwatersheds	Site Location	Frequency	Agency
Pit River	Pit River at Pittville	Monthly, April through September	Northeastern California Water Association
	Fall River at Fall River Ranch Bridge		
	Pit River at Canby Bridge		
Lake/Napa	Pope Creek upstream from Lake Berryessa	Three events (January, March, May)	Putah Creek Watershed Group
	Capell Creek upstream from Lake Berryessa		
Colusa Basin	Colusa Drain near Maxwell Road	Monthly, May through September	Glenn County Agriculture Department
	Stone Corral Creek		
	Butte Creek at Gridley Rd Bridge		
Sacramento / Amador	Big Indian Creek at Bridge	Three events (December 2004, March and June 2005)	Plymouth Area Vineyard Erosion Control
Colusa Basin	Colusa Basin Drain above KL	No samples were collected in 2005	Sacramento River Watershed Program
Butte/Yuba/Sutter	Sacramento Slough		

RECOMMENDED MONITORING FOR 2006

Consistent with R5-2005-0833 which states that "*Based on results of the monitoring program after a minimum of one year, the Coalition Group may submit a revised MRP Plan requesting a reduction in the constituents monitored and/or sample frequency…*" the Coalition is submitting the following MRPP proposal for 2006. The proposed monitoring plan is also summarized in the attached Table 7A, which includes additional detail for parameters, sampling frequency, and implementation. The categories and criteria used for making these monitoring recommendations are discussed below.

Sites with No Observed Toxicity

For most sites that did not exhibit toxicity during 2005, the Coalition will end Phase 1 testing and initiate Phase 2 testing (i.e., pesticides, metals, nutrients, general physical parameters). These sites are listed below, with a brief discussion of exceptions:

- *Tule Canal at I-80*
- *Coon Creek at Striplin Road*
- *Wadsworth Canal at South Butte Rd*
- McGaugh Slough at Finley Road East. Although no toxicity was observed at this site in 2005, Phase 1 testing is planned to continue in 2006 to increase the number of monitored events.
- *Toe Drain at Little Holland Tract*. Due to the access problems experienced in 2005, this site was replaced during the irrigation season with Shag Slough at Liberty Island Bridge, where Phase 1 monitoring will continue in 2006.
- *Middle Fork Feather River at County Road A-23*, *Spanish Creek above Greenhorn Cr.*, and *Indian Creek d/s from Indian Valley*. Phase 1 monitoring at

these sites excluded toxicity on the basis of minimal irrigated acreage and pesticide use in these drainages. Phase 2 monitoring will be implemented in 2006, but will exclude pesticide analyses on this same basis.

Sites with Observed Toxicity

Sites with occasional toxicity observed in 2005 will be sampled as described below in 2006. Toxicity observed at these sites is summarized in Table 3. The scope of Phase 2 monitoring was determined on a case-by-case basis as described below for each site.

- *Burch Creek at Woodson Ave Bridge* exhibited statistically significant toxicity in three samples, including two samples in January 2005 and one sample in May 2005. Phase 1 testing will continue at this site to attempt to assess causes of the observed toxicity. Phase 2 testing will also commence at this site in January 2006. The Shasta-Tehama subwatershed group has also provided a monitoring strategy for 2006 to more completely characterize agricultural drainage in this area. The proposed strategy includes contingency samples collected at two sites upstream from the original site to identify sources of toxicity observed in 2006.
- *Pine Creek at Nord-Gianella Road* exhibited statistically significant toxicity to *Selenastrum* in one sample in January 2005. The cause was not determined and the toxicity was not repeated. Based on these results, Phase 1 toxicity testing will continue at this site for the 2006 Storm season, but will not be continued in the irrigation season. The Coalition will commence Phase 2 testing at Pine Creek beginning with the 20006 storm season. This sampling will continue analyses for organophosphorus pesticides which were identified in the January 2005 event (0.0141 ug/l diazinon and 0.227 ug/l chlorpyrifos), but determined not to be the cause of the observed *Selenastrum* toxicity.
- At the *Z Drain – Dixon RCD* site, water column toxicity has been evaluated on twelve occasions since July 2004. Three water samples exhibited statistically significant toxicity to three different test species respectively, and one sediment sample caused statistically significant toxicity. None of the samples resulted in mortality greater than or equal to 50% of the control and therefore no Toxicity Identification Evaluations (TIEs) were initiated. The Coalition will continue Phase 1 toxicity testing in 2006, and will also expand analysis of the Phase 2 analyses implemented in 2005 at this site.
- At *Stony Creek on Hwy 45 near Rd 24*, limited algae toxicity observed in one 2005 event, and therefore Phase 1 aquatic toxicity is discontinued at this site. Phase 1 sediment toxicity testing will be continued due to observed moderate toxicity in two 2005 events. Phase 2 parameters will be implemented in 2006. Due to low use of pyrethroids in this drainage, these pesticides will be excluded from the list of Phase 2 analyses in 2006.
- At *Rough and Ready Pumping Plant*, complete mortality to *Ceriodaphnia* was observed in one sample. The probable cause of the observed toxicity was determined to be the organophosphorus pesticide, dichlorvos (.087 ug/l), which is not registered for cultivated crop use in California. Because the cause of the single case of observed toxicity was determined, Phase 1 parameters (including toxicity)

are discontinued for 2006. However, there will be continued investigation of the potential source(s) of dichlorvos. Phase 2 monitoring will be implemented in 2006, including continued analysis for dichlorvos.

- At *Butte Slough at Pass Road*, complete mortality to *Ceriodaphnia* was observed in one sample (October 2005). Two additional samples caused low but statistically significant mortality to *Selenastrum* and *Hyalella*. The probable cause of the observed *Ceriodaphnia* toxicity was determined to be an organophosphorus pesticide, dichlorvos (0.542 ug/L), which is not registered for cultivated crop use in California. Because the cause of the single case of substantial observed toxicity was determined, monitoring of Phase 1 parameters (including toxicity) by the Coalition will be discontinued for 2006. However, the California Rice Commission *ILP* monitoring is continuing toxicity testing at this site, and there will be continued investigation of the potential source(s) of dichlorvos by the Coalition and subwatershed. Phase 2 monitoring will be implemented in 2006, including continued analysis for dichlorvos.
- At *North Canyon Creek*, negligible sediment toxicity (<20% effect) and no aquatic toxicity were observed in 2005. Therefore Phase 1 parameters are discontinued and Phase 2 parameters will be implemented in 2006 (including OP pesticides that were detected in 2005, but not associated with any observed toxicity).
- At *Cosumnes River at Twin Cities Rd*, negligible sediment toxicity (<20% effect) was observed in one sample and no aquatic toxicity was observed in 2005. The minimal sediment toxicity observed was associated with late season zero flow conditions not related to agricultural runoff. Therefore Phase 1 parameters are discontinued at this site and Phase 2 parameters will be implemented in 2006.
- At *Pit River at Canby Bridge*, low but statistically significant toxicity to Selenastrum was observed in one sample. Phase 1 parameters will be continued for the 2006 storm season (Dec-March) because toxicity was not monitored for storms in 2005 at this site. Phase 1 will be discontinued if no further toxicity is observed in the Storm season. Phase 2 nutrients will be added for 2006 to address 303(d) listings downstream for low DO and elevated nutrients. Organophosphate pesticides will be monitored in three events (following dormant spray application, and in July and October) to monitor potential discharges of malathion and chlorpyrifos. Bioassessment monitoring has also been added by the subwatershed monitoring agency (Northeastern California Water Association).

Table 3. Sites exhibiting toxicity in 2004-2005 initial toxicity screening tests

			(units = percent of control)		
Site	**Sample Event**	**Initial Toxicity Screening Test**	**Initial Test Result**	**Re-Test Result**	**Re-Sample Result**
Burch Creek at Woodson Ave Bridge	Jan 2005	*Ceriodaphnia* survival	20%	85%	0%
	May 2005	*Selenastrum* growth	69%	n/a	n/a
Pine Creek at Nord-Gianella Road	Jan 2005	*Selenastrum* growth	46%	62%	100%
Z Drain – Dixon RCD	Aug 2004	*Selenastrum* growth	68%	n/a	n/a
	Sep 2004	Fathead survival	78%	n/a	n/a
	Jan 2005	*Ceriodaphnia* survival	55%	80%	100%
	Jun 2005	*Hyalella* survival (replicate sample)	63%, 78%	n/a	n/a
Stony Creek on Hwy 45 near Rd 24	Jun 2005	*Hyalella* survival	61%	n/a	n/a
	Sep 2005	*Hyalella* survival	74%	n/a	n/a
Rough and Ready Pumping Plant	Sep 2005	*Ceriodaphnia* survival	0%	0% (100% conc.	100%
Butte Slough at Pass Road	Aug 2005	*Selenastrum* growth	80%	n/a	(1)
	Jun 2005	*Hyalella* survival	80%	n/a	n/a
	Oct 2005	*Ceriodaphnia* survival	0%	(1)	n/a
		(replicate sample)[2]	0%		
		(replicate sample)[3]	0%	n/a	100%
North Canyon Creek	Sep 2005	*Hyalella* survival	88%	n/a	n/a
Cosumnes River at Twin Cities Rd	Sep 2005	*Hyalella* survival	84%	n/a	n/a
Pit River at Canby Bridge	Apr 2005	*Selenastrum* growth	74%	n/a	n/a

(1) Retest and re-sampling were not initiated by CRC for these samples.

(2) Collected by CRC and tested by Pacific EcoRisk.

(3) Collected by Regional Board and UC Davis staff and tested by California Department of Fish and Game ATL. Preliminary TIE results indicated non-polar organic was cause of toxicity.

Completion of Phase 1 Monitoring

Phase 1 parameters will be continued for the 2006 storm season (Dec-March) at the following sites, either because toxicity was not monitored for storms in 2005, or to provide additional sample events. Phase 1 will be discontinued if no further toxicity is observed in the 2006 storm season. No toxicity was observed in irrigation season monitoring events at these sites.

- *Colusa Basin Drain near Maxwell Road, Stone Corral Creek,* and *Butte Creek at Gridley Rd Bridge.* Phase 2 testing will also begin at these three sites in January 2006 and continue throughout the irrigation season during each event. The Glenn County Agriculture Department implemented monitoring at these sites in 2005. The Coalition will assume full responsibility for monitoring these sites in 2006.
- *Fall River at River Ranch Bridge*, and *Pit River at Pittville*. Phase 2 nutrients will be added for 2006 to address 303(d) listings downstream for low DO and elevated nutrients. Phase 2 Organophosphate pesticides will be monitored in three events (following dormant spray application, and in July and October) to monitor potential discharges of malathion and chlorpyrifos. Bioassessment monitoring has also been added by the subwatershed agency conducting monitoring (Northeastern California Water Association).

- *Pope Creek* and *Capell Creek* in the Napa/Lake subwatershed. These two sites will continue to be monitored for a drainage-specific sub-set of Phase 1 parameters, based on minimal irrigated acreage and pesticide use. Toxicity is not monitored at these sites.

New and Modified Monitoring Sites

The Coalition is proposing to add three new monitoring sites at which Phase 1 testing (water column and sediment toxicity, drinking water constituents, and general physical parameters) will commence in January 2006 and continue throughout the 2006 irrigation season:

- One new site will be monitored on *Gilsizer Slough at George Washington Road* in the Butte/Yuba/Sutter subwatershed. This site is needed to assess diazinon use and TMDL compliance in this Gilsizer Slough drainage, and complements an ongoing BMP study being conducted in this drainage.
- *Ulatis Creek at Brown Road* is a new site that will be monitored in the Solano/Yolo subwatershed. This site was added to more completely characterize agricultural drainages in this subwatershed. The site characterizes a large proportion of the irrigated acreage in Solano County.
- One site will be added on Andersen Creek in Southern Shasta County. This site is needed to more completely characterize agricultural drainages in this subwatershed. Phase 1 and Phase 2 parameters will be monitored simultaneously. Phase 2 pesticides will be limited to organophosphate pesticides, based on usage in this subwatershed. The exact location of the monitoring site will be confirmed by the Shasta Tehama Water Education Coalition (STWEC) prior to implementing monitoring in January.
- Sampling will cease at the *Big Indian Creek at Bridge* site in the Sacramento/Amador subwatershed after one additional storm event. This site will be replaced with *Dry Creek at Alta Mesa Road* (also in the Sacramento/Amador subwatershed), with analysis of Phase 1 parameters (water column and sediment toxicity, drinking water constituents and general physical parameters) beginning in January 2006. Monitoring at this site will be implemented by the Coalition.

New monitoring location are listed in Table 4. A summary of all monitoring by the Coalition and coordinating partners is provided in Table 5, with a more detailed summary in MRPP Table 7A (attached).

Table 4. New monitoring sites for 2006

Subwatersheds	Site Location	Latitude	Longitude
Butte/Yuba/Sutter	Gilsizer Slough at George Washington Road	39.0090	-121.6716
Solano/Yolo	Ulatis Creek at Brown Road	38.3070	-121.7940
Shasta/Tehama	Andersen Creek (location TBD)	NA	NA
Sacramento/Amador	Dry Creek at Alta Mesa Road	38.2480	-121.2260

Table 5. Coalition Monitoring Summary: Planned samples in 2006

Location	Physical and Chemical Parameters												Toxicity and Follow-up Testing				Implementation
	Water Column Sample Events	Sediment Sample Events	Flow	pH, conductivity, DO, temperature	Color, Turbidity, TDS, TSS, TOC	Nutrients	Trace metals	Organophosphate pesticides	Organonochlorines, triazines, pyrethroids	Glyphosate, Paraquat	Carbofuran	Pathogen Indicators: *E. Coli* bacteria	Ceriodaphnia, 96-h acute	Pimephales, 96-h acute	Selenastrum, 96-h short-term chronic	Hyalella, 10-day short-term chronic	
Butte Slough at Pass Road	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	ns	ns	SVWQC
Colusa Drain near Maxwell Road	8	2	8	8	8	8	8	8	8	8	6	8	8	8	8	2	SVWQC
Stone Corral Creek near Maxwell Road	8	2	8	8	8	8	8	8	8	8	6	8	8	8	8	2	SVWQC
Butte Creek at Gridley Rd Bridge	8	2	8	8	8	8	8	8	8	8	6	8	8	8	8	2	SVWQC
Wadsworth Canal at South Butte Rd	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	ns	ns	SVWQC
Pine Creek at Nord-Gianella Rd	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	ns	ns	SVWQC
Gilsizer Slough at George Washington Rd	8	2	8	8	8	ns	ns	8	ns	ns	ns	8	8	8	8	2	SVWQC
Z-Drain (Dixon RCD)	8	2	8	8	8	8	8	8	8	8	6	8	8	8	8	2	SVWQC
Shag Slough at Liberty Island	8	2	8	8	8	8	8	8	8	8	6	8	8	8	8	2	SVWQC
Tule Canal at NE corner of I-80	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	ns	ns	SVWQC
Ulatis Creek	8	2	8	8	8	8	8	8	8	8	6	8	8	8	8	2	SVWQC
Rough and Ready Pumping Plant	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	ns	ns	SVWQC
Stony Creek on Hwy 45 near Rd 24	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	ns	2	SVWQC
North Canyon Creek	8	2	8	8	8	8	8	8	8	ns	ns	8	ns	ns	ns	ns	SVWQC
McGaugh Slough at Finley Road East	3	2	3	3	3	3	3	3	3	ns	ns	3	3	3	3	2	SVWQC
Coon Creek at Striplin Road	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	ns	ns	SVWQC
Cosumnes River at Twin Cities Rd	8	2	8	8	8	8	8	8	8	8	ns	8	ns	ns	ns	ns	SVWQC
Big Indian Creek at Bridge	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	SVWQC
Dry Creek at Alta Mesa Road	8	2	8	8	8	ns	ns	ns	ns	ns	ns	8	8	8	8	2	SVWQC
Burch Creek at Woodson Ave Bridge	8	2	8	8	8	8	8	8	8	ns	6	8	8	8	8	2	SVWQC
Anderson Creek in Shasta County	8	2	8	8	8	8	8	8	ns	ns	6	8	8	8	8	2	SVWQC
Spanish Creek above Greenhorn Creek	7	ns	7	7	7	7	7	ns	ns	ns	ns	7	ns	ns	ns	ns	SVWQC
Indian Creek d/s from Indian Valley	7	ns	7	7	7	7	7	ns	ns	ns	ns	7	ns	ns	ns	ns	SVWQC
Middle Fork Feather River at County Rd A-23	7	ns	7	7	7	7	7	ns	ns	ns	ns	7	ns	ns	ns	ns	SVWQC
Pit River at Pittville	8	ns	8	8	8	8	ns	3	ns	ns	ns	8	2	2	2	ns	NECWA
Fall River at Fall River Ranch Bridge	8	ns	8	8	8	8	ns	3	ns	ns	ns	8	2	2	2	ns	NECWA
Pit River at Canby Bridge	8	ns	8	8	8	8	ns	3	ns	ns	ns	8	2	2	2	ns	NECWA
Pope Creek upstream from Lake Berryessa	8	ns	8	8	8	ns	ns	ns	ns	ns	ns	8	ns	ns	ns	ns	PCWG
Capell Creek upstream from Lake Berryessa	8	ns	8	8	8	ns	ns	ns	ns	ns	ns	8	ns	ns	ns	ns	PCWG
Colusa Drain above Knight's Landing	9	ns	9	9	9	9	ns	6	6	ns	6	9	9	9	9	ns	SRWP
Sacramento Slough	9	ns	9	9	9	9	ns	6	6	ns	6	9	9	9	9	ns	SRWP

Notes: Tabled values indicate number of regular samples planned for 2006. "ns" indicates parameter is not sampled. Implementation indicates whether monitoring is implemented by the Coalition (SVWQC), Northeastern California Water Association (NECWA), Putah Creek Watershed Group (PCWG), or Sacramento River Watershed Program (SRWP)

Table 7A. Sacramento Valley Water Quality Coalition Monitoring Sites

Sacramento Valley Water Quality Monitoring Sites

Table 7A
Revised 2/24/05

Site Index	Sampling Location	Drainage Area (See WER)	Schedule	Parameters	Implementation	Priority	Miles^2 Irrig. Ag
Pit River Subwatershed							
1	Pit River at Hat Creek Confluence	Big Lake	9/03-10/05/Monthly	temperature*, flow, dissolved oxygen*, ph/electrical conductivity, turbidity, suspended sediment, nutrients*, pathogens, E. Coli, TOC, macroinvertabrates (2 times per year)	Pit River Watershed Alliance	M	50+
2	Malacha Power Plant (check map)	Bieber	9/03-10/05/Monthly	temperature*, flow, dissolved oxygen*, ph/electrical conductivity, turbidity, suspended sediment, nutrients*, pathogens, E. Coli, TOC, macroinvertabrates (2 times per year)	Pit River Watershed Alliance	M	50+
Shasta/Tehama Subwatershed							
3	Burch Creek @ Woodson Avenue Bridge	Burch Creek	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6)	SVWQC	H	25+
Colusa Basin Subwatershed							
4	Stony Creek on Hwy. 45 near Road 24	Orland and Lower Stony Creek	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, table 6)	SVWQC	H	25+
5	Colusa Drain (near Delevan Road)	Willow Creek, Upper Colusa, Bounde, Provident	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), Azinphos-methyl*, diazinon*, malathion*, methyl parathion*, carbofuran*, Group A Pesticides*	Glenn County Surface Water Stewardship Program	H	50+

6	Logan Creek	Logan Creek	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), Azinphos-methyl*, diazinon*, malathion*, methyl parathion*, carbofuran*, Group A Pesticides*	Glenn County Surface Water Stewardship Program	M	25+
7	Rough and Ready Pumping Plant (RD 108)	Sycamore	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, table 6)	SVWQC	H	50+
8	Colusa Basin Drain @ Outfall Gates	Colusa Basin	Event Based	TSS, % sand in TSS, TOC, DOC, TDS, Nitrogen and Phos., E. Coli,FC, (Tox.-Cerio and Selanstrum),OPs, Other Pests.(Benthic Inverts. And Habitat Assessment, 2 times),	SRWP	M	50+
9	Butte Creek (Gridley Road - Colusa Hwy. Bridge)	Butte Creek	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*	Glenn County Surface Water Stewardship Program	M	50+
	Placer/Nevada/South Sutter/North Sacramento Subwatershed						*Miles^2*
Site Index	***Sampling Location***	***Drainage Area (See WER)***	***Schedule***	***Parameters***	***Implementation***	***Priority***	***Irrig. Ag***
10	Coon Creek @ Striplin Road (west of Power Line Road)	Lower Coon Creek, Upper Coon Creek	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*	SVWQC	H	50+
	Butte/Yuba/Sutter Subwatershed						*Miles^2*
Site Index	***Sampling Location***	***Drainage Area (See WER)***	***Schedule***	***Parameters***	***Implementation***	***Priority***	***Irrig. Ag***
11	Butte Slough @ Pass Rd.	Butte Creek, Cherokee Canal	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*	SVWQC	H	50+
12	Wadsworth Canal @ S. Butte Road (Weir #4)	Wadsworth	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*	SVWQC	H	25+

13	Simmerly Slough	Jack Slough	Start Date: 7/04, 2x Per Month during Irrigation Season	Toxicity	Regional Board, Phase II	H	10+
14	Pine Creek at Sacramento River	Pine Creek	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*	SVWQC	M***	25+
15	Sacramento Slough	Butte, Yuba, Sutter	Event Based	TSS, % sand in TSS, TOC, DOC, TDS,Nitrogen and Phos:, E. Coli, FC, (Tox.-Cerio and Selanstrum), OPs, Other Pests., (Benthic Inverts. And Habitat Assessment, 2 times), diazinon*	SRWP	H***	50+
16	Yankee Slough at Swanson Road	Grasshopper Slough	Start Date: 7/04, 2x Per Month during Irrigation Season	Toxicity	Regional Board, Phase II	H***	10+
	Solano/Yolo Subwatershed						*Miles^2*
	Sampling Location	***Drainage Area (See WER)***	***Schedule***	***Parameters***	***Implementation***	***Priority***	***Irrig. Ag***
17	Z-Drain (Dixon RCD)	Lower Yolo	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*, chlorpyrifos*	SVWQC	L	10+
18	Toe Drain @ Northeast Corner of Little Holland	Lower Yolo	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*, chlorpyrifos*	SVWQC	H	50+
19	Tule Canal @ NE Corner of I-80	Upper Yolo	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6), diazinon*, chlorpyrifos*	SVWQC	H	50+
	Upper Feather River Watershed						*Miles^2*
	Sampling Location	***Drainage Area (See WER)***	***Schedule***	***Parameters***	***Implementation***	***Priority***	***Irrig. Ag***
20	Spanish Creek (at confluence with Greenhorn Creek)	North Fork Feather (American Valley)	Monthly (May-September); 2 Storm Events	flow, temperature, turbidity, E.Coli, pH, dissolved oxygen, conductivity, total dissolved solids, color, TOC, total suspended solids	SVWQC	M	5+

	Sampling Location	Drainage Area (See WER)	Schedule	Parameters	Implementation	Priority	Miles^2 Irrig. Ag
21	Middle Fork Feather at County Rd. A-23 (Bridge)	Middle Fork Feather	Monthly (May-September); 2 Storm Events	flow, temperature, turbidity, E.Coli, pH, dissolved oxygen, conductivity, total dissolved solids, color, TOC, total suspended solids	SVWQC	M	50+
						M	<5
22	Indian Creek (at gauging station downstream from Indian Valley)	North Fork Feather (Indian Valley)	Monthly (May-September); 2 Storm Events	flow, temperature, turbidity, E.Coli, pH, dissolved oxygen, conductivity, total dissolved solids, color, TOC, total suspended solids	SVWQC	M	5+
	Lake/Napa						Miles^2
	Sampling Location	**Drainage Area (See WER)**	**Schedule**	**Parameters**	**Implementation**	**Priority**	**Irrig. Ag**
23	McGaugh Slough at Finley Rd. East	Big Valley	3 events per year: Winter, Fall, Spring	Phase 1 Required Parameters (MRP, Table 6)	SVWQC	**	5+
24	Pope Creek (prior to confluence w/ Lake Berryessa	Pope Creek (Napa County)	Frequency: 1/1, 3/1, 5/1	Color, Turbidity, TDS, TSS, TOC, E. Coli, Temperature, DO, Conductivity, pH, Organophosphate/Carbamate Scan, Simazine, Glyphosate	Napa County Putah Creek Watershed Group	**	
25	Capell Creek (prior to confluence w/ Lake Berryessa	Putah Creek (Napa County)	Frequency: 1/1, 3/1, 5/1	Color, Turbidity, TDS, TSS, TOC, E. Coli, Temperature, DO, Conductivity, pH, Organophosphate/Carbamate Scan, Simazine, Glyphosate	Napa County Putah Creek Watershed Group	**	
	El Dorado County						Miles^2
	Sampling Location	**Drainage Area (See WER)**	**Schedule**	**Parameters**	**Implementation**	**Priority**	**Irrig. Ag**
26	North Canyon Creek	Coloma	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6)	SVWQC	**	
	Sacramento/Amador						Miles^2
	Sampling Location	**Drainage Area (See WER)**	**Schedule**	**Parameters**	**Implementation**	**Priority**	**Irrig. Ag**
27	Cosumnes River @ Twin Cities Road	Lower Cosumnes	Frequency: Irrigation Season (April - September), Monthly; Storm Season: 2 events	Phase 1 Required Parameters (MRP, Table 6)	SVWQC	H	50+

28	Big Indian Creek @ confluence w/ Cosumnes River	North Fork Cosumnes	Frequency:3 Storm Season Events	Phase 1 Required Parameters (MRP, Table 6)	Sacramento-Amador Water Quality Alliance	L	5+
	*Denotes constituent being monitored because waterbody is, or drains to, a waterbody that is on the State Water Resources Control Board 303(d) list for identified constituent.						
	** The subwatershed groups in each of these subwatersheds did proceed through prioritzation processes in order to identify monitoring sites.						
	*** Denotes site is downstream of a high priority drainage and upstream of a confluence to mainstem.						

SVWQC

January 10, 2007

Pamela Creedon, Executive Officer
California Regional Water Quality Control Board
Central Valley Region
11020 Sun Center Drive, #200
Rancho Cordova, CA 95670-6114

RE: Monitoring Program for 2007

Dear Ms. Creedon:

Enclosed is the Sacramento Valley Water Quality Coalition's Monitoring Plan for 2007, which will serve as an attachment to the Coalition's amended Monitoring and Reporting Program Plan (MRP).

Please call if you would like to discuss this further.

Sincerely yours,

David J. Guy

455 Capitol Mall, Suite 335 / Sacramento, CA 95814-4495 / Phone (916) 442-8333 / Fax (916) 442-4035
www.norcalwater.org/sacvalleycoalition.html

Monitoring Program for 2007:

Sacramento Valley Water Quality Coalition

In January 2005, the Sacramento Valley Water Quality Coalition commenced monitoring under its Monitoring and Reporting Program Plan (MRPP) and Quality Assurance Project Plan (QAPP) submitted to the Regional Water Quality Control Board, Central Valley Region (Regional Board) on April 1, 2004 and December 22, 2004 respectively. The Regional Board issued a Conditional Approval of the Coalition's MRPP on December 2, 2004.

The following document is the Coalition monitoring plan for 2007 and is provided as an attachment to the Coalition's amended MRRP. The monitoring plan for 2007 is a more aggressive approach to completing the monitoring requirements in the R5-2005-0833 MRP for monitoring intermediate drainages. This more aggressive approach is based on replacing previously monitored sites with high priority sites in intermediate size drainages, and conducting concurrent monitoring of Phase 1 and Phase 2 parameters at most new locations.

MONITORING IN 2006

Monitoring conducted in 2005 and 2006 under the Coalition's MRPP provides the basis for the monitoring proposed for 2007. This monitoring is briefly summarized in the following sections, along with the basis for changes implemented for the 2006 storm and irrigation season monitoring.

Core Monitoring Sites

The Coalition has collected samples and performed analyses at sixteen core sites throughout the watershed (Table 1). Consistent with the conditionally approved MRPP and QAPP, monitoring was generally conducted twice during the storm season (December – March), and monthly during the 2006 irrigation season (May – September).

Exceptions to the planned monitoring frequencies documented in the MRPP and QAPP in 2006 were as follows:

Burch Creek at Woodson Avenue Bridge: This site was sampled for two storm events in 2006. This site was replaced with *Burch Creek West of Rawson Road* at the beginning of irrigation season. There was inadequate flow to sample this site in July, and the site was found to be dry for the remainder of the irrigation season.

Pine Creek at Nord-Gianella Road: This site was sampled for two storm events and two irrigation events. There was inadequate flow to sample this site in July, and the site was found to be dry for the remainder of the irrigation season.

Cosumnes River at Twin Cites Road: This site was sampled for two storm events and four irrigation events. There was inadequate flow to sample this site in September, and the site was found to be dry for the remainder of the irrigation season.

Table 1. SVWQC monitoring sites, 2005-2006

Site Index	Subwatersheds	Site Location
12	ButteYubaSutter	Butte Slough at Pass Road
13	ButteYubaSutter	Wadsworth Canal at South Butte Rd
14	ButteYubaSutter	Pine Creek at Nord Gianella Road
33	ButteYubaSutter	Gilsizer Slough at George Washington Road
5	ColusaBasin	Stony Creek on Hwy 45 near Rd 24
6	ColusaBasin	Colusa Drain near Maxwell Road
7	ColusaBasin	Stone Corral Creek near Maxwell Road
8	ColusaBasin	Rough and Ready Pumping Plant (RD 108)
10	ColusaBasin	Butte Creek at Gridley Rd Bridge
25	ElDorado	North Canyon Creek
22	LakeNapa	McGaugh Slough at Finley Road East
11	PlacerNevadaSSutterNSacramento	Coon Creek at Striplin Road
26	SacramentoAmador	Cosumnes River at Twin Cities Rd
27	SacramentoAmador	Dry Creek at Alta Mesa Road
4	ShastaTehama	Burch Creek at Woodson Ave Bridge
30	ShastaTehama	Anderson Creek at Ash Creek Road
34	ShastaTehama	Burch Creek west of Rawson Rd
16	SolanoYolo	Z Drain – Dixon RCD
18	SolanoYolo	Tule Canal at I-80
29	SolanoYolo	Shag Slough at Liberty Island Bridge
32	SolanoYolo	Ulatis Creek at Brown Road
19	UpperFeatherRiver	Spanish Creek above Greenhorn Creek
20	UpperFeatherRiver	Middle Fork Feather River at County Rd A-23
21	UpperFeatherRiver	Indian Creek d/s from Indian Valley

Coordinated Monitoring

The Coalition also coordinated efforts with five other programs collecting samples in priority drainage areas throughout the Sacramento Valley. Samples were collected at the sites listed in Table 2 at the frequencies specified.

Table 2. Coordinating program monitoring sites in 2006

<table>
<tr><th>Subwatersheds</th><th>Site Location</th><th>Frequency</th><th>Agency</th></tr>
<tr><td rowspan="3">Pit River</td><td>Pit River at Pittville</td><td rowspan="3">Monthly, April through September</td><td rowspan="3">Northeastern California Water Association (NECWA)</td></tr>
<tr><td>Fall River at Fall River Ranch Bridge</td></tr>
<tr><td>Pit River at Canby Bridge</td></tr>
<tr><td rowspan="2">Lake/Napa</td><td>Pope Creek upstream from Lake Berryessa</td><td rowspan="2">Three events (2 Storm, 1 Irrigation)</td><td rowspan="2">Putah Creek Watershed Group</td></tr>
<tr><td>Capell Creek upstream from Lake Berryessa</td></tr>
<tr><td>Colusa Basin</td><td>Colusa Basin Drain above KL</td><td rowspan="2">Monthly beginning irrigation season 2006</td><td rowspan="2">Sacramento River Watershed Program</td></tr>
<tr><td>Butte/Yuba/Sutter</td><td>Sacramento Slough</td></tr>
</table>

LONG-TERM MONITORING STRATEGY

The Coalition's overall monitoring strategy as outlined in the Coalition's MRPP has been to select monitoring sites that represent the maximum percentage of high priority irrigated acreage. This strategy has resulted in rapid characterization of a large percentage of the overall irrigated acreage in the Coalition's watershed. The R5-2005-0833 MRP includes a requirement for monitoring "20% additional intermediate drainages per year", although the R5-2005-0833 MRP does not provide a definition of an intermediate drainage, or any guidance for classifying drainages by size. It was considered that implementing the Coalition's strategy would satisfy the intent of the 20% requirement, but how this would be accomplished was not explicitly addressed in the Coalition's initial MRPP. Consequently, Regional Board staff requested a list of Coalition drainages and classifications, and a long term strategy to meet the 20% requirement in the R5-2005-0833 MRP. A complete list of drainages without classifications has been provided previously to the Regional Board in response to this request. The Coalition's long term monitoring strategy is proposed herein. This monitoring plan for 2007 presents the Coalition's drainage classification method, provides the classifications for each drainage, and evaluates the progress toward the R5-2005-0833 MRP monitoring requirement.

Long-Term Strategy Overview

The Coalition's long term monitoring strategy is designed to achieve overall characterization of high and medium priority drainages in 5 years. The Coalition's strategy also somewhat anticipates changes in monitoring requirements in the revised MRP that will be released by the Regional Board late in 2006. These changes are expected to include an end to the phased monitoring approach of the current MRP, and replacement of the poorly defined requirement for 20% additional intermediate drainages per year with a more general requirement for a long term monitoring strategy to characterize agricultural drainages. Revisions to the Regional Board MRP are also expected to include numerous technical changes in monitoring requirements.

The elements that are key to achieving the Coalition's goal and satisfying the intent of the requirements of the R5-2005-0833 MRP are the Coalition's prioritization process for selecting drainages and monitoring sites, and an efficient strategy for implementing monitoring in intermediate drainages. The overall strategy for efficiently completing the required monitoring is to focus selectively on unmonitored intermediate drainages that are rated *high* or *medium* priority based on their irrigated acreage, cropping patterns, pesticide use, and their potential for contributing to cumulative impacts on receiving waters. Generally, this will be achieved by replacing sites with completed monitoring with new sites in intermediate drainages. Additionally, the Coalition will continue to monitor several integrator sites that characterize multiple smaller drainages and provide an assessment of the overall or cumulative quality of irrigated agriculture runoff. Examples of these integrator sites are Colusa Basin Drain near Knights Landing, and Shag Slough at Liberty Island Bridge.

The other aspect of efficiently completing the required monitoring is to concurrently analyze all parameters required for Phase 1 and Phase 2 of the current R5-2005-0833 MRP. This allows drainages to be characterized in a single year instead in the two years of requiring under the phased approach. All new sites will include the full suite of parameters required for the MRP, as appropriate for cropping and pesticide use patterns in each drainage. For continuing sites, a reduced set of parameters may be monitored based on previous monitoring results, with the goal of completing the Phase 2 monitoring for these sites in 2007. In cases where continued monitoring is required to evaluate effectiveness of management plans, the frequency and locations of monitoring will be established in the specific management plan and will be focused on the parameters of concern.

Updated Prioritization Method

The Coalition's initial method for prioritizing monitoring sites is described in the Coalition's MRPP. This method prioritized drainages within each subwatershed based on total irrigated acres, crop types, and pesticide use. These initial subwatershed priorities were re-evaluated for 2007 and were adjusted based on the potential for cumulative agricultural impacts downstream from each drainage. This was accomplished by calculating the cumulative percent of irrigated acreage in waters directly downstream from each drainage, and assigning a category of *Low*, *Medium*, or *High* based on equal percentiles in each category. The Coalition's initial subwatershed-based priorities (also *Low*, *Medium*, or *High*) were elevated if the potential for cumulative agricultural impacts downstream of the drainage was higher than the initial subwatershed priority, or reduced if it was lower than the subwatershed priority. As a consequence of this reevaluation, 41 drainages were elevated from *Low* to *Medium* priority, and 16 drainages were elevated from *Medium* to *High* priority. Priorities were not reduced for any *Medium* or *High* priority drainages. Drainages with less than 640 irrigated acres and previously classified as *Low* priority were considered not critical to adequately characterize irrigated agricultural lands and were excluded from further classification. Final monitoring priority adjustments are summarized in Table 3.

Table 3. Final 2007 Monitoring Priorities for drainages, adjusted for cumulative downstream irrigated acres

	Initial Subwatershed Drainage Priority				
Cumulative % Irrigated Acres Downstream of Drainage	Irrigated acres <640	Low	Med	High	Totals
Low (0 - 33.3 percentile)	Excluded	Low	Low	Med	
<0.4% Irrigated Acres	n = 79	n = 0	n = 0	n = 0	***n = 79***
Medium (33.4 - 66.6 percentile)	Excluded	Low	Med	High	
0.4 - 12.15% Irrigated Acres	n = 23	n = 47	n = 10	n = 0	***n = 80***
High (66.7 - 100 percentile)	Excluded	Med	High	High	
>12.15% Irrigated Acres	n = 1	n = 41	n = 16	n = 20	***n = 78***
Totals	***103***	***88***	***26***	***20***	***237***

Classification of Drainages

To evaluate progress toward the R5-2005-0833 MRP requirements for monitoring intermediate drainages, all individual drainages with greater than 640 irrigated acres were classified as *Large*, *Intermediate*, and *Small*. Drainages with less than 640 irrigated acres were excluded from this drainage size classification, as described above. The size classification of the remaining drainages was based on a simple percentile breakdown of the total acreage in each individual drainage: 20% *Large* drainages, 50% *Intermediate* drainages, and 30% *Small* drainages. The limits for each drainage size category are provided in Table 4. Tables of excluded drainages and classified drainages are provided in Appendix A.

Table 4. Drainage size category definitions.

	DRAINAGE SIZE CATEGORY		
	1 (SMALL)	2 (INT)	3 (LARGE)
Minimum Size, Acres	3,150	29,690	131,824
Maximum Size, Acres	29,072	131,356	1,186,577
Percent of all drainages w/ >640 irrigated acres	30%	50%	20%

Evaluation of Progress Toward Completion of Monitoring Requirements

The Coalition's current progress toward meeting the monitoring requirements of the R5-2005-0833 MRP was evaluated based on the percentage of drainages and acres monitored through 2006. The same evaluations were used to determine whether the Coalition monitoring strategy is on track to complete the required monitoring. The monitored drainages included in these assessments include all Coalition sites monitored through 2006, sites monitored by coordinating partners (SRWP, UFRW, NECWA, and PCWG), and Regional Board monitoring in Coalition watershed drainages. The evaluations of current monitoring progress through 2006 are summarized in Table 5 for all drainages and in Table 6 for *High* and *Medium* priority drainages, which are the focus of the Coalition strategy. The evaluations of projected monitoring progress through 2007 are similarly summarized in Table 7 and Table 8.

The results of these evaluations validate the effectiveness of the original Coalition monitoring strategy. The Coalition's prioritization process and monitoring strategy through 2006 has resulted in characterization of 50% of *High* and *Medium* priority drainages and 68% of *High* and *Medium* priority acreage for large and medium sized drainages with significant irrigated acreage (Table 6). This total breaks down to 44% of intermediate drainages, and 73% of large drainages in the *High* and *Medium* priorities. Although the original focus of the Coalition has been to characterize the largest percentage of irrigated acreage first, this strategy also successfully characterized a large proportion of intermediate drainages. These results demonstrate substantial progress towards completing the monitoring requirements of the R5-2005-0833 MRP.

The same analysis was applied to the projected monitoring progress at the end of 2007. After completion of this proposed monitoring plan, the Coalition and coordinating partners will have characterized of 72% of *High* and *Medium* priority drainages and 81% of *High* and *Medium* priority acreage for large and medium sized drainages with significant irrigated acreage. This total breaks down to 72% of intermediate drainages, and 73% of large drainages in the *High* and *Medium* priorities. After 2007, there will remain 11 unmonitored *High* or *Medium* priority intermediate drainages and 4 *High* or *Medium* priority large drainages. It is expected that monitoring for at least two or more of these will be completed by the Regional Board's ILP monitoring effort in the next several years. That leaves approximately 8 or 9 different unmonitored intermediate drainages to monitor in 2008 and 2009 to complete the characterization of all *High* or *Medium* priority intermediate drainages. This clearly indicates that the Coalition monitoring strategy is on track to meet the stated monitoring requirements of the R5-2005-0833 MRP, and that no drastic changes in long-term strategy are required to meet these goals.

Table 5. Monitoring in drainages with >640 irrigated acres through 2006

	DRAINAGE SIZE CATEGORY			
	1 (SMALL)	2 (INT)	3 (LARGE)	*Totals for drainages with >640 Irrigated Acres*
Sum of Individual Drainages, Acres	594,042	4,543,921	7,352,028	12,489,992
Total Number of Drainages	40	67	27	134
Percent of Drainages	30%	50%	20%	100%
Number of Drainages Monitored	3	20	12	35
Sum of Acres Monitored	41,374	1,417,649	4,164,093	5,623,116
Percent of Drainages Monitored	**8%**	**30%**	**44%**	**26%**
Percent of Acres Monitored	**7%**	**31%**	**57%**	**45%**

Table 6. Monitoring in High and Medium priority drainages through 2006

	DRAINAGE SIZE CATEGORY				
	1 (SMALL)	2 (INT)	3 (LARGE)	*Total for All High and Medium Priority Drainages*	*Total for Lg and Int, High and Med Priority Drainages*
Total Number of High or Medium Priority Drainages	34	39	15	88	54
Sum of Individual Drainages, Acres	451,328	2,633,096	4,867,618	7,952,041	7,500,713
Number of Drainages Monitored	3	16	11	30	27
Sum of Acres Monitored	41,374	1,151,564	3,950,319	5,143,257	5,101,883
Percent of Drainages Monitored	**9%**	**41%**	**73%**	**34%**	**50%**
Percent of Acres Monitored	**9%**	**44%**	**81%**	**65%**	**68%**

Table 7. Monitoring in drainages with >640 irrigated acres, estimated for 2007

	DRAINAGE SIZE CATEGORY			
	1 (SMALL)	2 (INT)	3 (LARGE)	Totals for all drainages with >640 Irrigated Acres
Sum of Individual Drainages, Acres	594,042	4,543,921	7,352,028	12,489,992
Total Number of Drainages	40	67	27	134
Percent of Drainages	30%	50%	20%	100%
Number of Drainages Monitored	3	34	12	49
Sum of Acres Monitored[1]	41,374	2,551,649	4,164,093	6,757,116
Percent of Drainages Monitored	**8%**	**51%**	**44%**	**37%**
Percent of Acres Monitored	**7%**	**56%**	**57%**	**54%**

(1) Based on average intermediate drainage of 81,000 acres

Table 8. Monitoring in High and Medium priority drainages, estimated for 2007

	DRAINAGE SIZE CATEGORY				
	1 (SMALL)	2 (INT)	3 (LARGE)	Total for High and Medium Priority Drainages	Total for Lg and Int, High and Med Priority

					Drainages
Total Number of High or Medium Priority Drainages	34	39	15	88	54
Sum of Individual Drainages, Acres	451,328	2,633,096	4,867,618	7,952,041	7,500,713
Number of Drainages Monitored	3	28	11	42	39
Est'd Sum of Acres Monitored(1)	41,374	2,123,564	3,950,319	6,115,257	6,073,883
Percent of Drainages Monitored	**9%**	**72%**	**73%**	**48%**	**72%**
Est'd Percent of Acres Monitored	**9%**	**81%**	**81%**	**77%**	**81%**

(1) Based on average intermediate drainage of 81,000 acres

RECOMMENDED MONITORING FOR 2007

The Coalition is submitting the following MRPP proposal for 2007. Thirteen new monitoring locations in unmonitored drainages will replace sites monitored in 2006 with completed Phase 2 monitoring. Candidate drainages for new monitoring locations were selected based on overall monitoring priorities and an increased focus on maximizing the number of *Intermediate* size drainages in 2007 to meet the requirements of the R5-2005-0833 MRP. The basis for making these monitoring recommendations for sites monitored in 2006 are provided in Table 9.

Table 9. Monitoring Recommendations for Sites Monitored by SVWQC in 2006

Subwatershed	Site	2007 Action and Rationale
ButteYubaSutter	Butte Slough at Pass Road	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. Two years of monitoring completed. No exceedances of objectives in 2006.
ButteYubaSutter	Gilsizer Slough at George Washington Road	Continue Phase 2 monitoring. Discontinue aquatic toxicity (no toxicity in 2006).
ButteYubaSutter	Pine Creek at Nord Gianella Road	Continue with selected analytes to support documentation of management practice effectiveness. 2 years of monitoring completed. No exceedances of objectives for Phase 2 parameters in 2006. *E. coli* exceedances addressed through regional Mgt Plan.
ButteYubaSutter	Wadsworth Canal at South Butte Rd	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No exceedances of objectives for Phase 2 parameters in 2006. *E. coli* exceedances addressed by regional Mgt Plan.
ColusaBasin	Butte Creek at Gridley Rd Bridge	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No toxicity or exceedances of Phase 2 parameters. *E. coli* exceedances addressed by regional Mgt Plan.
ColusaBasin	Colusa Drain near Maxwell Road	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No toxicity or exceedances of Phase 2 parameters. *E. coli* exceedances addressed by regional Mgt Plan.
ColusaBasin	Rough and Ready Pumping Plant (RD 108)	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No toxicity or exceedances of Phase 2 parameters except DDE (n=2) in 2006. *E. coli*, TDS, and EC exceedances addressed by regional Mgt Plans.
ColusaBasin	Stone Corral Creek near Maxwell Road	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No toxicity or exceedances of Phase 2 parameters in 2006. *E. coli* exceedances addressed by regional Mgt Plan. Single EC/TDS exceedance.
ColusaBasin	Stony Creek on Hwy 45 near Rd 24	Continue Aquatic toxicity, OP and triazine pesticides through 2007 Storm Season to address single simazine and diazinon exceedances observed in 2006. *E. coli* exceedances addressed by regional Mgt Plan. 2 years of monitoring completed.
ElDorado	North Canyon Creek	Continue monitoring for selected parameters at the North Canyon site for up to four sample events. No toxicity in 2006. Single DDE exceedance in 2006. No other Phase 2 exceedances in 2006. Add new site in LOW priority intermediate drainage (no other HIGH or MED priority drainages in subwatershed).

Subwatershed	Site	2007 Action and Rationale
LakeNapa	McGaugh Slough at Finley Road East	Exchange for new site at same frequency. 2 years of monitoring completed. No exceedances of Phase 2 parameters in 2006. *E. coli* exceedance(s) addressed through regional Mgt Plan.
Pit River	Pit River at Pittville Pit River Canby Fall River at River Ranch Bridge	Continue all three sites in 2007;
Placer-Nevada-SSutter-NSacramento	Coon Creek at Striplin Road	Exchange for new site in *MED* priority intermediate drainage. There are no other unmonitored *HIGH* priority drainages in subwatershed. 2 years of monitoring completed. No exceedances of Phase 2 parameters in 2006. *E. coli* exceedance(s) addressed through regional Mgt Plan. Minor DO exceedance in 2006.
Sacramento-Amador	Cosumnes River at Twin Cities Rd	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No exceedances or toxicity in 2006.
Sacramento-Amador	Dry Creek at Alta Mesa Road	Implement Phase 2 monitoring. Continue Ceriodaphnia through storm season only (toxicity observed in 2006 Storm season). Discontinue Ceriodaphnia beginning irrigation season (no toxicity observed in 2006 Irr.Season).
Shasta-Tehama	Anderson Creek at Ash Creek Road	Continue Phase 2 monitoring. Discontinue toxicity testing (no significant toxicity observed in 2006). No exceedances of Phase 2 parameters in 2006. *E. coli* exceedance(s) addressed through regional Mgt Plan.
Shasta-Tehama	Burch Creek at Rawson Road	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No toxicity or chemical exceedances observed at Rawson Road location.
SolanoYolo	Shag Slough at Liberty Island Bridge	Continue monitoring as long-term integrator site. Include aquatic and sediment toxicity, 303d parameters for Delta (OP pesticides in water, OC and pyrethroids in sediment) and trace metals with exceedances or active management plan (boron only).
SolanoYolo	Tule Canal at I-80	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. >2 years of monitoring completed. No exceedances of objectives for Phase 2 parameters except boron. Exceedances of E. coli, EC, TDS, and boron addressed through regional Mgt Plan.
SolanoYolo	Ulatis Creek at Brown Road	Continue with Phase 2 monitoring. Continue detected pesticides and add remaining Phase 2 parameters. Continue Ceriodaphnia through Storm Season to address chlorpyrifos and diazinon exceedances. Continue Selenastrum through storm season to address Selenastrum toxicity observed in Storm Season 2006.
SolanoYolo	Z Drain - Dixon RCD	Exchange for new site in *HIGH* or *MED* priority intermediate drainage. 2 years of monitoring completed. No toxicity in 2006. No exceedances of objectives for Phase 2 parameters except selenium (1 exceedance, no downstream or regional selenium problems) and boron. Exceedances of E. coli, EC, TDS, and boron addressed through regional Mgt Plan.
UpperFeatherRiver	Indian Creek at Arlington Bridge	Continued Phase 2 monitoring by UFRW. No toxicity observed in 2006, no pesticides monitored unless toxicity observed. Implement sediment toxicity testing in 2007.
UpperFeatherRiver	Middle Fork Feather River at County Rd A-23	Continued Phase 2 monitoring by UFRW. No toxicity observed in 2006, no pesticides monitored unless toxicity observed. Implement sediment toxicity testing in 2007.
UpperFeatherRiver	Spanish Creek below confluence with Greenhorn Creek	Continued Phase 2 monitoring by UFRW. No toxicity observed in 2006, no pesticides monitored unless toxicity observed. Implement sediment toxicity testing in 2007.

New Monitoring Drainages and Sites

The Coalition is proposing to move to thirteen new monitoring sites in unmonitored drainages at which concurrent Phase 1 and Phase 2 testing (water column and sediment toxicity, drinking water constituents, pesticides, nutrients, trace metals, and general physical parameters) will commence in Storm Season 2007 and continue throughout the 2007 irrigation season. Sites in these new drainages will be selected in coordination with the Coalition's subwatershed representatives in October, 2006. New drainages were inititally selected from the list of highest priority drainages in each subwatershed that have not yet been monitored by the Coalition (Table 10). Additional sites were also considered based on coordination with planned management practice studies. Specific monitoring sites selected for 2007 monitoring are listed in Table 11. A summary of monitoring planned by the Coalition and coordinating partners is provided in Table 12.

Table 10. Candidate Drainages for New Monitoring Sites in 2007

Subwatershed	# of Replacement Sites	Candidate Drainages	Monitoring Priority	Drainage Size Category
Butte-Sutter-Yuba	3	Cherokee Canal	1 HIGH	Large
		Grasshopper Slough	1 HIGH	Intermediate
		Jack Slough	1 HIGH	Intermediate
		Lower Honcut Creek	2 MED	Intermediate
		Lower Oroville	2 MED	Intermediate
		Lower Snake	1 HIGH	Small
		RD 1500	1 HIGH	Intermediate
Colusa Basin	4	Buckeye Creek	2 MED	Intermediate
		Freshwater Creek	2 MED	Intermediate
		Logan Creek	1 HIGH	Intermediate
		Lurline Creek	2 MED	Intermediate
		Orland Area	1 HIGH	Intermediate
		Sand Creek - Colusa	1 HIGH	Intermediate
		Willow Creek	1 HIGH	Large
El Dorado	1	Middle Fork Cosumnes River	3 LOW	Intermediate
Lake-Napa	1	Lower Lake	3 LOW	Intermediate
		Upper Lake	3 LOW	Intermediate
Placer N Sac	1	Coon Creek - Auburn	2 MED	Intermediate
		Middle Coon Creek	2 MED	Intermediate
		Pleasant Grove Creek	2 MED	Intermediate
Sac-Amador	1	Elder Creek - Sacramento	1 HIGH	Large
		Middle Cosumnes	1 HIGH	Intermediate
		Sacramento Delta	1 HIGH	Intermediate
Shasta-Tehama	1	Cow Creek	2 MED	Large
		Coyote Creek	2 MED	Intermediate
		Elder Creek	2 MED	Intermediate
		Salt Creek	1 HIGH	Intermediate
Solano-Yolo	2	Cache Creek	1 HIGH	Intermediate
		Putah Creek South	2 MED	Intermediate
		Willow Slough	1 HIGH	Intermediate
Grand Total	14			

Table 11. Coalition Monitoring Sites, 2007

Subwatershed	Site Name	Latitude	Longitude	Implementation	Map Index
ButteYubaSutter	Pine Creek at Nord Gianella Road	39.7811	-121.9877	SVWQC	14
	Sacramento Slough	38.7833	-121.6338	SRWP	15
	Gilsizer Slough at George Washington Road	39.0090	-121.6716	SVWQC	33
	Grasshopper Slough at Forty Mile Road	38.9960	-121.4910	SVWQC	39
	Lower Snake R. at Nuestro Rd	39.1852	-121.7035	SVWQC	40
ColusaBasin	Stony Creek on Hwy 45 near Rd 24	39.7101	-122.0040	SVWQC	5
	Colusa Basin Drain above KL	38.8121	-121.7741	SRWP	9
	Freshwater Creek at Gibson Rd	39.1766	-122.1891	SVWQC	41
	Logan Creek at 4 Mile-Excelsior Rd	39.3652	-122.1160	SVWQC	42
	Lurline Creek at Lurline Rd	39.2181	-122.1433	SVWQC	43
	Walker Creek at Co Rd 48	39.5389	-122.1762	SVWQC	44
ElDorado	North Canyon Creek	38.7604	-120.7102	SVWQC	25
	NEW SITE TBD	TBD	TBD	SVWQC	45
LakeNapa	Pope Creek upstream from Lake Berryessa	38.6464	-122.3642	PCWG	23
	Capell Creek u/s from Lake Berryessa	38.4825	-122.2411	PCWG	24
	Middle Creek u/s from Highway 20	39.1635	-122.9161	SVWQC	38
PitRiver	Pit River at Pittville	41.0454	-121.3317	NECWA	1
	Fall River at Fall River Ranch Bridge[2]	41.0351	-121.4864	NECWA	2
	Pit River at Canby Bridge[2]	41.4017	-120.9310	NECWA	3
Placer-Nevada-SSutter-NSac.	Coon Creek at Brewer Road	38.9341	-121.4518	SVWQC	46
SacramentoAmador	Dry Creek at Alta Mesa Road	38.2480	-121.2260	SVWQC	27
	Laguna Creek at McKenzie	38.3122	-121.3013	SVWQC	47
ShastaTehama	Anderson Creek at Ash Creek Road	40.4180	-122.2136	SVWQC	30
	Coyote Creek at Tyler Road	40.0925	-122.1588	SVWQC	48
SolanoYolo	Willow Slough Bypass at SP	38.5994	-121.7528	SVWQC	49
	Cache Cr. at Diversion Dam	38.7137	-122.0851	SVWQC	50
	Shag Slough at Liberty Island Bridge	38.3068	-121.6934	SVWQC	29
	Ulatis Creek at Brown Road	38.3070	-121.7940	SVWQC	32
UpperFeatherRiver	Middle Fork Feather River at County Rd A-23	39.8189	-120.3918	UFRW	20
	Indian Creek at Arlington Bridge	40.0846	-120.9161	UFRW	36
	Spanish Creek below Greenhorn Creek	39.9735	-120.9103	UFRW	37

Table 12. Coalition Monitoring Summary: Planned Samples in 2007

				Physical, Chemical, and Microbiological											Toxicity			
Subwatershed	Location	Water Column Sample Events	Sediment Sample Events	pH, conductivity, DO, temperature, Q	Color, Turbidity, TDS, TSS, TOC	Nutrients	Trace metals	Organophosphate pesticides	Triazines	Organonochlorines	Pyrethroids in toxic sediments	Glyphosate, Paraquat	Carbamate and Urea Pesticides	Pathogen Indicators: *E. Coli*	Ceriodaphnia, 96-h acute	Selenastrum, 96-h short-term chronic	Hyalella, 10-day short-term chronic	Implementation
Butte-Sutter-Yuba	Grasshopper Sl. at confluence	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Lower Snake R. at Nuestro Rd	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Pine Creek at Nord Gianelli Rd	8	2	8	8	8	ns	8	ns	ns	2	ns	ns	ns	8	ns	2	SVWQC
	Gilsizer Sl. at G. Washington Rd	8	ns	8	8	8	8	8	8	8	ns	8	8	8	ns	ns	ns	SVWQC
	Sacramento Slough	7	ns	7	7	7	ns	7	7	ns	ns	ns	5	7	7	7	ns	SRWP
Colusa Basin	Freshwater Creek at Gibson Rd	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Logan Creek at 4 Mile Rd	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Lurline Creek at Lurline Rd	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Walker Creek u/s confluence	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Stony Cr. on Hwy 45 near Rd 24	2	ns	2	2	2	2	2	2	ns	ns	ns	ns	ns	2	ns	ns	SVWQC
	Colusa Drain above KL	7	ns	7	7	7	ns	7	5	ns	ns	ns	5	7	7	7	ns	SRWP
El Dorado	North Canyon Creek	4	ns	2	4	ns	ns	4	ns	4	ns	ns	ns	4	ns	ns	ns	SVWQC
	NEW SITE TBD	8	2	8	8	8	8	8	ns	8	2	ns	ns	8	8	8	2	SVWQC
Lake-Napa	Middle Creek u/s Hwy 20	3	2	3	3	3	3	3	3	3	2	ns	ns	3	3	3	2	Lake Co.
	Pope Cr u/s from L. Berryessa	3	ns	3	3	ns	ns	ns	ns	ns	ns	ns	ns	3	ns	ns	ns	PCWG
	Capell Cr u/s from L. Berryessa	3	ns	3	3	ns	ns	ns	ns	ns	ns	ns	ns	3	ns	ns	ns	PCWG
Pit River	Pit River at Pittville	8	ns	8	8	8	ns	ns	ns	ns	ns	ns	ns	8	ns	ns	ns	NECWA
	Fall R. at Fall R. Ranch Bridge	8	ns	8	8	8	ns	ns	ns	ns	ns	ns	ns	8	ns	ns	ns	NECWA
	Pit River at Canby Bridge	8	ns	8	8	8	ns	ns	ns	ns	ns	ns	ns	8	ns	ns	ns	NECWA
Placer-NSac-Nev-SSutter	Coon Creek at Brewer Rd	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
Sac-Amador	Laguna Creek at Alta Mesa Rd	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Dry Creek at Alta Mesa Road	8	ns	8	8	8	8	8	8	8	ns	8	8	8	2	ns	ns	SVWQC
Shasta-Tehama	Coyote Creek at Tyler Rd	8	2	8	8	8	8	8	ns	ns	2	ns	8	8	8	8	2	SVWQC
	Anderson Cr. at Ash Creek Rd	8	ns	8	8	ns	8	ns	ns	ns	ns	ns	ns	2	ns	ns	ns	SVWQC
Solano-Yolo	Willow Slough Bypass at SP	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Cache Cr. at Diversion Dam	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
	Ulatis Creek at Brown Road	8	ns	8	8	8	8	8	8	8	ns	8	8	8	2	2	ns	SVWQC
	Shag Sl. at Liberty Island Bridge	8	2	8	8	8	8	8	8	8	2	8	8	8	8	8	2	SVWQC
Upper Feather	Spanish Cr. below Greenhorn Cr	7	2	7	7	7	7	7	ns	ns	ns	ns	ns	7	7	7	2	UFRW
	Indian Creek at Arlington Bridge	7	2	7	7	7	7	7	ns	ns	ns	ns	ns	7	7	7	2	UFRW
	Middle Fk Feather R. @.Rd A-23	7	2	7	7	7	7	7	ns	ns	ns	ns	ns	7	7	7	2	UFRW

Notes: Tabled values indicate number of regular samples planned for 2007. “ns” indicates parameters are not sampled. Implementation indicates whether monitoring is conducted by the Coalition (SVWQC), Northeastern California Water Association (NECWA), Lake County, Putah Creek Watershed Group (PCWG), Upper Feather River Watershed group (UFRW) or Sacramento River Watershed Program (SRWP).

Appendix G
Sacramento Valley Water Quality Coalition Monitoring and Reporting Program Plan Semi-Annual Irrigation Season Monitoring Report 2006

D E C E M B E R 3 1 , 2 0 0 6

S A C R A M E N T O V A L L E Y W A T E R
Q U A L I T Y C O A L I T I O N

Monitoring and Reporting Program Plan

Semi-Annual Irrigation Season Monitoring Report 2006

prepared by

LARRY WALKER ASSOCIATES

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Introduction

The primary purpose of this report is to document the monitoring efforts and results of the Sacramento Valley Water Quality Coalition (Coalition) Monitoring and Reporting Program Plan (MRPP). This Semi-Annual Monitoring Report also serves to document the Coalition's progress toward fulfilling the requirements of the *Conditional Waiver for Irrigated Lands* (hereinafter abbreviated as *ILP* for *Irrigated Lands Program*) and subsequent amendments to the *ILP* requirements (WQO-2004-0003, SWRCB 2004, RB 2005-0833).

The Semi-Annual Report includes the following elements, as specified in the *ILP*:

- A description of the watershed
- A summary of monitoring objectives
- Descriptions of sampling site locations and characteristics
- A summary of the sampling and analytical methods used
- All monitoring results, including field logs, laboratory reports, and Chains-of-Custody,
- An evaluation of pesticide use information
- Interpretation of the monitoring results reported
- Evaluation of management practices in the Coalition watershed
- Actions taken to address exceedances observed in monitoring
- Conclusions and recommendations of the Annual Report

All report elements required by the *ILP* or subsequently requested by the California Regional Water Quality Control Board, Central Valley Region (Water Board) are included in this annual report.

Description of the Watershed

The Sacramento River watershed drains over 27,000 square miles of land in the northern part of California's Central Valley into the Sacramento River. The upper watersheds of the Sacramento River region include the Pit River watershed above Lake Shasta and the Feather River above Lake Oroville. The Sacramento Valley drainages include the Colusa, Cache Creek, and Yolo Bypass watersheds on the west side of the valley, and the Feather, and American River watersheds on the east side of the valley. Additionally, the Coalition monitors in the Cosumnes River watershed, which isn't part of the Sacramento river watershed. Beginning near the town of Red Bluff at its northern terminus, the Sacramento Valley stretches about 150 miles to the southeast where it merges into the Sacramento-San Joaquin River Delta south of the Sacramento metropolitan area. The valley is 30 to 45 miles wide in the southern to central parts but narrows to about 5 miles near Red Bluff. Its elevation decreases from 300 feet at its northern end to near sea level in the Delta.

The Sacramento River Basin is a unique mosaic of farm lands, refuges and managed wetlands for waterfowl habitat, spawning grounds for numerous salmon and steelhead trout, and the cities and rural communities that make up this region. This natural and working landscape between the crests of the Sierra Nevada and the Coast Range includes:

- More than a million acres of family farms that provide the economic engine for the region provides a working landscape and pastoral setting and serves as valuable habitat for waterfowl along the Pacific Flyway. The predominant crops include: rice, general grain and hay, improved pasture, corn, tomatoes, alfalfa, almonds, walnuts, prunes, safflower, and vineyards.
- Habitat for 50% of the threatened and endangered species in California, including the winter-run and spring-run salmon, steelhead, and many other fish species.
- Six National Wildlife Refuges, more than fifty state Wildlife Areas and other privately managed wetlands that support the annual migration of waterfowl, geese, and waterbirds in the Pacific Flyway. These seasonal and permanent wetlands provide for 65% of the North American Waterfowl Management Plan objectives.
- The small towns and rural communities that form the backbone of the region, as well as the State Capital that serves as the center of government for the State of California.
- The forests and meadows in the numerous watersheds of the Sierra Nevada and Coast Range.

Monitoring Objectives

The Coalition MRPP will achieve the following objectives as a condition of the *ILP*:

1. Assess the impacts of waste discharges from irrigated lands to surface waters;
2. Determine the degree of implementation of management practices to reduce discharge of specific wastes that impact water quality;
3. Determine the effectiveness of management practices and strategies to reduce discharge of wastes that impact water quality;
4. Determine concentration and load of wastes in these discharges to surface waters; and
5. Evaluate compliance with existing narrative and/or numeric water quality objectives to determine if additional implementation of management practices is necessary to improve and/or protect water quality.

The Coalition is achieving these objectives by implementing a phased monitoring and reporting program plan that initially evaluates samples for the presence of statistically significant toxicity of sufficient magnitude in original analysis to trigger follow-up actions designed to identify constituents causing toxicity. Also, the Coalition is evaluating samples for violations of applicable numeric water quality objectives to trigger follow-up actions. Additionally, the Coalition is evaluating the degree of current management practices implementation in priority watersheds and recommending specific practices as water quality results indicate a need to do so. The Coalition is committed to the principle of adaptive management to control specific discharges of waste that are having an impact on water quality. This iterative approach allows for the most effective use of scarce human and fiscal resources.

The parameters monitored by the Coalition to achieve these objectives are as specified in the *ILP* and in subsequent amendments to the *ILP* requirements (WQO-2004-0003, SWRCB 2004). The following environmental monitoring elements are included in the Phases 1-3 of the Coalition MRPP:

- Water column and sediment toxicity
- Physical and conventional parameters in water and sediment
- Organic carbon and ultraviolet absorbance in water
- Pathogen indicator organisms in water
- Trace metals in water and sediment
- Pesticides in water and sediment
- Nitrogen and phosphorus compounds in water

Note that not all parameters are monitored during every phase of monitoring. Specific individual parameters to be measured and the relevant Phases of the Coalition monitoring effort are listed in Table 1. Note that this list is consistent with the *ILP* in effect when the Coalition monitoring program was implemented in January 2005. It is expected that this list will be modified at least annually as the Water Board continues to revise requirements of the *ILP*.

Table 1. Constituents to be Monitored for Phases 1–3 of Monitoring

	Quantitation Limit (in Water)	Reporting Unit	Monitoring Phases
Physical Parameters			
Flow	NA	CFS (ft^3/Sec)	Phase 1, 2 & 3
pH	0.1 [(a)]	-log[H^+]	Phase 1, 2 & 3
Conductivity	0.1 [(a)]	μmhos/cm	Phase 1, 2 & 3
Dissolved Oxygen	0.1 [(a)]	mg/L	Phase 1, 2 & 3
Temperature	0.1 [(a)]	˚C	Phase 1, 2 & 3
Color	NA	Chloroplatinate Units (CU)	Phase 1, 2 & 3
Hardness, total as $CaCO_3$	10	mg/L	Phase 2
Turbidity	1.0	NTU	Phase 1, 2 & 3
Total Dissolved Solids	3.0	mg/L	Phase 1, 2 & 3
Total Suspended Solids	3.0	mg/L	Phase 1, 2 & 3
Total Organic Carbon	0.5	mg/L	Phase 1, 2 & 3
Pathogen Indicators			
E. Coli bacteria	2	MPN/100 mL	Phase 1
Water Column and Sediment Toxicity			
Ceriodaphnia, 96-h acute	NA	% Mortality	Phase 1
Pimephales, 96-h acute	NA	% Mortality	Phase 1
Selenastrum, 96-h short-term chronic	NA	Cell Growth	Phase 1
Hyalella, 10-day short-term chronic	NA	% Mortality	Phase 1
Pesticides			
Carbamates	(b)	ug/L	Phase 2 [(c)]
Organochlorines	(b)	ug/L	Phase 2 [(c)]
Organophosphorus	(b)	ug/L	Phase 2 [(c)]
Pyrethroids	(b)	ug/L	Phase 2 [(c)]
Herbicides	(b)	ug/L	Phase 2 [(c)]
Trace Elements			
Arsenic	0.5	ug/L	Phase 2 [(c)]
Boron	10	ug/L	Phase 2 [(c)]
Cadmium	0.1	ug/L	Phase 2 [(c)]
Copper	0.5	ug/L	Phase 2 [(c)]
Lead	0.25	ug/L	Phase 2 [(c)]
Nickel	0.5	ug/L	Phase 2 [(c)]
Selenium	1.0	ug/L	Phase 2 [(c)]
Zinc	1.0	ug/L	Phase 2 [(c)]
Nutrients			
Total Kjeldahl Nitrogen	0.1	mg/L	Phase 2 [(c)]
Phosphorus, total	0.1	mg/L	Phase 2 [(c)]
Soluble Orthophosphate	0.01	mg/L	Phase 2 [(c)]
Nitrate as N	0.1	mg/L	Phase 2 [(c)]
Nitrite as N	0.03	mg/L	Phase 2 [(c)]
Ammonia as N	0.1	mg/L	Phase 2 [(c)]

(a) Detection and reporting limits are not strictly defined. Tabled value indicates required reporting precision.

(b) Limits are different for individual pesticides.

(c) Some Phase 2 monitoring may be conducted concurrently with Phase 1. Pesticides, trace elements, or nutrients suspected of causing toxicity or of causing exceedances of relevant water quality objectives may also be monitored in Phase 3.

Sampling Site Descriptions

To successfully implement the monitoring and reporting program requirements contained in the *ILP* adopted by the Water Board in June 2003, the Coalition worked directly with landowners in the twenty-one county watershed to identify and develop ten subwatershed groups. Representatives from each subwatershed group utilized agronomic and hydrologic data generated by the Coalition in an attempt to prioritize watershed areas for initial evaluation to ultimately select monitoring sites in their respective areas based upon existing infrastructure, historical monitoring data, land-use patterns, historical pesticide use, and the presence of 303(d)-listed water bodies.

Coalition members selected sampling sites in priority watersheds based upon the following fundamental assumptions regarding management of non-point source discharges to surface water bodies: 1) Landscape scale sampling at the bottom of drainage areas allows for determinations regarding the presence of a water quality problems using a variety of analytical methods including water column and sediment toxicity testing as well water chemistry analyses and bioassessment; 2) Strategic source investigations utilizing Geographic Information Systems can be used to identify upstream parcels with attributes that may be related to the analytical results, including crops, pesticide applications, and soil type; and 3) Though recognizably complex, management practice effectiveness can best be assessed by coalitions at the watershed scale to determine compliance with water quality objectives in designated water bodies. Farm-level management practices evaluations can complement Coalition efforts on the watershed scale by providing crop-specific research results that then can support management practice recommendations.

SAMPLING SITE LOCATIONS AND LAND USES

The sites monitored by the Coalition in 2006 are listed in Table 2. All of the sites have been approved by the Water Board as full *ILP* Compliance Sites. An overall map of Coalition and subwatershed sites is presented in Figure 1. Site-specific drainage maps with land use patterns for all monitoring locations are also provided in Appendix F.

Table 2. Status of Coalition Monitoring Sites

Map[1] Index	Status[2]	Drainages	Site Name	Lat	Long
1	Approved	Big Lake, Fall River Valley	Pit River at Pittville	41.0454	-121.3317
2	Approved	Fall River Valley	Fall River at Fall River Ranch Bridge	41.0351	-121.4864
3	Approved	Big Lake, Fall River Valley	Pit River at Canby Bridge	41.4017	-120.9310
4	Approved	Burch Creek	Burch Creek at Woodson Ave Bridge	39.9053	-122.1837
5	Approved	Orland & Lower Stony Creek	Stony Creek on Hwy 45 near Rd 24	39.7101	-122.0040
6	Approved	Colusa Basin	Colusa Drain near Maxwell Road	39.2756	-122.0862
7	Approved	Colusa Basin	Stone Corral Creek near Maxwell Road	39.2751	-122.1043
8	Approved	Sycamore Area Drainage	Rough and Ready Pumping Plant	38.8621	-121.7927
9	Approved	Colusa Basin	Colusa Basin Drain above Knight's Landing[3]	38.8121	-121.7741
10	Approved	Butte Creek	Butte Creek at Gridley Rd Bridge	39.3619	-121.8927
11	Approved	Lower Coon Creek, Upper Coon Creek	Coon Creek at Striplin Road	38.8661	-121.5803
12	Approved	Butte Creek, Cherokee Canal	Butte Slough at Pass Road	39.1873	-121.9085
13	Approved	Wadsworth	Wadsworth Canal at South Butte Rd	39.1534	-121.7344
14	Approved	Pine Creek	Pine Creek at Nord-Gianella Road	39.7811	-121.9877
15	Approved	Butte/Yuba/Sutter	Sacramento Slough[3]	38.7833	-121.6338
16	Approved	Lower Yolo	Z Drain – Dixon RCD	38.4157	-121.6752
18	Approved	Upper Yolo	Tule Canal at I-80	38.5700	-121.5800
19	Approved	N. Fk. Feather River (American Valley)	Spanish Cr. above confluence with Greenhorn Cr.	39.9678	-120.9164
20	Approved	Middle Fork Feather Plumas	Middle Fork Feather River at County Road A-23	39.8189	-120.3918
21	Approved	North Fork Feather (Indian Valley)	Indian Creek downstream from Indian Valley	40.0507	-120.9741
22	Approved	Big Valley	McGaugh Slough at Finley Road East	39.0042	-122.8623
23	Approved	Putah Creek (Napa County)	Pope Creek upstream from Lake Berryessa	38.6464	-122.3642
24	Approved	Putah Creek (Napa County)	Capell Creek upstream from Lake Berryessa	38.4825	-122.2411
25	Approved	Coloma	North Canyon Creek	38.7604	-120.7102
26	Approved	Lower Cosumnes	Cosumnes River at Twin Cities Rd	38.2910	-121.3804
27	Approved	Lower Cosumnes	Dry Creek at Alta Mesa Road[4]	38.248	-121.226
28	Approved	North Fork Cosumnes	Big Indian Creek at Bridge	38.5498	-120.8478
29	Approved	Lower Yolo	Shag Slough at Liberty Island Bridge	38.3068	-121.6934
30	Approved	Shasta County	Anderson Creek at Ash Creek Road[4]	40.4180	-122.2136
32	Approved	Ulatis Creek	Ulatis Creek at Brown Road[4]	38.3070	-121.7940
33	Approved	Gilsizer Slough	Gilsizer Slough at G. Washington Rd[4]	39.0090	-121.6716
34	Approved	Burch Creek	Burch Creek west of Rawson Rd[4]	39.9254	-122.2182
36	Approved	N. Fk. Feather (Indian Valley)	Indian Creek at Arlington Bridge	40.0846	-120.9161
37	Approved	N. Fk. Feather R. (American Valley)	Spanish Cr. below confluence with Greenhorn Cr.	39.9735	-120.9103

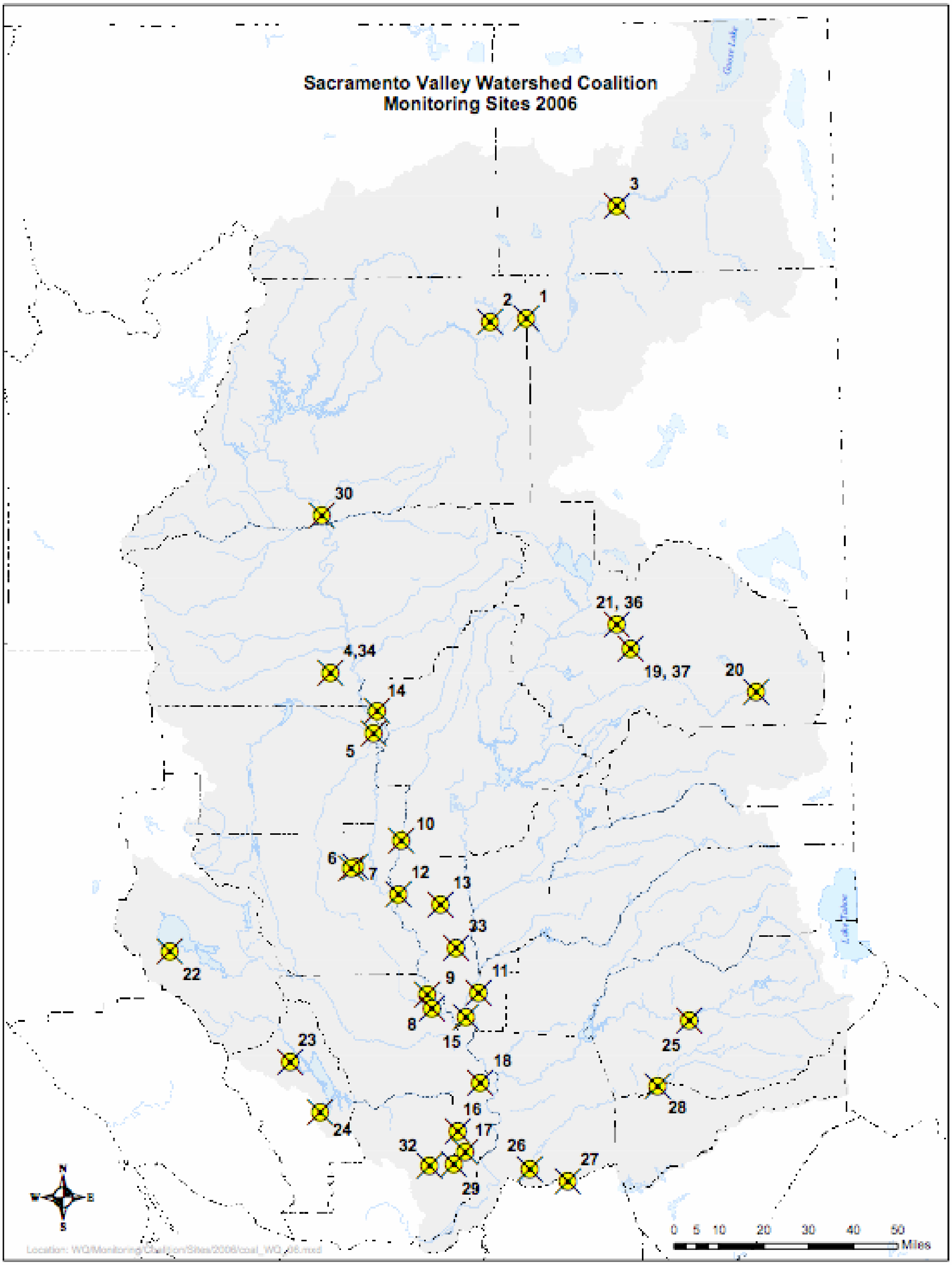
(1) Numbered indices for the SVWQC monitoring site map (Figure 1)

(2) "Approved" indicates site was approved as an *ILP* Compliance Site by Water Board.
"Pending" indicates site approval as an *ILP* Compliance Site is pending Water Board review of additional site-specific information, additional pesticide monitoring, or implementation of toxicity special studies.

(3) Coordinated with the Sacramento River Watershed Monitoring Program (SRWP). This site was not monitored in Winter 2006 by the SRWP.

(4) These are new sites implemented in 2006.

Figure 1. Coalition Monitoring Sites



SITE DESCRIPTIONS

Pit River Subwatershed

Pit River at Pittville Bridge

This site captures a portion of the Big Lake drainage. This site captures drainage from the primary land-use, native pasture, as well as alfalfa, oat hay, grain and duck marsh, ultimately incorporating approximately 9,000 acres in the Fall River Valley.

Fall River at Fall River Ranch Bridge

This site is located at the lower end of Fall River before the river is partially diverted for hydroelectric uses at the Pit 1 Power House. The majority of Fall River water is spring-fed water that emerges in the northern portions of the valley (e.g., Lava Creek Springs, Spring Creek Springs, Crystal Springs, Mallard Springs, Big Lake Springs, Thousand Springs, Hideaway Spring, Rainbow Spring). These springs form the Little Tule River, Tule River, Spring Creek, Lava Creek, Mallard Creek, and Ja She Creek. One major tributary to Fall River, Bear Creek, captures flow mostly from private timberland comprising approximately 27 square miles of watershed. Bear Creek joins the Fall River near Thousand Springs. Finally, small amounts of water enter the Fall River from overland flow during winter and from irrigated lands during the growing season. Pasture, wild rice, and alfalfa are the primary agriculture crops in the northern portion of the valley. Total irrigated acreage draining to this site is approximately 12,000 acres.

Pit River at Canby

This site captures drainage from the Alturas and Canby drainage areas. Land-uses are primarily pasture and grain and hay crops. Approximate irrigated acreage is 50,000.

Shasta/Tehama Subwatershed

Burch Creek at Woodson Avenue Bridge

Burch Creek was identified as the highest priority drainage in this subwatershed based upon the relatively high amount of irrigated acreage and the high degree of pesticide use. Burch Creek flows in an easterly direction from the foothills in southwestern Tehama County and joins the Sacramento River southeast of the City of Corning. Due to the need to select an accessible site, the site chosen on Burch Creek will probably capture approximately about 12,500 of the acres listed for the entire drainage. Burch Creek has a balanced acreage of olives, almonds, pasture, and wheat and hay crops.

Burch Creek west of Rawson Road

Burch Creek west of Rawson Road is a replacement site for Woodson Avenue Bridge. Burch Creek was identified as the highest priority drainage in this subwatershed based upon the relatively high amount of irrigated acreage and the high degree of pesticide use. Burch Creek flows in an easterly direction from the foothills in southwestern Tehama County and joins the Sacramento River southeast of the City of Corning. Due to the need to select an accessible site, the site chosen on Burch Creek will probably capture approximately about 12,500 of the acres listed for the entire drainage. Burch Creek has a balanced acreage of olives, almonds, pasture, and wheat and hay crops.

Anderson Creek at Ash Creek Road

Anderson Creek was identified as the highest priority drainage in the Shasta county portion of the Shasta/Tehama subwatershed. This ranking was based on total irrigated acreage, crop types by acreage, and amount and type of pesticide use. Anderson Creek originates about three miles west of the city of Anderson and then flows into the Sacramento River. Crops are predominantly pasture, followed by walnuts and alfalfa/hay and then smaller amounts of other field and orchard crops. Total irrigated land is 8,989 acres.

Colusa Basin Subwatershed

Stony Creek at Hwy 45 (near Rd. 24)

This site characterizes water from the contributing area downstream of Black Butte Reservoir just north of the town of Orland and includes approximately 20,000 acres of irrigated lands. The major irrigated crops in the Lower Stony Creek drainage are pasture, almonds, prunes, and wheat.

Colusa Drain at Maxwell Road

This site is just downstream from the original site, Upper Colusa Drain. It captures additional drainage from the federal wildlife refuge. The site receives water from central Glenn County and northeast Colusa County. The contributing drainage areas include Willow Creek, Upper Colusa Drain, and the Provident Area as indicated on the Colusa Basin subwatershed map. This area has considerable acreages of almonds, walnuts, wheat, pasture, and corn.

Stone Corral Creek at Maxwell Road:

This site captures drainage from approximately 10,000 irrigated acres in the Stone Corral Creek drainage area as indicated on the Colusa Basin subwatershed map. The primary crops include pasture, wheat, rice, and safflower.

Rough & Ready Pumping Plant

The Rough & Ready Pumping Plant aggregates runoff and return flows for the Sycamore drainage as noted on the Colusa Basin subwatershed map. The pumps lift the water into the Sacramento River. This drainage area contains large amounts of tomatoes, safflower, wheat, melons, corn, and pasture. Smaller acreages of prunes and walnuts are located directly on the banks of the Sacramento River.

Colusa Basin Drain above Knights Landing

This site is near the outfall gates of the Colusa Basin Drain before its confluence with the Sacramento River. This site is downstream of all of the other monitoring sites within the basin. The upstream acreage consists of almonds, tomatoes, wetlands, pasture, corn, and walnuts. Monitoring at this site is administered by the Sacramento River Watershed Program. No sampling was conducted in 2005.

Butte Creek at Colusa Gridley Highway

This station monitors water from upper Butte Creek and the southeast portion of Glenn County that is east of the Sacramento River. The upper drainage area consists of foothills and orchards, including walnuts, almonds, and prunes. The middle part of this drainage area is primarily rice. The lower part of the drainage area includes beans, melons, and pasture, with some walnuts and prunes.

Placer/Nevada/South Sutter/North Sacramento Subwatershed

Coon Creek at Striplin Road

This site captures drainage from the Middle and Lower Coon Creek drainage areas as identified in the Placer-Northern Sacramento Drainage Prioritization Table in the Coalition's Watershed Evaluation Report (WER) . This site is on Coon Creek about one mile downstream of the confluence with Ping Slough. The site drains approximately 25,000 irrigated acres of orchards, pasture, and wheat. It is recognized that there may be urban contributions at this site, but many of the growing cities in Western Placer County are conducting monitoring to identify potential urban impacts and are prepared to work closely with the Coalition in analyzing results and determining sources.

Butte/Yuba/Sutter Subwatershed

Butte Slough at Pass Road

This site is farther downstream from the other monitoring site on Butte Creek at the Gridley Colusa Highway. In addition to the Butte Creek water from the upstream site, this station includes water from the wetlands of Gray Lodge and Butte Sink, the fields surrounding Cherokee Canal and the orchards near Gridley.

Wadsworth Canal at South Butte Road (Weir #4)

This site will test water downstream of approximately 22,000 irrigated acres in the Wadsworth drainage as shown in the Butte-Sutter-Yuba subwatershed map. This area includes primarily prunes with some acreage of peaches, walnuts, pasture, wheat, and almonds.

Pine Creek at Nord-Gianella Road

The watershed sampled upstream from the monitoring site represents approximately 13,440 acres of varied farmland, riparian habitat and farmsteads. The predominant crops in this area are walnuts, almonds, prunes, wheat, oats, barley, beans, squash, cucumbers, alfalfa, pasture, and safflower.

Sacramento Slough

This site aggregates water from all areas in the subwatershed between the Feather and Sacramento Rivers. The major contributing areas include the areas downstream of the Butte

Slough and Wadsworth monitoring sites. These areas include Sutter Bypass and its major inputs from Gilsizer Slough, RD 1660, RD 1500, and the Lower Snake River. Monitoring at this site is administered by the Sacramento River Watershed Program. No sampling was conducted in 2005.

Gilsizer Slough at George Washington Road

Gilsizer Slough is an unlined storm drainage outfall canal that runs from the Gilsizer County Drainage District's north pump station approximately 15 miles to the Sutter Bypass, draining 6,005 total acres. The actual monitoring location is located roughly 1.5 drainage miles from its confluence with the Sutter bypass and is a natural drainage channel that historically has drained Yuba City and the area south of town. Principal crops grown in this area include prunes, walnuts, peaches, and almonds.

Yolo/Solano Subwatershed

Z-Drain (Dixon RCD)

The Z-Drain is a major input into the Yolo Bypass south of Interstate 80. This site drains the SW Yolo Bypass drainage area as designated in the Yolo/Solano subwatershed map. The major crops in this area include pasture, wheat, corn, tomatoes, and alfalfa.

Shag Slough at Liberty Island Bridge:

The Liberty Island Bridge site is approximately 2.5 to 3 miles southwest of the Toe Drain in Shag slough and is within the South Yolo Bypass drainage area. Like the Toe Drain, it is a tidally influenced site and is likely to contain a mixture of Toe Drain water along with water from other sub-drainages within the South Yolo Bypass and the Southwest Yolo Bypass.

Tule Canal at North East corner of I-80

This site is near the USGS Gauging Station in the Upper Yolo Bypass and is located just South of Interstate 80. This site characterizes the East Side Canal in the bypass and serves as a major drain for croplands in the North Yolo Bypass drainage as indicated on the Yolo/Solano subwatershed map. This drainage area includes corn, wheat, tomatoes, safflower and pasture.

Ulatis Creek at Brown Road

Ulatis Creek is a flood control project (FCP) that drains the majority of the central portion of Solano County. The Ulatis Creek FCP monitoring site is approximately 8.5 miles south of Dixon and 1.5 miles east of State Highway 113 on Brown Road. This site drains the Cache Slough area, as designated in the Yolo/Solano subwatershed map, and empties into Cache Slough. The major crops in this area include wheat, corn, pasture, tomatoes, alfalfa, Sudan grass, walnuts and almonds.

Upper Feather River Watershed

Agriculture in this subwatershed is localized in mountain valleys that are suitable for grazing and growing alfalfa, hay and grain crops. Monitoring in this subwatershed is therefore focused on characterizing drainage from three valleys with considerable agricultural acreage. Monitoring in this subwatershed is conducted in coordination with the Upper Feather River Watershed (UFRW) Prop 50 Project, which assumed responsibility sampling and analyses during the irrigation season of 2006.

Spanish Creek above confluence with Greenhorn Creek

This site captures drainage from the American Valley, which encompasses approximately 1,800 irrigated acres of pasture. Spanish Creek and Greenhorn Creek are the two primary streams draining the valley. A third stream, Mill Creek, connects with Spanish Creek upstream of the monitoring point. These creeks generally flow in a northerly direction, and ultimately, Spanish Creek connects with the North Fork Feather River. This site was replaced by Spanish Creek *below* the confluence with Greenhorn Creek during the irrigation season, with approval of Regional Board staff.

Middle Fork Feather River at County Rd. A-23

This site drains Sierra Valley, the largest irrigated agricultural region in this subwatershed. The three major creeks that drain into the Sierra Valley (Smithneck Creek, Cold Stream Creek, and Last Chance Creek) ultimately drain to the north towards this monitoring point and the headwaters of the Middle Fork Feather River. Monitoring conducted at this site in the first year provides a solid baseline for potential upstream monitoring on these other streams. This site captures approximately 30,000-35,000 irrigated acres, which is almost exclusively native pasture.

Indian Creek downstream from Indian Valley

This site drains the second largest irrigated agricultural region in this subwatershed, the Indian Valley. There are approximately 12,500 acres of native pasture, hay, and alfalfa. Drainage flows through the Indian Valley via Wolf Creek, Cooks Creek, Lights Creek and Indian Creek. The first three creeks ultimately flow to the southwest and join Indian Creek on the west side of the valley upstream from the monitoring site. This site provides a baseline for potential upstream monitoring on these tributary streams if necessary. This site was replaced by Indian Creek *at Arlington Bridge* during the irrigation season, with approval of Regional Board staff.

Lake/Napa Subwatershed

McGaugh Slough at Finley Road East

McGaugh Slough captures irrigated agricultural drainage from about 10,300 acres of orchard and vineyard crops in Lake County. This site is in the most prevalent drain for the Big Valley, which is the most intensive area for agricultural operations in Lake County. Given the ephemeral nature of the creek, sampling at this site is planned three times per year: twice during the storm season, and once after commencement of the irrigation season.

Pope Creek and Capell Creek

The sites on Pope Creek and Capell Creek in Napa County are downstream of major storm runoff but are above the level of the receiving waters of Lake Berryessa. Collectively, these sites capture drainage from approximately 3,400 acres of irrigated lands. Primary crops include vineyards and olive orchards. Based upon the ephemeral nature of these two Napa County creeks, samples are planned to be collected three times per year: in January, March, and May.

El Dorado County Subwatershed

North Canyon Creek

This site captures representative agricultural drainage from the Camino-“Apple Hill” drainage in El Dorado County. Crops grown in this region include apples, pears, wine grapes, stone fruit, and

Christmas trees. This site is approximately one (1) mile upstream from the confluence with the South Fork American River and is a perennial stream.

Sacramento/Amador Subwatershed

Cosumnes River at Twin Cities Road

Water flows to this monitoring point from the east via the Cosumnes River and a handful of tributary creeks which originate in the foothills and flow through considerable agricultural acreage including pasture, vineyards, corn, and grains. This site captures drainage from the two largest drainages in the subwatershed: Lower Cosumnes and Middle Cosumnes, which drain a total of approximately 55,000 irrigated acres.

Dry Creek at Alta Mesa Road

Dry Creek originates in the eastern foothills and flows through considerable agricultural acreage. The drainage includes the southern portion of Amador County, the southeast corner of Sacramento County and the northeast corner of San Joaquin County. Amador County agriculture includes grain and irrigated pasture in the Dry Creek Valley and row crops, irrigated pasture, grain, vineyard, and orchard in the Jackson Valley. Sacramento County agriculture includes vineyard, irrigated pasture, grain, and scattered dairies. Dry Creek drains approximately 329 square miles (N.B. the number of irrigated acres is still being determined).

Sampling and Analytical Methods

The objective of data collection for this monitoring program is to produce data that represent, as closely as possible, *in-situ* conditions of agricultural discharges and water bodies in the Central Valley. This objective will be achieved by using standard accepted methods to collect and analyze surface water and sediment samples. Assessing the monitoring program's ability to meet this objective will be accomplished by evaluating the resulting laboratory measurements in terms of detection limits, precision, accuracy, representativeness, comparability, and completeness, as described in the Coalition's QAPP (SVWQC 2006) and approved by the Water Board.

Surface water samples were collected for analysis of the constituents listed in Table 1 as appropriate for the monitoring Phase in effect. Surface water and sediment samples were collected for chemical analyses and toxicity testing. All samples were collected and analyzed using the methods specified in the QAPP; any deviations from these methods were explained.

SAMPLE COLLECTION METHODS

All samples were collected in a manner appropriate for the specific analytical methods used and to ensure that water column samples are representative of the flow in the channel cross-section. Water quality samples were collected using clean techniques that minimize sample contamination. Samples were cross-sectional composite samples or mid-stream, mid-depth grab samples, depending on sampling site and event characteristics. Where appropriate, water samples were collected using a standard multi-vertical depth integrating method. Abbreviated sampling methods (i.e., weighted-bottle or dip sample) may be used for collecting representative water samples. If grab sample collection methods were used, samples were taken at approximately mid-stream and mid-depth at the location of greatest flow (where feasible).

Sediment sampling was conducted on an approximately 50 meter reach of the waterbody near the same location as water quality sampling stations. The specific reach definitions vary based on conditions at each sampling station. Sediment sub-samples were collected from 5 to 10 wadeable depositional zones. Depositional zones include areas on the inside bend of a stream or areas downstream from obstacles such as boulders, islands, sand bars, or simply shallow waters near the shore. In low energy waterbodies, composite samples may be collected from the bottom of the channel using appropriate equipment, as specified in the Coalition QAPP. Sediment samples for toxicity analyses were collected in such a manner to minimize air above sediment and to prevent exposure to air. Details of the standard operating procedures (SOPs) for collection of surface water and sediment samples are provided in Appendix C of the Coalition's QAPP.

The Coalition monitoring program was implemented using a three-phased approach. Phase 1 monitoring includes analyses of physical parameters, drinking water constituents, and toxicity testing. Phase 2 monitoring includes chemical analyses of pesticides, metals, inorganic constituents and nutrients as well as continued monitoring of some required Phase 1 parameters, plus specific constituents that are identified as causes of toxicity testing in Phase 1. Phase 3 monitoring will include management practice effectiveness and implementation tracking and may include monitoring of additional water quality sites in the upper portions of the watershed. The initiation, scope, and schedule of Phase 2 and Phase 3 monitoring are dependent on the results of Phase 1 monitoring, as described in the MRPP. Some elements of Phase 2 and Phase 3 monitoring may be conducted concurrently with Phase 1 monitoring. The sites and annual frequency of samples planned for the Coalition's 2006 monitoring are summarized in Table 3.

Table 3. Coalition 2005-2006 Monitoring: Planned Annual Sampling Frequency

	Events		Physical and Chemical Parameters										Toxicity		
Location	Water Column Sample Events	Sediment Sample Events	Flow	pH, conductivity, DO, temperature	Color, Turbidity, TDS, TSS, TOC	Nutrients	Trace metals	Organophosphate pesticides	Organonochlorines, triazines, pyrethroids	Glyphosate, Paraquat	Carbamates, urea pesticides	Pathogen Indicators: *E. Coli* bacteria	Ceriodaphnia, 96-h acute Pimephales, 96-h acute Selenastrum, 96-h short-term chronic	Hyalella, 10-day short-term chronic	Implementation (1)
Butte Slough at Pass Road	8	2	8	8	8	8	8	8	8	8	6	ns	ns	ns	SVWQC
Colusa Drain near Maxwell Road	8	2	8	8	8	8	8	8	8	8	6	8	8	2	SVWQC
Stone Corral Creek near Maxwell Road	8	2	8	8	8	8	8	8	8	8	6	8	8	2	SVWQC
Butte Creek at Gridley Rd Bridge	8	2	8	8	8	8	8	8	8	8	6	8	8	2	SVWQC
Wadsworth Canal at South Butte Rd	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	SVWQC
Pine Creek at Nord-Gianella Rd	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	SVWQC
Gilsizer Slough at G. Washington Rd	8	2	8	8	8	ns	ns	8	ns	ns	ns	8	8	2	SVWQC
Z-Drain (Dixon RCD)	8	2	8	8	8	8	8	8	8	8	6	8	8	2	SVWQC
Shag Slough at Liberty Island	8	2	8	8	8	8	8	8	8	8	6	8	8	2	SVWQC
Tule Canal at NE corner of I-80	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	SVWQC
Ulatis Creek at Brown Road	8	2	8	8	8	8	8	8	8 (3)	ns	ns	8	8	2	SVWQC
Rough and Ready Pumping Plant	8	2	8	8	8	8	8	8	8	8	6	ns	ns	ns	SVWQC
Stony Creek on Hwy 45 near Rd 24	8	2	8	8	8	8	8	8	8	8	6	ns	ns	2	SVWQC
North Canyon Creek	8	2	8	8	8	8	8	8	8	ns	ns	ns	ns	ns	SVWQC
McGaugh Slough at Finley Road East	3	2	3	3	3	3	3	3	3	ns	ns	3	3	2	SVWQC
Coon Creek at Striplin Road	8	2	8	8	8	8	8	8	8	8	6	8	ns	ns	SVWQC
Cosumnes River at Twin Cities Rd	8	2	8	8	8	8	8	8	8	8	ns	8	ns	ns	SVWQC
Big Indian Creek at Bridge	1	1	1	1	1	1	1	1	1	1	1	1	1	1	SVWQC
Dry Creek at Alta Mesa Road	8	2	8	8	8	ns	ns	ns	ns	ns	ns	8	8	2	SVWQC
Burch Creek at Woodson Ave Bridge	2	1	2	2	2	2	2	2	2	ns	ns	2	2	1	SVWQC
Burch Creek west of Rawson Road	6	1	6	6	6	6	6	6	6	ns	6	6	6	1	SVWQC
Anderson Creek at Ash Creek Road	8	2	8	8	8	8	8	8	ns	ns	ns	8	8	2	SVWQC
Spanish Creek above Greenhorn Creek	7	ns	7	7	7	7	7	ns	ns	ns	ns	7	(2)	(2)	SVWQC
Indian Creek d/s from Indian Valley	7	ns	7	7	7	7	7	ns	ns	ns	ns	7	(2)	(2)	SVWQC
Middle Fk Feather River at County Rd A-23	7	ns	7	7	7	7	7	ns	ns	ns	ns	7	(2)	(2)	SVWQC
Pit River at Pittville	8	ns	8	8	8	8	ns	3	ns	ns	ns	8	2	ns	NECWA
Fall River at Fall River Ranch Bridge	8	ns	8	8	8	8	ns	3	ns	ns	ns	8	2	ns	NECWA
Pit River at Canby Bridge	8	ns	8	8	8	8	ns	3	ns	ns	ns	8	2	ns	NECWA
Pope Cr. upstream from Lake Berryessa	3	ns	3	3	3	ns	ns	ns	ns	ns	ns	8	ns	ns	PCWG
Capell Cr. upstream from Lake Berryessa	3	ns	3	3	3	ns	ns	ns	ns	ns	ns	8	ns	ns	PCWG
Colusa Drain above Knight's Landing	9	ns	9	9	9	9	ns	6	6	ns	6	9	9	ns	SRWP
Sacramento Slough	9	ns	9	9	9	9	ns	6	6	ns	6	9	9	ns	SRWP

Tabled values indicate number of regular samples planned for 2006. “ns” indicates parameter is not sampled.

(1) Implementation indicates whether monitoring is implemented by the Coalition (SVWQC), Northeastern California Water Association (NECWA), Putah Creek Watershed Group (PCWG), or Sacramento River Watershed Program (SRWP).

(2) Toxicity testing was implemented by the Upper Feather River Watershed Prop. 50 project.

(3) Organochlorine pesticides only.

ANALYTICAL METHODS

Water chemistry samples were analyzed for filtered (dissolved) and unfiltered/whole (total) fractions of the samples. Pesticide analyses were conducted only on unfiltered (whole) samples. Laboratories analyzing samples for this program have demonstrated the ability to meet the minimum performance requirements for each analytical method, including the ability to meet the project-specified quantitation limits (QL), the ability to generate acceptable precision and recoveries, and other analytical and quality control parameters documented in the Coalition QAPP. Analytical methods used for chemical analyses follow accepted standard methods or approved modifications of these methods, and all procedures for analyses are documented in the QAPP or available for review and approval at each laboratory.

Toxicity Testing and Toxicity Identification Evaluations

Water quality samples were analyzed for toxicity to *Ceriodaphnia dubia*, *Pimephales promelas*, and *Selenastrum capricornutum*. Sediment samples were analyzed for toxicity to *Hyalella azteca*. Toxicity tests were conducted using standard USEPA methods for these species.

- Determination of acute toxicity to *Ceriodaphnia* and *Pimephales* was performed as described in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms, Fifth Edition* (USEPA 2002a). Toxicity tests with *Ceriodaphnia* and *Pimephales* were conducted as 96-hour static renewal tests, with sample renewal 48 hours after test initiation. Acute test procedures with *Pimephales* were modified to control pathogen-related mortality by using smaller test containers with two fish per container, and increasing the number of replicate containers to ten.
- Determination of toxicity to *Selenastrum* shall be performed using the non-EDTA procedure described in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, Fourth Edition* (USEPA 2002b). Toxicity tests with *Selenastrum* are conducted as a 96-hour static non-renewal test.
- Determination of sediment toxicity to *Hyalella* was performed as described in Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates–Second Edition (USEPA 2000). Toxicity tests with *Hyalella* were conducted as a 10-day whole-sediment toxicity test with renewal of overlying water at 12 hour intervals.

For all initial screening toxicity tests at each site, 100% ambient water and a control will be used for the acute water column tests. If 100% mortality to a test species is observed any time after the initiation of the initial screening toxicity test, a multiple dilution test using a minimum of five sample dilutions will be conducted with the initial water sample to estimate the magnitude of toxicity.

Procedures in the currently effective QAPP state that if any measurement endpoint from any of the three aquatic toxicity tests exhibits a significantly significant difference from the control of greater than 50%, Toxicity Identification Evaluation (TIE) procedures will be initiated using the most sensitive species to investigate the cause of toxicity. The 50% mortality threshold is consistent with the approach recommended in guidance published by U.S. EPA for conducting TIEs (USEPA 1996b), which recommends a minimum threshold of 50% mortality because the probability of completing a successful TIE decreases rapidly for samples with less than this level of toxicity. For samples that met these trigger criteria, Phase 1 TIEs to determine the general class of constituent (e.g., metal, non-polar organics) causing toxicity or pesticide-focused TIEs were conducted. TIE methods generally adhere to the documented EPA procedures referenced in the QAPP. TIE procedures were initiated as soon as possible after toxicity is observed to reduce the potential for loss of toxicity due to extended sample storage. Procedures for initiating and conducting TIEs are documented in the QAPP (SVWQC 2006).

During the continuing Phase 1 monitoring effort in 2006, sediment toxicity testing was conducted at the sites and frequencies indicated in Table 3. Coalition sediment monitoring was conducted during one event in the 2006 storm season.

Detection and Quantitation Limits

The Method Detection Limit (MDL) is the minimum analyte concentration that can be measured and reported with a 99% confidence that the concentration is greater than zero. The Quantitation Limit (QL) represents the concentration of an analyte that can be routinely measured in the sampled matrix within stated limits and confidence in both identification and quantitation. For this program, QLs were established based on the verifiable levels and general measurement capabilities demonstrated by labs for each method. These QLs are considered to be maximum allowable limits to be used for laboratory data reporting. Note that samples required to be diluted for analysis (or corrected for percent moisture for sediment samples) may have sample-specific QLs that exceed these QLs. This is unavoidable in some cases.

Project Quantitation Limits

Laboratories generally establish QLs that are reported with the analytical results—these may be called *reporting limits*, *detection limits*, *reporting detection limits*, or several other terms by different laboratories. In most cases, these laboratory limits are less than or equal to the project QLs listed in Table 4. Wherever possible, project QLs are lower than the proposed or existing relevant numeric water quality objectives or toxicity thresholds, as required by the *ILP*.

All analytical results between the MDL and QL are reported as numerical values and qualified as estimates (“J-values”).

Table 4. Laboratory Method Detection Limit (MDL) and Quantitation Limit (QL) Requirements for Analyses of Surface Water for SVWQC Monitoring and Reporting Program Plan

Method	Analyte	Fraction	Units	MDL	QL	LAB
Physical and conventional Parameters						
EPA 110.2	Color	Filtered	ACU	2	5	CALTEST
EPA 130.2	Hardness, total as $CaCO_3$	Unfiltered	mg/L	3	5	CALTEST
EPA 180.1	Turbidity	Unfiltered	NTU	0.1	1	CALTEST
EPA 160.1	Total Dissolved Solids (TDS)	Filtered	mg/L	6	10	CALTEST
EPA 160.2	Total Suspended Solids (TSS)	Particulate	mg/L	2	3	CALTEST
EPA 415.1	Organic Carbon	Unfiltered	mg/L	0.3	0.5	CALTEST
Pathogen Indicators						
SM 9223B	*E. Coli* bacteria	NA	MPN/100 mL	2	2	CALTEST
Organophosphorus Pesticides						
EPA 625(m)	Azinphos-methyl	Unfiltered	µg/L	0.05	0.1	CRG
EPA 625(m)	Chlorpyrifos	Unfiltered	µg/L	0.005	0.01	CRG
EPA 625(m)	Diazinon	Unfiltered	µg/L	0.005	0.01	CRG
EPA 625(m)	Dimethoate	Unfiltered	µg/L	0.005	0.01	CRG
EPA 625(m)	Disulfoton	Unfiltered	µg/L	0.01	0.02	CRG
EPA 625(m)	Malathion	Unfiltered	µg/L	0.005	0.01	CRG
EPA 625(m)	Methamidophos	Unfiltered	µg/L	0.05	0.1	CRG
EPA 625(m)	Methidathion	Unfiltered	µg/L	0.01	0.02	CRG
EPA 625(m)	Parathion, Methyl	Unfiltered	µg/L	0.01	0.02	CRG
EPA 625(m)	Parathion, Ethyl	Unfiltered	µg/L	0.01	0.02	CRG
EPA 625(m)	Phorate	Unfiltered	µg/L	0.01	0.02	CRG
EPA 625(m)	Phosmet	Unfiltered	µg/L	0.05	0.1	CRG
Carbamate and Urea Pesticides						
EPA 8321	Aldicarb	Unfiltered	µg/L	0.2	0.4	APPL
EPA 8321	Carbaryl	Unfiltered	µg/L	0.05	0.07	APPL
EPA 8321	Carbofuran	Unfiltered	µg/L	0.05	0.07	APPL
EPA 8321	Diuron	Unfiltered	µg/L	0.2	0.4	APPL
EPA 8321	Linuron	Unfiltered	µg/L	0.2	0.4	APPL
EPA 8321	Methiocarb	Unfiltered	µg/L	0.2	0.4	APPL
EPA 8321	Methomyl	Unfiltered	µg/L	0.05	0.07	APPL
EPA 8321	Oxamyl	Unfiltered	µg/L	0.2	0.4	APPL
Organochlorine pesticides						
EPA 625(m)	4,4'-DDT (o,p' and p,p')	Unfiltered	µg/L	0.001	0.005	CRG
EPA 625(m)	4,4'-DDE (o,p' and p,p')	Unfiltered	µg/L	0.001	0.005	CRG
EPA 625(m)	4,4'-DDD (o,p' and p,p')	Unfiltered	µg/L	0.001	0.005	CRG
EPA 625(m)	Dicofol	Unfiltered	µg/L	0.05	0.1	CRG
EPA 625(m)	Dieldrin	Unfiltered	µg/L	0.001	0.005	CRG
EPA 625(m)	Endrin	Unfiltered	µg/L	0.001	0.005	CRG
EPA 625(m)	Methoxychlor	Unfiltered	µg/L	0.001	0.005	CRG

Table 4 (continued from previous page). Laboratory Method Detection Limit and Quantitation Limit (QL) Requirements for Analyses of Surface Water for SVWQC Monitoring and Reporting Program Plan

Method	Analyte	Fraction	Units	MDL	QL	LAB
Pyrethroid Pesticides						
EPA 625(m)	Biphenthrin	Unfiltered	µg/L	0.005	0.025	CRG
EPA 625(m)	Cyfluthrin	Unfiltered	µg/L	0.005	0.025	CRG
EPA 625(m)	Cypermethrin	Unfiltered	µg/L	0.005	0.025	CRG
EPA 625(m)	Esfenvalerate/Fenvalerate	Unfiltered	µg/L	0.005	0.025	CRG
EPA 625(m)	Lambda-Cyhalothrin	Unfiltered	µg/L	0.005	0.025	CRG
EPA 625(m)	Permethrin	Unfiltered	µg/L	0.005	0.025	CRG
Herbicides						
EPA 625(m)	Atrazine	Unfiltered	µg/L	0.005	0.01	CRG
EPA 625(m)	Simazine	Unfiltered	µg/L	0.005	0.01	CRG
EPA 625(m)	Molinate	Unfiltered	µg/L	0.05	0.1	CRG
EPA 625(m)	Thiobencarb	Unfiltered	µg/L	0.05	0.1	CRG
EPA 625(m)	Cyanazine	Unfiltered	µg/L	0.005	0.01	CRG
EPA 549.2	Paraquat	Unfiltered	µg/L	0.2	0.5	APPL
EPA 547	Glyphosate	Unfiltered	µg/L	4	5	APPL
Trace Elements						
EPA 200.8	Arsenic	Filtered, Unfiltered	µg/L	0.08	0.5	CALTEST
EPA 200.8	Cadmium	Filtered, Unfiltered	µg/L	0.04	0.1	CALTEST
EPA 200.8	Copper	Filtered, Unfiltered	µg/L	0.2	0.5	CALTEST
EPA 200.8	Lead	Filtered, Unfiltered	µg/L	0.02	0.25	CALTEST
EPA 200.8	Nickel	Filtered, Unfiltered	µg/L	0.2	0.5	CALTEST
EPA 200.8	Selenium	Unfiltered	µg/L	0.5	2	CALTEST
EPA 200.8	Zinc	Filtered, Unfiltered	µg/L	0.3	10	CALTEST
EPA 2008/200.7	Boron	Filtered, Unfiltered	µg/L	2	10	CALTEST
Nutrients						
EPA 351.3	Total Kjeldahl Nitrogen	Unfiltered	mg/L	0.07	0.1	CALTEST
EPA 300	Nitrate as N	Unfiltered	mg/L	0.006	0.1	CALTEST
EPA 354.1	Nitrite as N	Unfiltered	mg/L	0.003	0.03	CALTEST
EPA 350.2	Ammonia as N	Unfiltered	mg/L	0.02	0.1	CALTEST
EPA 365.2	Dissolved Orthophosphate	Unfiltered	mg/L	0.01	0.05	CALTEST
EPA 365.2	Phosphorus, Total	Unfiltered	mg/L	0.01	0.1(1)	CALTEST

(1) The QL for total phosphorus is higher than those specified in the R5-2005-0833 MRP document but has proved to be adequate to characterize ambient water quality (~95% detected results) and assess any potential impacts on beneficial uses.

Monitoring Results

The following sections summarize the monitoring conducted by the Coalition and its subwatershed partners for the 2006 irrigation season (May 2006 through September 2006).

SUMMARY OF SAMPLE EVENTS CONDUCTED

This report presents irrigation season monitoring results from five Coalition sampling events (Events 12-16) as well as several sampling events conducted by Subwatershed monitoring programs coordinating with the Coalition monitoring effort, all of which were completed from May through September 2006. These Subwatershed program sampling events include four events for the Northeastern California Water Association (NECWA), one event for the Putah Creek Watershed Group (PCWG), four events for the Sacramento River Watershed Program (SRWP), and five events for the Upper Feather River Watershed (UFRW) project. Samples collected for these events are listed in Table 5.

The Coalition and Subwatershed monitoring events were conducted during seasonally normal dry weather. Event monitoring analyses included water chemistry and aquatic toxicity. Sediment toxicity testing was also conducted by the Coalition once during this irrigation season (in September), as specified in the MRPP and QAPP. The sites and parameters for all events were monitored in accordance with the Coalition's MRPP and QAPP.

The field logs for all Coalition and Subwatershed samples collected for events from May through September 2006 are provided in Appendix A.

Table 5. Sampling for the Coalition Irrigation Season Monitoring: May – September 2006

Site Name	Sample Count: Planned	Sample Count: Collected	Months Sampled[1] Irrigation Season Events: May 012	June 013	July 014	August 015	September 016[2]
Sacramento Valley Water Quality Coalition (SVWQC)							
Anderson Creek at Ash Creek Road	5	6	5/23	6/20	7/18	8/15	9/19, **20**
Burch Creek west of Rawson Road	5	2	5/23	6/20	DRY	DRY	DRY
Butte Creek at Gridley Rd Bridge	5	5	5/24	6/21	7/18	8/15	9/20
Butte Slough at Pass Road	5	5	5/24	6/21	7/18	8/15	9/20
Colusa Drain near Maxwell Road	5	5	5/24	6/21	7/18	8/15	9/20
Coon Creek at Striplin Road	5	5	5/25	6/21	7/19	8/16	9/21
Cosumnes River at Twin Cities Rd	5	4	5/26	6/22	7/20	8/16	DRY
Dry Creek at Alta Mesa Road	5	5	5/26	6/22	7/20	8/16	9/21
Gilsizer Slough at G. Washington Road	5	5	5/24	6/21	7/19	8/16	9/20
McGaugh Slough at Finley Road East	1	1	5/25	—	—	—	—
North Canyon Creek	5	6	5/25	6/22	7/19	8/16, **17**	9/21
Pine Creek at Nord-Gianella Road	5	2	5/23	6/20	DRY	DRY	DRY
Rough and Ready Pumping Plant (RD 108)	5	5	5/25	6/21	7/18	8/15	9/19
Shag Slough at Liberty Island Bridge	5	5	5/26	6/22	7/20	8/17	9/22
Stone Corral Creek near Maxwell Road	5	6	5/24	6/21	7/18	8/15	9/19, **20**
Stony Creek on Hwy 45 near Rd 24	5	7	5/24	6/20	7/18, **19**	8/15	9/19, **21**
Tule Canal at I-80	5	5	5/25	6/22	7/20	8/17	9/22
Ulatis Creek at Brown Road	5	5	5/26	6/22	7/20	8/17	9/22
Wadsworth Canal at South Butte Rd	5	5	5/24	6/21	7/19	8/15	9/20
Z Drain – Dixon RCD	5	5	5/26	6/22	7/20	8/17	9/22
Northeastern California Water Association (NECWA)							
Fall River at Fall River Ranch Bridge	5	5	5/10	6/30	7/27	8/29	9/28
Pit River at Canby Bridge	5	5	5/10	6/30	7/27	8/29	9/28
Pit River at Pittville	5	7	5/10	6/30	7/27	**8/21**, **22**, 29	9/28
Putah Creek Watershed Group (PCWG)							
Capell Creek upstream from Lake Berryessa	1	1	5/1	—	—	—	—
Pope Creek upstream from Lake Berryessa	1	1	5/1	—	—	—	—
Sacramento River Watershed Program (SRWP)							
Colusa Drain above Knight's Landing	6	6	5/30	—[5]	7/5-7, 24-26	8/22-24	9/19-21[4]
Sacramento Slough	6	7	5/30	—[5]	7/5-7, 24-26	8/22-24, **30**	9/19-21[4]
Upper Feather River Watershed (UFRW)[3]							
Indian Creek at Arlington Bridge[3]	5	10	5/1, 23	6/6, 20	7/11, 24	8/8, 22	9/5, 26
Middle Fork Feather River at County Road A-23	5	10	5/1, 23	6/6, 20	7/11, 24	8/8, 22	9/5, 26
Spanish Creek below Greenhorn Cr. [3]	5	10	5/1, 23	6/6, 20	7/11, 24	8/8, 22	9/5, 26
	140	**156[6]**					

(1) "—" indicates no samples planned.

(2) Follow-up sediment toxicity sampling was conducted on 11/21/2006.

(3) Sampling for this watershed was conducted by SVWQC in May and June, with samples collected at Spanish Creek above Greenhorn Creek, and at Indian Creek d/s from Indian Valley.

(4) Samples continued to be collected after the defined SVWQC irrigation season.

(5) SRWP samples planned for June were collected in early July

(6) Includes additional samples collected by Coalition and UFRW. Total initial planned samples collected equals 133.

BOLD: Indicates **f**ollow-up samples

DRY: Indicates streambed was dry or consisted of isolated standing water and no samples were collected.

SAMPLE CUSTODY

All samples that were collected for the Coalition monitoring effort met the requirements for sample custody. Sample custody must be traceable from the time of sample collection until results are reported. A sample is considered under custody if:

- it is in actual possession;
- it is in view after in physical possession; and
- it is placed in a secure area (i.e., accessible by or under the scrutiny of authorized personnel only after in possession).

The chain-of-custody forms (COCs) for all samples collected by Coalition contractors for the monitoring events conducted from May to September 2006 are included with the related lab reports, which are provided in Appendix B.

QUALITY ASSURANCE RESULTS

The Data Quality Objectives (DQOs) used to evaluate the results of the Coalition monitoring effort are detailed in the Coalition's QAPP (SVWQC 2006). These DQOs are the detailed quality control specifications for precision, accuracy, representativeness, comparability, and completeness. These DQOs are used as comparison criteria during data quality review to determine if the minimum requirements have been met and the data may be used as planned.

Results of Field and Laboratory QC Analyses

Quality Control (QC) data are summarized in Table 6 through Table 13 and discussed below. All QC results programs are included with the lab reports in Appendix B of this document, and any qualifications of the data provided were retained and are presented with the tabulated monitoring data. Monitoring results for all programs discussed are tabulated in Appendix C.

Hold Times

Results were evaluated for compliance with required preparation and analytical hold times. With the exceptions discussed below, all analyses met the target data quality objectives:

- One E. coli sample exceeded the 24-hour hold time for analysis initiation, and a second sample was collected the following day. The result for the initial sample was accepted and qualified as *estimated*.
- Five samples analyzed for nitrate and one sample analyzed for nitrite exceeded hold times due to lab oversight error. The results were accepted and qualified as *estimated*.

Method Detection Limits and Quantitation Limits

Target Method Detection Limits (MDL) and Quantitation Limits (QL) were assessed for all parameters. With the exceptions discussed below, all analyses met the target data quality objectives:

- The analytical MDL and QL for 44 total dissolved solids analysis were elevated because the samples required dilution for analysis. All sample results were greater than the elevated QL and were not adversely affected or qualified.

- The analytical MDL and QL for 49 total suspended solids analyses were elevated above the DQOs because the samples required dilution for analysis. This resulted in an additional 5 results qualified as “J-values”. All remaining results were greater than the elevated QL and were not adversely affected or qualified.
- The analytical MDL and QL for 28 organic carbon analyses were elevated above the DQOs due to requirements to dilute the samples for analysis and because samples were analyzed by an alternate lab, due to equipment problems at the planned laboratory. This may have resulted in one an additional result being below detection. All remaining results were greater than the elevated QL and were not adversely affected or qualified.
- The analytical QL for 59 analyses of dissolved orthophosphate was elevated above the DQO of 0.05 mg/L and were reported at a QL of 0.1 mg/L. The target MDL (0.01 mg/L) was achieved, and results were reported to this level. The elevated QL resulted in an additional 8 results qualified as “J-values”.
- The analytical QLs for 6 analyses of organochlorine pesticides were elevated above the DQOs due to bottle breakage and sample loss during shipping. The target MDLs were achieved, and results were reported to this level. All affected sample results were below detection at the target MDL and no results required qualification on this basis.
- The analytical QL for boron was elevated above the Coalition DQO of 10 ug/L for 26 analyses. This resulted in five additional results qualified as “J-values”. All remaining results were greater than the elevated QL and were not adversely affected or qualified. However, the achieved MDL and QL were adequate to evaluate exceedances and potential impacts on beneficial uses for all results.
- The analytical QL for selenium achieved the Coalition DQO of 2 ug/L for all analyses, and achieved the QL specified in the MRP (1 ug/L) for 135 of 144 analyses. However, the achieved MDL and the QL were adequate to evaluate exceedances and potential impacts on beneficial uses for all results.
- The analytical QL for zinc achieved the Coalition DQO of 10 ug/L for all analyses. The achieved QL was above the QL specified in the MRP (1 ug/L) for 6 of 144 analyses. However, the achieved QL and MDL were adequate to evaluate exceedances and potential impacts on beneficial uses for all results.
- The analytical QLs for six pesticide samples were elevated above their Coalition DQOs due to bottle breakage and partial sample loss during shipment. However, the target MDLs and QLs achieved by the laboratory with the reduced sample volumes met the requirements of the MRP and were adequate to evaluate exceedances and potential impacts on beneficial uses for all results.
- The analytical QL for 28 glyphosate analyses was elevated above the Coalition DQO and MRP target of 5 ug/L. However, the achieved MDL and the QL were adequate to evaluate exceedances and potential impacts on beneficial uses for all results.
- The analytical QL for one sample analysed for carbamate pesticides (aldicarb, carbaryl, carbofuran, linuron, methiocarb, methomyl, oryzalin, oxamyl) (was elevated above the Coalition DQO and MRP target of 0.5 ug/L. The achieved MDL and the QL were adequate to evaluate exceedances and potential impacts on beneficial uses for all results.

- The analytical MDL and QLs for paraquat analyses were elevated above the Coalition DQO of 0.2 ug/L for all analyses, and were higher than the MRP target QL of 0.5 ug/L for 22 analyses due to requirements to dilute the samples for analysis. All results for paraquat were below detection. Based on consultation with the analyzing laboratory, the method prescribed in the MRP and used for Coalition monitoring is not able to achieve the target QL in matrices containing significant particulate matter (as is typical of agricultural drainage samples). The laboratory stated that this limitation of the method (which frequently causes "matrix interference") is due to the high affinity of paraquat for particulates and can only be addressed by dilution (which elevates the QL) or by filtration (which would remove all particulate-bound paraquat in addition to the interfering matrix components). Based on the chemical characteristics of paraquat, this pesticide presents a low risk to be present in dissolved concentrations capable of affecting toxicity test species, and is unlikely to be detectable using standard analytical methods. paraquat has not been detected in any Coalition sample. It is recommended that this pesticide be removed from the MRP-required list of analytes.

Field Blanks

Field blanks were collected and analyzed for analyses of coliform bacteria, total organic carbon, ultraviolet absorbance, trace metals, and pesticides. With the exceptions discussed below, analytes of interest were generally not detected in field blanks:

- Organic carbon was detected above the QL in 2 field blanks. This resulted in 2 analytical result being qualified as an *upper limit* due to potential contamination. This continued a trend observed in previous monitoring and was investigated with the laboratory. Subsequently the laboratory temporarily suspended analysis of TOC and these samples were analyzed by a second laboratory. Since resuming analysis of TOC for the Coalition, detections in field blanks have not been a problem.

Field Duplicates

Field duplicate samples were collected and analyzed for all parameters except coliform bacteria. The data quality objective for field duplicates is a Relative Percent difference (RPD) not exceeding 25%. With the exceptions discussed below, all field replicates met this data quality objective:

- Field duplicate results exceeded the DQO for one analysis each of total dissolved solids, total suspended solids, ammonia, nitrate, nickel and total organic carbon, and for two analyses of zinc. Ten environmental results were qualified as *estimated* on this basis.

Method Blanks

Method blanks were analyzed for TDS, TSS, TOC, turbidity, trace metals, nutrients, and pesticides. The data quality objective for method blanks is no detectible concentrations of the analyte of interest. With the exceptions discussed below, all analyses met this data quality objective:

- Trace metals were detected at low levels in 14 method blank analyses. Thirteen of these below the QL and resulted in no qualified data. One method blank result for lead was greater than the QL and required qualification of one analytical result for an environmental sample as an *Upper Limit* (UL). No other analytical results were qualified as a result and all other results for environmental samples were below detection.

Laboratory Control Spikes and Surrogates

Laboratory Control Spike (LCS) recoveries were analyzed for TDS, TSS, TOC, trace metals, nutrients, and pesticides. Surrogate recoveries were analyzed for organophosphorus, organochlorine, and carbamate pesticides. The data quality objective for Laboratory Control Spikes (LCS) is 80-120% recovery of the compounds of interest for most analyses. The data quality objectives for Laboratory Control Sample recoveries and surrogate recoveries of pesticides varies for each analyte and surrogate and are based on the standard deviation of actual recoveries for the method.

With the exceptions discussed below, results of all LCS analyses met DQOs.

- One LCS recovery for paraquat and one recovery for aldicarb were lower than the minimum acceptable recovery DQO. This required qualification of 14 environmental sample results as *Low Biased* (LB). Two LCS result for barban and one result for chloroxuron were greater than the maximum acceptable DQO. Because all associated environmental sample results were below detection, no data were qualified due to the elevated recoveries.

With the exceptions discussed below, all surrogate recovery analyses met data quality objectives:

- Five surrogate recoveries for carbamate pesticides were greater than the maximum acceptable recovery DQO. Because all associated environmental sample results were below detection, no data were qualified.

Laboratory Duplicates

Laboratory Duplicates were analyzed for TDS, TSS, turbidity, and pesticides (Table 11). The data quality objective for laboratory duplicates is a Relative Percent difference (RPD) not exceeding 20%. With the exceptions discussed below, all laboratory duplicate analyses met this data quality objective:

- Three lab duplicate analyses of lab control samples for paraquat exceeded the DQO. Because all associated environmental sample results were below detection, no data were qualified.

Matrix Spikes and Matrix Spike Duplicates

Matrix Spikes and Matrix Spike Duplicates were analyzed for trace metals, nutrients, and pesticides (Table 12 and Table 13). The data quality objective for matrix spikes is 80-120% recovery of most analytes of interest. The data quality objective for matrix spike recoveries of pesticides varies for each analyte or surrogate and is based on the standard deviation of actual recoveries for the method. The data quality objective for matrix spike duplicates is a Relative Percent difference (RPD) not exceeding 20%. With the exceptions discussed below, all analyses met these data quality objectives:

- Matrix Spike recoveries for one trace metal analyses for zinc was outside the DQO. The sample matrix was not a Coalition sample and the analytical batch was accepted based on acceptable LCS recoveries. No Coalition environmental results were qualified.
- Matrix Spike recoveries for 1 TOC analysis was outside the DQO. This required qualification of one analytical result as *Low Biased* (LB) due to matrix interference.
- Matrix Spike recoveries for seven paraquat analyses were below the DQO. Five results were qualified as *Low Biased* (LB) due to matrix interference.

- Matrix Spike recoveries for 14 organophosphate pesticide analyses were outside their DQOs. This resulted in qualification of 7 environmental results as *Low Biased* (LB) due to matrix interference.
- Matrix Spike recoveries for three carbamate analyses were below the DQO. This resulted in qualification of one environmental result as *Low Biased* (LB) due to matrix interference. Matrix Spike recoveries for three carbamate analyses were above the DQO. All environmental results for the specific analytes were below detection and no results were qualified as *High Biased* (HB).
- The RPD for one pair of Matrix Spike Duplicate analyses for Total Organic Carbon was higher than the DQO. This resulted in qualification of one environmental result as *Estimated* (EST) due to matrix interference.
- The RPD for one pair of Matrix Spike Duplicate analyses for paraquat could not be calculated due to 0% recoveries of the matrix spikes. The associated results for the specific analytes were below detection and qualified as *Low Biased* (LB) due to matrix interference and no results were qualified as *Estimated* (EST) due to matrix interference.
- The RPD for one pair of Matrix Spike Duplicate analyses for malathion was higher than the DQO. The associated results were below detection and no results were qualified as *Estimated* (EST) on this basis.

Summary of Precision and Accuracy

Based on the QC data for the monitoring discussed above, the precision and accuracy of the majority of monitoring results meet the DQOs and there were no systematic sampling or analytical problems. These data are adequate for the purposes of the Coalition's monitoring program and very few results required qualification. Of the 68 total qualified data, 28 results were qualified as *estimated* due to high variability in lab or field replicate analyses or holding time exceedances, 28 results were qualified as *high biased* or *low biased*, and 12 results were potentially affected by contamination and qualified as *upper limits*. Of the 7,939 analytical results generated from May – September 2006, 68 results required qualification or rejection, resulting in 99.14% valid and unqualified data with no restrictions on use.

Completeness

The objectives for completeness are intended to apply to the monitoring program as a whole. As summarized in Table 5, 133 of 140 initial water column and sediment samples planned by the Coalition and coordinating programs were collected and all collected samples were analyzed, for an overall sampling success rate of 95%. All of the seven planned samples that were not collected were due to a lack of water in the streambed. Planned sampling and analyses that were not completed successfully are summarized below:

- Seven planned samples were not collected because the sites were dry or had only isolated standing water inappropriate for sampling.
- Samples planned to be analyzed for trace metals for Anderson Creek were inadvertently omitted from the Irrigation Season sample plans and will be collected and analyzed in 2007.

Table 6. Summary of Field Blank Quality Control Sample Evaluations: May – September 2006

Method	Analyte	Data Quality Objective	Number of Analyses	Number Passing	% Success
EPA 200.8	Trace Metals	< MDL	43	36	84%
EPA 350.2	Ammonia, as N	< MDL	5	5	100%
EPA 351.3	Total Kjeldahl Nitrogen	< MDL	5	5	100%
EPA 300 & EPA 353.2	Nitrate, as N, Nitrate+nitrite as N	< MDL	5	5	100%
EPA 354.1	Nitrite, as N	< MDL	3	3	100%
EPA 365.2	Total Phosphorus, as P	< MDL	5	5	100%
EPA 365.2 (filtered)	Dissolved Orthophosphate, as P	< MDL	5	5	100%
EPA 415.1	Total Organic Carbon (TOC)	< MDL	5	3	60%
EPA 547	Glyphosate	< MDL	5	5	100%
EPA 549.2	Paraquat	< MDL	5	5	100%
EPA 625m	Organophosphorus, Organochlorine, Triazine, and Pyrethroid Pesticides	< MDL	296	296	100%
EPA 8321A	Carbamate Pesticides		125	125	100%
SM20-9223	E. coli	< MDL	4	4	100%
Totals			***511***	***502***	***98%***

Table 7. Summary of Field Duplicate Quality Control Sample Results: May – September 2006

Method		Data Quality Objective	Number of Analyses	Number Passing	% Success
EPA 110.2	Color	RPD ≤ 25%	5	5	100.0%
EPA 160.1	Total Dissolved Solids (TDS)	RPD ≤ 25%	5	5	100.0%
EPA 160.2	Total Suspended Solids (TSS)	RPD ≤ 25%	5	4	80%
EPA 180.1	Turbidity	RPD ≤ 25%	5	4	80%
EPA 200.8	Trace Metals	RPD ≤ 25%	36	33	92%
EPA 350.2, SM 4500	Ammonia as N	RPD ≤ 25%	10	9	90 %
EPA 351.3	Total Kjeldahl Nitrogen	RPD ≤ 25%	5	4	80%
EPA 300 & EPA 353.2	Nitrate, and Nitrate+Nitrite, as N	RPD ≤ 25%	5	4	80%
EPA 354.1	Nitrite, as N	RPD ≤ 25%	3	3	100%
EPA 365.2	Phosphate as P, Total	RPD ≤ 25%	5	5	100.0%
EPA 365.2 (filtered)	Dissolved Orthophosphate, as P	RPD ≤ 25%	5	5	100.0%
EPA 415.1	Total Organic Carbon (TOC)	RPD ≤ 25%	5	4	80.0%
EPA 625m	Organophosphorus, Organochlorine, Triazine, and Pyrethroid Pesticides	RPD ≤ 25%	303	303	100%
EPA 547	Glyphosate	RPD ≤ 25%	5	5	100.0%
EPA 549.1	Paraquat	RPD ≤ 25%	5	5	100.0%
EPA 8321A	Carbamate Pesticides	RPD ≤ 25%	125	125	100.0%
SM18-2320B	Alkalinity	RPD ≤ 25%	5	5	100.0%
SM18-2340C, EPA 130.2	Hardness	RPD ≤ 25%	6	6	100.0%
Toxicity tests	*Ceriodaphnia* survival, *Pimephales* survival, *Selenastrum* growth	RPD ≤ 25%	16	16	100.0%
Totals			***559***	***550***	***98%***

Table 8. Summary of Method Blank Results: May – September 2006

Method	Analyte	Data Quality Objective	Number of Analyses	Number Passing	% Success
EPA 130.2	Hardness	< MDL	3	3	100%
EPA 160.1	Total Dissolved Solids	< MDL	14	14	100%
EPA 160.2	Total Suspended Solids	< MDL	17	17	100%
EPA 200.8	Trace Metals	< MDL	222	208	94%
EPA 300, EPA 353.2	Nitrate, and Nitrate+Nitrite, as N	< MDL	15	15	100%
EPA 350.2	Ammonia as N	< MDL	15	15	100%
EPA 351.3	Total Kjeldahl Nitrogen	< MDL	16	16	100%
EPA 354.1	Nitrite, as N	< MDL	10	10	100%
EPA 365.2	Phosphate/Orthophosphate, as P	< MDL	20	20	100%
EPA 415.1	Total Organic Carbon	< MDL	17	17	100%
EPA 547	Glyphosate	< MDL	11	11	100%
EPA 549.2	Paraquat	< MDL	10	10	100%
EPA 625(m)	Organophosphorus, Organochlorine, Triazine, and Pyrethroid Pesticides	< MDL	753	753	100%
EPA 8321	Carbamate Pesticides	< MDL	225	225	100%
Totals			**1348**	**1334**	**99%**

Table 9. Summary of Lab Control Spike Results: May – September 2006

Method	Analyte	DQO	Number of Analyses	Number Passing	% Success
EPA 130.2	Hardness	80-120%	3	3	100%
EPA 160.1	Total Dissolved Solids	80-120%	13	13	100%
EPA 160.2	Total Suspended Solids	80-120%	17	17	100%
EPA 200.8/200.7	Trace Metals	80-120%	222	222	100%
EPA 350.2	Ammonia as N	80-120%	15	15	100%
EPA 351.3	Total Kjeldahl Nitrogen	80-120%	15	15	100%
EPA 300, EPA 353.2	Nitrate, and Nitrate+Nitrite, as N	80-120%	16	16	100%
EPA 354.1	Nitrite, as N	80-120%	10	10	100%
EPA 365.2	Phosphate/Orthophosphate, as P	80-120%	20	20	100%
EPA 415.1	Total Organic Carbon	80-120%	17	17	100%
EPA 547	Glyphosate	78-128%	20	20	100%
EPA 549.2	Paraquat	42-104%	22	21	95%
EPA 8321	Carbamate Pesticides	(1)	225	221	98%
Totals			**615**	**610**	**99%**

(1) Data Quality Objectives for pesticide LCS recoveries vary by parameter and are based on 3 x the standard deviation of the lab's actual recoveries for each parameter.

Table 10. Summary of Surrogate Recovery Results: May – September 2006

Method	Analyte	Data Quality Objective	Number of Analyses	Number Passing	% Success
EPA 625(m)	Organophosphorus, Organochlorine, Triazine, and Pyrethroid Pesticides	(1)	460	460	100%
EPA 8321	Carbamate Pesticides	(1)	192	187	97%
Totals			**652**	**647**	**99.2%**

(1) Data Quality Objectives for pesticide Surrogate recoveries vary by parameter and are based on 3 x the standard deviation of the lab's actual recoveries for each parameter.

Table 11. Summary of Lab Duplicate Results: May – September 2006

Method	Analyte	Data Quality Objective	Number of Pairs Analyzed	Number Passing	% Success
EPA 160.1	Total Dissolved Solids	≤20% RPD	14	14	100%
EPA 160.2	Total Suspended Solids	≤20% RPD	17	17	100%
EPA 180.1	Turbidity	≤20% RPD	13	13	100%
EPA 547	Glyphosate	78-128%	10	10	100%
EPA 549.2	Paraquat	42-104%	11	8	73%
EPA 625(m)	Organophosphorus, Organochlorine, Triazine, and Pyrethroid Pesticides	≤20% RPD	439	439	100%
Totals			**504**	**501**	**99%**

Table 12. Summary of Matrix Spike Recovery Results: May – September 2006

Method	Analyte	Data Quality Objective	Number of Analyses	Number Passing	% Success
EPA 130.2	Hardness	80-120%	6	6	100%
EPA 200.8/200.7	Trace Metals	80-120%	444	443	99.8%
EPA 350.2	Ammonia as N	80-120%	30	30	100%
EPA 351.3	Total Kjeldahl Nitrogen	80-120%	30	30	100%
EPA 300, EPA 353.2	Nitrate, and Nitrate+Nitrite, as N	80-120%	32	32	100%
EPA 354.1	Nitrite, as N	80-120%	20	20	100%
EPA 365.2	Phosphate/Orthophosphate, as P	80-120%	40	40	100%
EPA 415.1	Total Organic Carbon	80-120%	34	33	97%
EPA 547	Glyphosate	78-128%	10	10	100%
EPA 549.2	Paraquat	50-126%	9	2	22%
EPA 625(m)	Organophosphorus, Organochlorine, Triazine, and Pyrethroid Pesticides	(1)	403	389	97%
EPA 8321	Carbamate Pesticides	(2)	250	244	98%
Totals			**1308**	**1279**	**98%**

(1) Data Quality Objectives for pesticide matrix spike recoveries vary by parameter and are based on 3 x the standard deviation of the lab's actual recoveries for each parameter.

(2) All matrix spikes with recoveries outside DQO were non-SVWQC matrices.

Table 13. Summary of Matrix Spike Duplicate Precision Results: May – September 2006

Method	Analyte	Data Quality Objective	Number of Pairs Analyzed	Number Passing	% Success
EPA 130.2	Hardness	80-120%	3	3	100%
EPA 200.8/200.7	Trace Metals	≤20% RPD	222	222	100%
EPA 350.2	Ammonia as N	≤20% RPD	15	15	100%
EPA 351.3	Total Kjeldahl Nitrogen	≤20% RPD	15	15	100%
EPA 300, EPA 353.2	Nitrate, and Nitrate+Nitrite, as N	≤20% RPD	16	16	100%
EPA 354.1	Nitrite, as N	≤20% RPD	10	10	100%
EPA 365.2	Phosphate/Orthophosphate, as P	≤20% RPD	20	20	100%
EPA 415.1	Total Organic Carbon	≤20% RPD	17	16	94%
EPA 547	Glyphosate	≤25% RPD	5	5	100%
EPA 549.2	Paraquat	≤25% RPD	4	3	75%
EPA 365(m)	Organophosphorus, Organochlorine, Triazine, and Pyrethroid Pesticides	≤25% RPD	794	796	99.9%
EPA 8321	Carbamate Pesticides	≤25% RPD	125	112	90%
Totals			**1249**	**1233**	**99%**

TABULATED RESULTS OF LABORATORY ANALYSES

The tabulated results for all validated and QA-evaluated data are provided in Appendix C. This appendix includes results for non-target pesticide analytes reported along with the pesticides of primary interest for the Coalition's monitoring program. All reported environmental data are included in Appendix A, with one exception: data analyzed by Basic Laboratory for NECWA were not provided in electronic format and are currently available only as hard copies. These data will be added to the electronic data set when they are made available to the Coalition in a suitable format. Copies of all final laboratory reports, including chromatographs for pesticide analyses, and all reported Quality Assurance data for Coalition monitoring results are provided in Appendix B.

Pesticide Use Information

Resolution R5-003-0826 requires sampling for 303(d)-listed constituents identified in waterbodies downstream from Coalition sampling locations. Additionally, the *ILP* requires pesticide use reporting in the annual monitoring report. Previous reports focused upon sampling results and use reports for the six priority pesticides that met these criteria. The six pesticides specifically analyzed for the Phase 1 Coalition monitoring were azinphos-methyl, carbofuran, chlorpyrifos, diazinon, malathion, and, methyl parathion.

Fourteen sites were monitored for these constituents during 2005 Coalition sampling events, and diazinon and chlorpyrifos were detected in 9 samples, overall. Azinphos-methyl, carbofuran, malathion, and, methyl parathion were not detected in any samples. Monitoring for organochlorine and pyrethroid pesticides was conducted at 9 and 7 sites, respectively. No organochlorine or pyrethroid pesticides were detected in any samples during that period.

Pesticide use information for the pesticides of primary concern in the Sacramento Valley watershed was acquired from the California Department of Pesticide Regulations' Pesticide Use Reporting (PUR) Database and compiled for the subwatersheds. The information for 2000-2003, including usage trends, was summarized in the 2005 AMR. Pesticide use data were also characterized for specific monitored drainages within each subwatershed. These additional detailed tables were also provided in the 2005 AMR. Based on available data (2000-2003), these pesticides have been widely used throughout the Coalition's subwatersheds and exhibited relatively small annual variations in use overall. Total pesticide applications in the Coalition watersheds are summarized by county in Table 14. Within this overall pattern, there were some spatial and temporal trends evident. The usage trends for 2000 to 2003, with available updates for 2005, are summarized below.

Azinphos-methyl has been used throughout the Coalition area, with the exception of the Upper Feather subwatershed. The major agricultural uses for azinphos-methyl in the Coalition watershed have been almonds, walnuts, and pears. Generally, the use of azinphosmethyl is on the decline, except for the Colusa Drain subwatershed, where there have been increased applications reported in the Willow Creek and Lower Stony Creek drainages.

Carbofuran use in the Coalition watershed has decreased dramatically (approximately 70-80%) since the 1990s. Consequently, the reported percentage of carbofuran detections in the Sacramento River watershed in CDPR's Surface Water Database has also decreased from approximately 66% of analyses in 1994, to 2.5% in 2000, with no detected carbofuran reported in 2001-2003 monitoring. These decreases correspond to changes made by the rice farming industry to pesticide application practices and in holding times for irrigation water after pesticide application. Granular formulations of carbofuran were also banned in 1994 to protect wildlife. Although carbofuran was historically used primarily on rice acreage, the majority of use in recent years has been on alfalfa and cotton. Based on data reported in the PUR database, the use of carbofuran in the Coalition subwatersheds has remained fairly stable at this lower level since 2001. Carbofuran is still used in the Colusa basin, Yolo/Solano, Butte/Sutter/Yuba, and Sacramento/Amador subwatersheds. Within the Yolo/Solano subwatershed, there has been an apparent change in the geographic pattern of use, with increased use in the Willow Slough and Cache Creek drainages and decreased use in the South Yolo Bypass.

Overall use of cholinesterase-inhibiting organophosphate insecticides has declined over the last ten years (CDPR 2003, CDPR 2006, Spurlock 2002). DPR reported that this trend has continued through 2005. In contrast, over the same period, the total number of acres planted in fruit and vegetable crops and the total pounds of all varieties of pesticides applied has increased in California (CDPR 2003). This suggests that there may be a general shift from organophosphate insecticides to other categories of pesticides, possibly in response to economic pressures, patterns of pest pressures, and pesticide resistance, as well as to significant regulatory pressures and increased label restrictions. Within this category, chlorpyrifos continues to be used in most Coalition subwatersheds at stable reduced rates. The primary agricultural uses of chlorpyrifos in recent years have been for walnuts, with smaller but significant application reported for alfalfa and almonds. However, as shown in Appendix E of the 2005 AMR, there were significant percentage increases in total applications of chlorpyrifos in 2002 and 2003 within the Pit River, Colusa Basin, and Placer/North Sacramento subwatersheds. Between 2004 and 2005, the total acreage treated with organophosphates increased statewide, mostly because of increased use of the insecticide chlorpyrifos. Within the entire Sacramento River watershed, the use of chlorpyrifos, based on total pounds applied, increased only slightly (2.7%) within the same time period.

The overall use of *diazinon* has also declined substantially over the past 10 years (CDPR 2003, Spurlock 2002), particularly for dormant spray applications. The predominant agricultural uses in the Sacramento Valley watersheds in recent years have been for stonefruit, almonds, tomatoes, pears, and walnuts. Diazinon continues to be used throughout the Coalition watershed, although with substantially higher rates of use per irrigated acre in the Butte/Yuba/Sutter and El Dorado subwatersheds. There was no overall trend apparent in total applications between 2000 and 2003, but there was a notable percent increase in applications in the Shasta/Tehama subwatershed and a decrease in the reported applications in the Napa/Lake subwatershed (see Appendix E of the 2005 AMR). Between 2004 and 2005, a 26% decrease in the total diazinon applications was observed within the Sacramento River watershed.

Malathion has exhibited a trend similar to the overall pattern observed in carbofuran use and detections. The major agricultural uses for malathion in the Coalition watershed have been walnuts and alfalfa in recent years. Malathion has been widely used throughout the Coalition subwatersheds, with the exception of the Upper Feather subwatershed. From 2000 to 2003, malathion applications increased in the Colusa Basin subwatershed and decreased substantially in the Pit River subwatershed, while overall applications in the Coalition watersheds remained relatively consistent (see Appendix E of the 2005 AMR).

Methyl parathion use also declined throughout the Coalition area as a whole from 2000 and 2003. The majority of the decrease and the total pounds applied were reported in the Butte/Sutter/Yuba subwatershed (approximately 80%), with much smaller total applications occurring in the Yolo/Solano, Placer/North Sacramento, and Colusa Basin subwatersheds. The majority of recent methyl parathion use in the Coalition watershed has been for walnut orchards.

TRENDS FOR PESTICIDES DETECTED IN 2006

Of the six priority pesticides discussed above, only two – chlorpyrifos and diazinon – were detected during the 2006 irrigation season. In addition, five other pesticides – atrazine, diuron, molinate, simazine, and thiobencarb – were detected in more than one sample and at multiple sites. None of these pesticides were detected at concentrations expected to cause toxicity to sensitive test species and none exceeded applicable water quality objectives in Irrigation Season 2006 samples. Usage information from the PUR Database was compiled for these seven pesticides for 2004 and 2005 to evaluate recent trends in their use in the Coalition watershed. This information is currently limited to historical data reported through 2005 and is not yet available for the monitoring period represented in this report. Based on these data, an overall decrease (i.e., greater than 10%) in total use of five of these seven pesticides was evident for the 16 counties within the Coalition watershed. Of these, four pesticides had greater than 25% decreases in total use. The recent usage trends and primary agricultural uses for these seven pesticides are summarized below.

Atrazine

- From 2004 to 2005, a 42% decrease in atrazine application was reported in the Coalition watersheds.
- In 2005, the predominant agricultural uses for atrazine in the Coalition watersheds were corn, sudangrass, and timberland forest.
- Atrazine was detected in six samples from four different Coalition sites.

Chlorpyrifos

- Between 2004 and 2005, the use of chlorpyrifos in the Coalition watersheds remained about the same (2.7% increase).
- In 2005, the predominant agricultural uses for chlorpyrifos in the Coalition watersheds were alfalfa, almond, and walnut crops.
- Chlorpyrifos was detected in only one irrigation season sample.

Diazinon

- Between 2004 and 2005, a 26% decrease in diazinon applications was reported in the Coalition watersheds.
- In 2005, the predominant agricultural uses for diazinon in the Coalition watersheds were almond, peach, prune, and walnut crops, and tomato processing.
- Diazinon was detected in only one irrigation season sample.

Diuron

- Between 2004 and 2005, a 27% decrease in diuron applications was reported in the Coalition watersheds.
- In 2005, the predominant agricultural uses for diuron in the Coalition watersheds were alfalfa and walnut crops, as well as rights-of-way (a non-agricultural use).
- Diuron was detected in three samples from two different Coalition sites.

Molinate

- Between 2004 and 2005, a 53% decrease in molinate applications was reported in the Coalition watersheds. Of the seven pesticides discussed here, use of molinate declined the most.
- Within the Coalition watersheds, molinate was solely used for rice crops in 2005.
- Molinate was detected in ten samples from five different Coalition sites.

Simazine

- Between 2004 and 2005, an 8.2% decrease in simazine applications was reported in the Coalition watersheds.
- In 2005, the predominant agricultural uses for simazine in the Coalition watersheds were almond, wine grape, and walnut crops, as well as rights-of-way (a non-agricultural use).
- Simazine was detected in eleven samples from six different Coalition sites.

Thiobencarb

- Between 2004 and 2005, an 11% decrease in thiobencarb applications was reported in the Coalition watersheds.
- Within the Coalition watersheds, thiobencarb was solely used for rice crops in 2005.
- Thiobencarb was detected in twenty samples from seven different Coalition sites.

Table 14. Total pesticide Applications in Sacramento Valley Water Quality Coalition Counties

County	Pounds Applied, 2003	Pounds Applied, 2004	Pounds Applied, 2005
Amador	101,889	117,736	150,022
Butte	3,062,292	2,962,210	3,142,996
Colusa	2,088,248	1,809,678	1,908,137
El Dorado	103,487	105,982	129,673
Glenn	2,284,461	2,399,082	2,207,066
Lake	786,874	704,033	757,574
Napa	1,934,856	2,236,410	2,338,185
Placer	267,931	374,618	318,128
Plumas	14,447	11,931	7,352
Sacramento	3,583,177	3,283,459	3,887,613
Shasta	293,445	294,416	217,830
Solano	1,089,607	1,025,269	1,013,223
Sutter	3,305,776	3,624,764	3,307,058
Tehama	659,978	596,303	858,989
Yolo	2,644,303	2,665,655	2,823,694
Yuba	1,427,355	1,398,577	1,499,642
Totals	**23,648,126**	**23,610,123**	**24,567,182**

Data Interpretation

SUMMARY OF SAMPLING CONDITIONS

Sample collection for the May – September 2006 Coalition irrigation season was characterized by predominantly dry weather with above-average temperatures. Based on climatic data available for the Sacramento Executive Airport weather station, a record total of 0.3 inches of precipitation fell during the month of May; 0.23 inches of this total occurred during a 24-hour period spanning May 21-22. A trace amount of precipitation occurred on July 19, and no precipitation occurred in August or September. The maximum temperature exceeded 90 degrees Fahrenheit on five days in May, 22 days in July, 17 days in August, and 11 days in September. Record-setting high temperatures occurred throughout the Sacramento Valley in July; the average maximum at the Sacramento Executive Airport during this month was 95.7 degrees Fahrenheit. No climatic data were available from the National Weather Service for the month of June.

ASSESSMENT OF DATA QUALITY OBJECTIVES

The QC data for the Coalition's monitoring program have been evaluated and discussed previously in this document (Quality Assurance Results, beginning page 24). Based on these evaluations, the program data quality objectives of completeness, representativeness, precision, and accuracy of monitoring data have largely been achieved. These results indicate that the data collected are valid and adequate to support the objectives of the monitoring program, and demonstrate compliance with the requirements of the *ILP*.

The results of these evaluations were summarized previously in Table 6 through Table 13.

EXCEEDANCES OF RELEVANT WATER QUALITY OBJECTIVES

Coalition and subwatershed monitoring data were compared to applicable narrative and numeric water quality objectives in the Central Valley Basin Plan (CVRWQCB 1995) and subsequent adopted amendments, and the California Toxics Rule (USEPA 2000). Observed exceedances of these recognized regulatory thresholds are the focus of this discussion. Other relevant water quality thresholds (e.g., recommended toxicity-based criteria or non-regulatory toxicity thresholds) were considered for the purpose of identifying potential causes of observed toxicity. It should be noted that these unadopted limits are not appropriate criteria for determining exceedances for the purpose of the Coalition's monitoring program and evaluating compliance with the *ILP*. The additional thresholds considered include USEPA aquatic life criteria (USEPA 1999) that were not included in the California Toxics Rule, USEPA Maximum Contaminant Levels (MCL) for drinking water, and minimum toxic thresholds from USEPA's Office of Pesticide Programs (OPP) Ecotoxicity database (USEPA 2002). Also considered are the recommended aquatic life criteria developed by the California Department of Fish and Game for diazinon and chlorpyrifos (Siepmann and Finlayson 2000), and the recently finalized National Water Criteria for diazinon (USEPA 2006). Water quality objectives and other relevant water quality thresholds discussed in this section are summarized in Table 15 and Table 16. Monitored analytes without relevant water quality objectives are listed in Table 17.

The data evaluated for exceedances in this document include all Coalition collected results, and the compiled results from the Subwatershed monitoring programs presented in this report. The results of these evaluations are discussed below.

Table 15. Adopted Basin Plan and California Toxics Rule Objectives for Analytes Monitored for the 2006 Irrigation Season

Analyte	Most Stringent Objective[1]	Units	Objective Source[2]
Ammonia, Total as N	narrative	mg/L	Basin Plan
Arsenic, dissolved	150	ug/L	CTR
Arsenic, total	50	ug/L	CA 1˚ MCL
Atrazine	1	ug/L	CA 1˚ MCL
Boron, dissolved	(700 as total)	ug/L	NA
Boron, total	700	ug/L	UN Ag Supply
Cadmium, dissolved	hardness dependent[4]	ug/L	CTR
Carbofuran	0.4	ug/L	Basin Plan
Chlorpyrifos	0.014	ug/L	DFG Recommended Criterion
Color	15[3]	CU	CA 1˚ MCL
Conductivity	900	uS/cm	CA Recommended 2˚ MCL
Copper, dissolved	hardness dependent[4]	ug/L	CTR
DDD (o,p' and p,p')	0.00083	ug/L	CTR
DDE (o,p' and p,p')	0.00059	ug/L	CTR
DDT (o,p' and p,p')	.00059	ug/L	CTR
Diazinon	0.05	ug/L	Basin Plan Amendment
Dieldrin	0.00014	ug/L	CTR
Dissolved Oxygen	5	mg/L	Basin Plan
Endrin	0.036	ug/L	CTR
Fecal coliform	400	MPN/100mL	Basin Plan
Glyphosate	700	ug/L	CA 1˚ MCL
Lead, dissolved	hardness dependent[4]	ug/L	CTR
Malathion	0.1	ug/L	Basin Plan
Molinate	10	ug/L	Basin Plan
Nickel, dissolved	hardness dependent[4]	ug/L	CTR
Nitrate, as N	10	mg/L	CA 1˚ MCL
Nitrite, as N	1	mg/L	CA 1˚ MCL
Oxamyl	200	ug/L	CA 1˚ MCL
Parathion, Methyl	0.13	ug/L	Basin Plan
pH	6.5-8.5	-log[H+]	Basin Plan
Selenium, total	5	ug/L	Basin Plan
Simazine	4	ug/L	CA 1˚ MCL
Temperature	narrative	ug/L	Basin Plan
Thiobencarb	1	ug/L	Basin Plan
Total Dissolved Solids	500	mg/L	CA Recommended 2˚ MCL
Total Suspended Solids	narrative	mg/L	Basin Plan
Toxicity, Algae Cell Density	narrative	ug/L	Basin Plan
Toxicity, Fathead Minnow Survival	narrative	ug/L	Basin Plan
Toxicity, Water Flea Survival	narrative	ug/L	Basin Plan
Turbidity	narrative	ug/L	Basin Plan
Zinc, dissolved	hardness dependent[4]	ug/L	CTR

(1) For analytes with more than one limit, the most limiting applicable adopted water quality objective is listed.

(2) *CA 1˚ MCLs* are the California's Maximum Contaminant Levels for treated drinking water; *CTR* indicates California Toxics Rule criteria.

(3) Applies only to treated drinking water.

(4) Objective varies with the hardness of the water.

Table 16. Unadopted Water Quality Limits for Analytes Monitored for the 2006 Irrigation Season

Analyte	Unadopted Limit(1)	Units	Limit Source
Boron, total	700	ug/L	UN Agricultural Supply Goal
Chlorpyrifos	0.014	ug/L	National Criterion DFG Recommended Criterion
Conductivity	900	uS/cm	CA Recommended 2˚ MCL
Diazinon	0.17	ug/L	USEPA 2006
E. coli (1)	235	MPN/100mL	Basin Plan Amendment
Conductivity	700	uS/cm	UN Agricultural Supply Goal
Diazinon	0.17	ug/L	National Criterion
Total Dissolved Solids	500	mg/L	CA Recommended 2˚ MCL
Total Dissolved Solids	450	mg/L	UN Agricultural Supply Goal

(1) Adopted by the Water Board but not approved by State Water Resources Control Board

Table 17. Analytes Required to be Monitored for the 2006 Irrigation Season Without Applicable Adopted or Unadopted Limits

Analytes	
Alkalinity	Orthophosphate, dissolved, as P
Bromacil	Oryzalin
Dimethoate	Paraquat
Discharge	Phosphorus as P, Total
Diuron	Total Kjeldahl Nitrogen
Hardness	Total Organic Carbon

Toxicity and Pesticide Results

Statistically significant toxicity was observed in one water quality sample collected from Spanish Creek below Greenhorn Creek on August 22, 2006, and in one sample collected by the SRWP at Sacramento Slough on August 24, 2006. Statistically significant toxicity to *Hyalella azteca* was also observed in sediment quality samples collected from three of ten different sites in September 2006 (Anderson Creek at Ash Creek Road, Dry Creek at Alta Mesa Road, and Z-Drain/Dixon RCD). Samples exhibiting statistically significant toxicity are summarized in Table 18.

The observations of toxicity to *Ceriodaphnia* and *Hyalella* were considered exceedances of the Basin Plan narrative objective for toxicity ("*All waters shall be maintained free of toxic substances in concentrations that produce detrimental physiological responses in human, plant, animal, or aquatic life*."), and the results were reported to the Water Board by the Coalition in "Exceedance Reports" as required by the *ILP* and the Coalition's MRPP. The Exceedance and Communication Reports detailing these results and any required follow-up testing and results are provided in Appendix D. The results of these reports are summarized below.

- Spanish Creek below Greenhorn Creek (SPGRN): In a toxicity test conducted with *Ceriodaphnia* on water samples, there was a reduction in survival of 50% compared to the control in the sample collected don August 22, 2006. This result was statistically significant and was reported as an exceedance of the Basin Plan narrative objective for toxicity. The observed toxicity triggered a Toxicity Identification Evaluation (TIE), which was initiated on August 28, 2006. The toxicity was not persistent in the original baseline sample (100% survival) for the TIE. Consequently, the TIE was inconclusive and the cause of the toxicity in the original sample could not be determined. A new sample was also collected on September

5, 2006 from the Spanish Creek site to evaluate the duration of toxicity at the site. There was no significant toxicity in the new sample.

- Sacramento Slough (SACSL): In a toxicity test conducted with *Ceriodaphnia* on water samples, there was a reduction in survival of 75% compared to the control. This result was statistically significant and was reported as an exceedance of the Basin Plan narrative objective for toxicity. The observed toxicity triggered a Toxicity Identification Evaluation (TIE), which was initiated on August 30 2006. The toxicity was not persistent in the original baseline sample (100% survival) for the TIE. Consequently, the TIE was inconclusive and the cause of the toxicity in the original sample could not be determined. There were no pesticides detected in the associated sample. New samples were also collected on August 30, 2006 from the SACSL site and from Reclamation Slough to evaluate the duration and potential sources of toxicity at the site. There was no significant toxicity in either of these two follow-up samples.
- Anderson Creek at Ash Creek Road (ACACR): In a toxicity test conducted on sediment samples with *Hyalella*, there was a reduction in survival of 5.1% compared to the control. This result was statistically significant and is therefore reported as an exceedance of the Basin Plan narrative objective for toxicity. Because the reduction in survival for the ACACR was less than 20% compared to the laboratory control, no further follow-up evaluations were pursued based on the results for this sample.
- Dry Creek at Alta Mesa Road (DCGLT): In a toxicity test conducted on sediment samples with *Hyalella*, there was a reduction in survival of 70% compared to the control. This result was statistically significant and is in exceedance of the Basin Plan narrative objective for toxicity.
- Z-Drain Dixon RCD (ZDDIX): In toxicity tests conducted on replicate sediment samples with *Hyalella*, there was a reduction in survival of 90% compared to the control. This result was statistically significant and is in exceedance of the Basin Plan narrative objective for toxicity.

The sediment samples originally collected from ZDDIX and DCGLT were inadvertently disposed of by the laboratory, subsequent to the determination of significant toxicity. If these samples were still available, they would have been analyzed for pesticides likely to be responsible for the toxicity. Because the original samples were no longer available, new samples were collected from these sites on November 21, 2006 and tested for sediment toxicity with *Hyalella*, and also analyzed for pyrethroid and organophosphate pesticides and total organic carbon. Toxicity was statistically significant in the new Z-Drain sample (21.8% reduction in survival compared to control), but not in the Dry Creek sample. The results of chemical analyses of these sediment samples indicated there were no detected organophosphate or pyrethroid pesticides in either sample.

Table 18. Summary of Water and Sediment Samples Exceeding the Basin Plan Narrative Toxicity Objective, May – September 2006

Test Species	Site	Sample Dates	% Survival	% of Control Survival	% Reduction in Survival
Ceriodaphnia	Lab Control (016-HA-HSControl-01)	NA	100%	100%	NA
	Spanish Creek below Greenhorn Creek	8/22/2006	50%	50%	50%
	Lab Control	NA	80%	100%	NA
	Sacramento Slough	8/22/2006	20%	25%	75%
	Lab Control	NA	100%	100%	NA
	Sacramento Slough (resample)	8/30/2006	100%	100%	0%(1)
	Reclamation Slough at Ensley	8/30/2006	100%	100%	0%(1)
Hyalella	Lab Control (016-HA-HSControl-01)	NA	98.8%	100%	NA
	Anderson Creek at Ash Creek Road	9/19/2006	93.8%	94.9%	5.1%
	Lab Control (016-HA-HSControl-02)	NA	100%	100%	NA
	Dry Creek at Alta Mesa Road	9/21/2006	30%	30%	70%
	Z-Drain Dixon RCD	9/22/2006	10%	10%	90%
	Z-Drain Dixon RCD (replicate sample)	9/22/2006	10%	10%	90%
	Lab Control (016-HA-HSControl-03)	NA	97.5%	100%	NA
	Dry Creek at Alta Mesa Road	11/21/2006	100%	103%	-3%(1)
	Z-Drain Dixon RCD	11/21/2006	76.3%	78.2%	21.8%

(1) No significant reduction compared to control.

Pesticides Detected in Coalition Monitoring

Pesticides were analyzed in 271 individual water column samples. Analyses were conducted for organophosphates, carbamates, organochlorines, triazines, glyphosate, paraquat, and pyrethroid pesticides. Within these categories, fourteen different pesticides were detected in 41 separate samples collected for Coalition monitoring (atraton, atrazine, chloroxuron, chlorpyrifos, DDE(p,p'), diazinon, dichlorvos, dimethoate, diuron, glyphosate, molinate, simazine, thiobencarb, and trifluralin). All detected pesticide concentrations for Coalition monitoring conducted between May and September are summarized in Table 19. Detection of pesticides alone does not necessarily indicate a water quality problem and most detections are not exceedances of adopted numeric or narrative water quality objectives.

- Detected pesticides did not appear to be the cause of toxicity in any water quality samples, and no pesticides were detected in 85% of Coalition samples analyzed for pesticides.
- Atraton was detected in one sample from North Canyon Creek (07/19/2006) and was not associated with any observed sample toxicity. There is no adopted objective for atraton.
- Atrazine was detected in six samples from three different sites and was not associated with any observed sample toxicity. Atrazine did not exceed the California 1˚ MCL (1 ug/L).

- Chloroxuron was detected in one sample from Z-Drain/Dixon RCD (05/26/2006) and was not associated with any observed sample toxicity. There is no adopted objective for chloroxuron.
- Chlorpyrifos was detected in only one sample (Butte Slough, 07/18/2006). The detected concentration (0.0028 ug/L) did not exceed the recommended California Department of Fish and Game criterion of 0.014 ug/L (Siepmann and Finlayson 2000), and the reported concentration is not expected to cause toxicity. Molinate and thiobencarb were also detected in this Butte Slough sample at concentrations well below those expected to cause toxicity.
- DDE(p,p') was detected below the limit of quantitation (QL) and below the required MRP QL in two samples from the Rough and Ready Pumping Plant site. DDE is a breakdown product of the legacy organochlorine pesticide DDT. Both detected concentrations exceeded the California Toxics Rule criterion (.00059 ug/L) for DDE. The detected concentrations of DDE were well below concentrations expected to be acutely toxic to aquatic organisms. No organochlorine legacy pesticides were detected in any other samples.
- Diazinon was detected in only one sample (North Canyon Creek, 05/25/2006). The detected concentrations (.008 ug/L) did not exceed the site-specific Basin Plan objective of 0.05 ug/L or the updated National criterion (0.17 ug/L, USEPA 2006), and is not expected to be acutely toxic to aquatic organisms. There was no toxicity observed in the associated sample.
- Dichlorvos was detected in one sample from Butte Slough (September 2006) and was not associated with any observed sample toxicity. Dichlorvos is a breakdown product of another pesticide (naled) and does not have any uses registered for irrigated agriculture. The primary use for naled is as a vector control agent for controlling adult mosquitos. Naled is typically applied for this use as an aerial spray and therefore has a relatively high risk of getting directly into surface water during application. There is no adopted objective for dichlorvos or naled.
- Dimethoate was detected in two samples and was not associated with any observed sample toxicity. There is no adopted objective for dimethoate.
- Diuron was detected in three samples. Detected concentrations were below levels expected to cause toxic effects to test species and detections were not associated with toxicity. There is no adopted objective for diuron.
- Glyphosate was detected in one sample from the Rough and Ready Pumping Plant site (08/16/2006). Glyphosate did not exceed or approach the California 1˚ MCL (700 ug/L), and the detected concentration was well below levels expected to cause toxic effects to the most sensitive test species (*Selenastrum*).
- Molinate was detected in nine samples from five sites. Detected concentrations were well below the Basin Plan objective (10 ug/L) and were below concentrations expected to cause acute toxicity to sensitive organisms. No toxicity was associated with the detected concentrations of molinate.
- Simazine was the second most common of the pesticides detected (in 11 samples from 6 different sites). Detected concentrations were below levels expected to cause toxic effects to sensitive test species and did not exceed the California 1˚ MCL of 4 ug/L in any sample. No toxicity was associated with the detected concentrations of simazine.

- Thiobencarb was the most common of the pesticides detected (in 18 samples from 7 different sites). Detected concentrations did not exceed the California 2˚ MCL of 1 ug/L in any sample and were below levels expected to cause toxic effects to sensitive test species. No toxicity was associated with detected concentrations of thiobencarb.
- Trifluralin was detected in one sample from the Rough and Ready Pumping Plant site (07/20/2006). The detected concentration was below levels expected to cause toxic effects to the most sensitive test species (*Selenastrum*). There is no adopted objective for trifluralin.
- Pyrethroid pesticides were not detected in any samples.
- Paraquat was not detected in any samples.

Table 19. Pesticides Detected in Coalition Monitoring, May – September 2006

Site	Date Sampled	Analyte	Result[1] (ug/L)	Water Quality Limits[2]	
Butte Creek at Gridley Rd Bridge	06/21/2006	Molinate	.173	10	Basin Plan
		(replicate)	.193	10	Basin Plan
		Thiobencarb	.184	1	CA 2˚ MCL
	07/18/2006	Thiobencarb	J .0635	1	CA 2˚ MCL
Butte Slough at Pass Road	06/21/2006	Molinate	1.8	10	Basin Plan
		Thiobencarb	.242	1	CA 2˚ MCL
	07/18/2006	Chlorpyrifos	.0028	.014	NA
		Molinate	.407	10	Basin Plan
		Thiobencarb	J .0617	1	CA 2˚ MCL
	08/15/2006	Molinate	.0963	10	Basin Plan
		Thiobencarb	.0274	1	CA 2˚ MCL
		(replicate)	.0314	1	CA 2˚ MCL
	09/19/2006	Dichlorvos	.1012	NA	NA
Colusa Drain near Maxwell Road	05/24/2006	Simazine	.0189	4	CA 1˚ MCL
	06/21/2006	Molinate	.118	10	Basin Plan
		Thiobencarb	J .0992	1	CA 2˚ MCL
	07/18/2006	Thiobencarb	J .0542	1	CA 2˚ MCL
	(replicate)		J .0582	1	CA 2˚ MCL
Coon Creek at Striplin Road	06/21/2006	Thiobencarb	J .0649	1	CA 2˚ MCL
	07/19/2006	Thiobencarb	J .0509	1	CA 2˚ MCL
	08/16/2006	Thiobencarb	.0347	1	CA 2˚ MCL
McGaugh Slough at Finley Road East	05/25/2006	Simazine	.0141	4	CA 1˚ MCL
North Canyon Creek	05/25/2006	Atrazine	J .0065	1	CA 1˚ MCL
		Diazinon	.0081	0.05; 0.17	Basin Plan; USEPA 2006
		Simazine	.152	4	CA 1˚ MCL
	06/22/2006	Atrazine	J .0056	1	CA 1˚ MCL
		Simazine	.0219	4	CA 1˚ MCL
	07/19/2006	Atraton	.01	NA	NA
		Atrazine	J .0066	1	CA 1˚ MCL
		Simazine	J .0077	4	CA 1˚ MCL
Rough and Ready Pumping Plant	05/25/2006	Diuron	J .29	NA	NA
	06/21/2006	DDE(p,p')	J .0032	.00059	CTR
		(replicate)	J .0044	.00059	CTR
		Thiobencarb	.598	1	CA 2˚ MCL
		(replicate)	.659	1	CA 2˚ MCL
	07/20/2006	DDE(p,p')	J .0049	.00059	CTR
		Dimethoate	.033	NA	NA
		Thiobencarb	.73	1	CA 2˚ MCL
		Trifluralin	.0154	NA	NA
	08/16/2006	Glyphosate	13	700	CA 1˚ MCL
		Thiobencarb	.118	1	CA 2˚ MCL
	09/20/2006	Thiobencarb	.102	1	CA 2˚ MCL
Shag Slough at Liberty Island Bridge	05/26/2006	Simazine	.0277	4	CA 1˚ MCL
	06/22/2006	Atrazine	J .008	1	CA 1˚ MCL
		Simazine	.02	4	CA 1˚ MCL
	07/20/2006	Simazine	J .0063	4	CA 1˚ MCL
Tule Canal at I-80	05/25/2006	Simazine	.0168	4	CA 1˚ MCL
	06/22/2006	Molinate	J .0776	10	Basin Plan

Site	Date Sampled	Analyte	Result[1] (ug/L)	Water Quality Limits[2]	
		Thiobencarb	J .0756	1	CA 2˚ MCL
	07/19/2006	Simazine	.0146	4	CA 1˚ MCL
	09/21/2006	Thiobencarb	J .0549	1	CA 2˚ MCL
Wadsworth Canal at South Butte Rd	06/21/2006	Molinate	.952	10	Basin Plan
		Thiobencarb	.12	1	CA 2˚ MCL
	07/19/2006	Molinate	.266	10	Basin Plan
	08/15/2006	Molinate	.132	10	Basin Plan
		Thiobencarb	.0258	1	CA 2˚ MCL
Z Drain – Dixon RCD	05/26/2006	Chloroxuron	J .25	NA	NA
	06/22/2006	Diuron	J .33	NA	NA
		Simazine	.0195	4	CA 1˚ MCL
	07/20/2006	Atrazine	J .009	1	CA 1˚ MCL
		Diuron	0.52	NA	NA
	09/22/2006	Atrazine	J .0064	1	CA 1˚ MCL
		Dimethoate	.7161	NA	NA
		(replicate)	.7343	NA	NA

(1) "J" indicates pesticide was detected below the quantitation limit (QL); "E" indicates measured value exceeded the calibration range and was qualified as *estimated*.

(2) "Basin Plan" indicates limit is an adopted objective in the Central Valley Basin Plan; "CA 1˚MCL" indicates a California Primary Maximum Contaminant Limit for drinking water (adopted by reference in the Basin Plan); "CDFG" is the recommended criterion for protection of aquatic life developed by the California Department of Fish and Game for chlorpyrifos, It is provided as an unadopted "Advisory Objective" for evaluation of the potential aquatic life impacts of chlorpyrifos; "NA" indicates no applicable objective available

(3) Concentration is qualified as *estimated* based on quality assurance results.

Other Coalition-Monitored Water Quality Parameters

Exceedances of adopted Basin Plan objectives and advisory limits were observed for pH and dissolved oxygen, conductivity and total dissolved solids, boron, and *E. coli* bacteria, (Table 20).

pH

pH was measured in 140 samples from 30 Coalition sites. In these samples, pH exceeded the Basin Plan maximum of 8.5 Standard Units (-log[H^+]) in 10 samples collected from 5 different sites, and was below the 6.5 minimum limit in one sample. The Basin Plan limit for pH is intended to be assessed based on "*…an appropriate averaging period that will support beneficial uses*". This parameter typically exhibits significant natural diurnal variation over 24 hours in natural waters with daily fluctuations controlled principally by photosynthesis, rate of respiration, and buffering capacity of the water. These processes are controlled by light and nutrient availability, concentrations of organic matter, and temperature. The factors combine to cause increasing pH during daylight hours and decreasing pH at night. Diurnal variations in winter are typically smaller because there is less light and lower temperatures. Irrigation return flows may influence this variation primarily by increasing or decreasing instream temperatures, or by increasing available nutrients or organic matter. The primary cause of elevated pH in nearly all of these samples was instream algal respiration, as confirmed by resampling to identify the diurnal pattern of pH and DO typical of this natural phenomenon. This cause was also often indicated by stagnant conditions, supersaturated oxygen concentrations and extensive benthic algal growth, particularly during late season low flow periods and unusually hot weather.

Dissolved Oxygen

Dissolved oxygen was measured in 139 samples from 30 sites. Dissolved oxygen concentrations were below the Basin Plan minimum objective for waters designated COLD (7 mg/L) in a total of 21 samples from 8 sites, and below the Basin Plan minimum objective for waters designated WARM (5 mg/L) in 11 samples from 7 sites. This is in contrast to the results for 2006 Storm Season samples, during which there were no exceedances for this parameter.

The primary causes of low dissolved oxygen concentrations during irrigation season were determined to be seasonally normal low flows and instream algal respiration, as confirmed by resampling to identify the diurnal pattern of pH and DO typical of this phenomenon. Evaluation of the field data indicate that similar conditions persisted from June through September sampling events at many sampled sites. These conditions are caused in substantial part by seasonally normal low flows and high water temperatures in small central valley streams and other water bodies, and it is expected that they will recur annually. The potential for the low flow and high ambient temperature conditions is increased by the lower volume of agricultural return flows that result from “best management practices” designed to improve irrigation efficiency and reduce pesticide and sediment transport from fields to surface waters. Consequently, generally accepted good management practices can be expected to result in a higher frequency of low dissolved oxygen and elevated pH in many Central Valley streams and drains. To the degree that this represents the natural condition of small seasonally dry streams in the Central Valley, this should not be viewed as an impact on the beneficial uses that are supported by these waterbodies. It also suggests that the designated COLD beneficial may not be appropriate for many of these water bodies on a seasonal basis.

E. coli bacteria

E. coli bacteria were monitored in 128 samples from 27 sites. Coliform bacteria numbers exceeded the single sample maximum objectives for *E. coli* (235 MPN/100mL) in 20 samples from 10 different Coalition locations. The Basin Plan objectives are intended to protect contact recreational uses where ingestion of water is probable (e.g., swimming). The *E. coli* objective was adopted by the Central Valley Regional Water Board as a Basin Plan Amendment in 2002, but the amendment has never been approved by the State Water Resources Control Board and therefore remains an unadopted objective. The primary potential agricultural sources of *E. coli* exceedances include cattle grazing and dairy operations, and direct manure applications to fields. Non-agricultural sources include leakage from septic tanks, wildlife, and waterfowl. In general, agricultural lands commonly support a large variety (and sometimes very large numbers) of birds and other wildlife. These avian and wildlife resources are suspected to be the primary sources of *E. coli* and other bacteria in Sacramento Valley agricultural runoff and irrigation return flows. The sources of *E. coli* exceedances are currently being investigated through a regional bacterial DNA study of sites with multiple *E. coli* exceedances. Based on the Study Plan schedule, initial results for the first sample event in September were expected to be available for inclusion in this report, but these results are not yet available for review.

Conductivity and Total Dissolved Solids

Conductivity was monitored in 130 samples from 26 sites. Conductivity exceeded the unadopted UN Agricultural Supply Goal (700 uS/cm) in nine samples from four sites, and exceeded the California recommended 2˚ MCL (900 uS/cm) for drinking water in six samples from three of these same sites. Total dissolved solids (TDS) was monitored in 116 samples from 28 sites. TDS exceeded the California recommended 2˚ MCL (450 mg/L) for drinking water in 6 samples collected from three sites. The conductivity and TDS objectives are intended to apply to treated drinking water and are based on aesthetic acceptance by consumers of the water. All except one of the exceedances of these unadopted objectives occurred in the Solano/Yolo Subwatershed. Conductivity and TDS are naturally high in the surface waters and groundwater that serve as the primary agricultural water supply in this drainage. This continues a pattern of exceedances of these parameters discussed in previous reports. Exceedances of narrative objectives for conductivity and TDS in the Solano/Yolo subwatershed are currently being addressed by the Yolo Management Plan for TDS, conductivity, and boron. The Management Plan also includes evaluation of potential agricultural impacts and management practice effectiveness.

Nutrients

Nutrients monitored during the 2006 irrigation season included nitrate, nitrite, total Kjeldahl nitrogen (TKN), ammonia, total phosphorus, and dissolved orthophosphate. Nutrients were monitored in 119 samples at 27 different Coalition sites, and did not exceed water quality objectives at any sites. Ammonia concentrations measured did not exceed the temperature- and pH-dependent National water quality criterion for this parameter in any sample, and nitrate and nitrite did not exceed their MCLs (10 mg/l as N, and 1 mg/L as N, respectively). There are no water quality objectives (adopted or unadopted) for TKN, total phosphorus, or orthophosphate.

Trace Metals

Total and dissolved trace metals monitored during the 2006 irrigation season included arsenic, boron, cadmium, copper, lead, nickel, selenium, and zinc. Trace metals were monitored in 86 samples collected from 21 Coalition sites. No trace metals exceeded adopted Basin Plan objectives or CTR criteria in any sample. Boron exceeded the unadopted UN Agricultural Supply Goal (700 ug/L) in four samples from two different Solano/Yolo subwatershed sites. Boron is naturally high in the soil and groundwater in this drainage. These exceedances are being evaluated and addressed by a regional management plan for Yolo County.

Table 20. Other Physical, Chemical, and Microbiological Parameters Observed to Exceed Numeric Objectives in Coalition Monitoring, May – September 2006

Site	Date	Analyte	Units	WQO	WQO Source(1)	Result
Andersen Creek at Ash Creek Road	05/23/2006	E. coli	MPN/100mL	235	BPA(4)	420
	06/20/2006	DO	mg/L	7 (COLD)	Basin Plan	6.74
		E. coli	MPN/100mL	235	BPA(4)	1700
	07/18/2006	DO	mg/L	7 (COLD)	Basin Plan	6.3
		E. coli	MPN/100mL	235	BPA(4)	610
	08/15/2006	E. coli	MPN/100mL	235	BPA(4)	400
	09/19/2006	DO	mg/L	7 (COLD)	Basin Plan	6.4
		E. coli	MPN/100mL	235	BPA(4)	250
	09/20/2006	E. coli	MPN/100mL	235	BPA(4)	1400
Burch Creek west of Rawson Rd	05/23/2006	PH	-log[H+]	6.5-8.5	Basin Plan	9.05
Butte Creek at Gridley Rd Bridge	06/21/2006	DO	mg/L	7 (COLD)	Basin Plan	6.16
		E. coli	MPN/100mL	235	BPA(4)	460
Coon Creek at Striplin Road	05/25/2006	E. coli	MPN/100mL	235	BPA(4)	1000
	07/19/2006	E. coli	MPN/100mL	235	BPA(4)	870
	08/16/2006	E. coli	MPN/100mL	235	BPA(4)	300
	09/21/2006	E. coli	MPN/100mL	235	BPA(4)	550
Dry Creek at Alta Mesa Road	06/22/2006	PH	-log[H+]	6.5-8.5	Basin Plan	8.58
	08/16/2006	PH	-log[H+]	6.5-8.5	Basin Plan	8.52
	09/21/2006	PH	-log[H+]	6.5-8.5	Basin Plan	8.69
Gilsizer Slough at George Washington Road	06/21/2006	DO	mg/L	5 (WARM)	Basin Plan	3.68
		E. coli	MPN/100mL	235	BPA(4)	770
	07/19/2006	DO	mg/L	5 (WARM)	Basin Plan	0
	08/16/2006	DO	mg/L	5 (WARM)	Basin Plan	.4
	09/20/2006	Conductivity	uS/cm	700	UN Ag Goal(3)	890
		DO	mg/L	5 (WARM)	Basin Plan	.46
Middle Fork Feather River at County Rd A-23	05/23/2006	DO	mg/L	7 (COLD)	Basin Plan	6.7
North Canyon Creek	06/22/2006	E. coli	MPN/100mL	235	BPA(4)	290
Rough and Ready Pumping Plant (RD 108)	07/20/2006	DO	mg/L	5; 7	Basin Plan	4.4
Shag Slough at Liberty Island Bridge	06/22/2006	boron	ug/L	(700 as total)	NA	1100
Spanish Creek above Greenhorn Creek	05/23/2006	PH	-log[H+]	6.5-8.5	Basin Plan	6.37
	06/20/2006	E. coli	MPN/100mL	235	BPA(4)	250
Stone Corral Creek near Maxwell Road	07/18/2006	DO	mg/L	7 (COLD)	Basin Plan	6.5
Stony Creek on Hwy 45 near Rd 24	06/20/2006	PH	-log[H+]	6.5-8.5	Basin Plan	8.73
	07/18/2006	PH	-log[H+]	6.5-8.5	Basin Plan	8.54
	09/19/2006	PH	-log[H+]	6.5-8.5	Basin Plan	8.61
Tule Canal at I-80	06/22/2006	boron	ug/L	700	NA	990
		Conductivity	uS/cm	700	UN Ag Goal(3)	905
		E. coli	MPN/100mL	235	BPA(4)	610
		TDS	mg/L	500	CA 2˚ MCL(2)	580
	07/19/2006	boron	ug/L	700	NA	1300
		Conductivity	uS/cm	700	UN Ag Goal(3)	952
		TDS	mg/L	500	CA 2˚ MCL(2)	1000
	08/17/2006	boron	ug/L	700	NA	1100
		Conductivity	uS/cm	700	UN Ag Goal(3)	822
		TDS	mg/L	500	CA 2˚ MCL(2)	550
Ulatis Creek at Brown Road	05/26/2006	Conductivity	uS/cm	700	UN Ag Goal(3)	763
		PH	-log[H+]	6.5-8.5	Basin Plan	8.7
	06/22/2006	Conductivity	uS/cm	700	UN Ag Goal(3)	931
		TDS	mg/L	500	CA 2˚ MCL(2)	620

Site	Date	Analyte	Units	WQO	WQO Source[1]	Result
	07/20/2006	Conductivity	uS/cm	700	UN Ag Goal[3]	1047
		E. coli	MPN/100mL	235	BPA[4]	280
		TDS	mg/L	500	CA 2˚ MCL[2]	610
	08/17/2006	Conductivity	uS/cm	700	UN Ag Goal[3]	1016
		E. coli	MPN/100mL	235	BPA[4]	2400
		PH	-log[H+]	6.5-8.5	Basin Plan	8.7
	09/22/2006	E. coli	MPN/100mL	235	BPA[4]	240
Wadsworth Canal at South Butte Rd	07/19/2006	E. coli	MPN/100mL	235	BPA[4]	490
Z Drain – Dixon RCD	05/26/2006	Conductivity	uS/cm	700	UN Ag Goal[3]	1080
		E. coli	MPN/100mL	235	BPA[4]	520
		TDS	mg/L	500	CA 2˚ MCL[2]	680
	07/20/2006	DO	mg/L	5 (WARM)	Basin Plan	4.15
		E. coli	MPN/100mL	235	BPA[4]	> 2400
	08/17/2006	E. coli	MPN/100mL	235	BPA[4]	650
	09/22/2006	E. coli	MPN/100mL	235	BPA[4]	290

(1) Sources of adopted objectives are the Central Valley Basin Plan and the California Toxics Rule (CTR).

(2) Unadopted limit, California recommended secondary MCL

(3) Unadopted limit, United Nations Agricultural Supply Goal

(4) Basin Plan Amendment for bacteria adopted by Central Valley Regional Board and not approved by State Water Resources Control Board.

Summary of Management Practices

COALITION STRATEGY

On May 10, 2005, the Coalition sent a "*Management Practices Action Plan*" to the Chairs of the Water Boards. The *Management Practices Action Plan*, which has been documented in previous Annual Reports, describes the aggressive approach that the Coalition has and will undertake to ensure the timely implementation of management practices in the Sacramento River Basin. Building on both the Coalition's *Management Practices Action Plan*, and the "*Regional Plan for Action*," submitted June 2003, the Coalition developed the *Landowner Outreach and Management Practices (MP) Implementation Communications Process for Monitoring Results* (provided in Appendix G). The Coalition's *Communications Process* outlines a more aggressive approach for the Coalition and its subwatersheds to follow when there are exceedances of water quality objectives formally adopted by the Regional Board.

The *Communications Process* provides a detailed approach that the Coalition and its subwatersheds will take when notifying the affected subwatershed landowners, farm operators and/or wetland managers about the cause(s) of toxicity or exceedances of water quality objectives. Depending on the causes of toxicity or exceedances, solutions will include a targeted outreach program with landowners and operators. The outreach program will encourage the adoption of known management practices or modifying the uses of specific farm and wetland inputs to prevent movement of constituents of concern into surface waters. The *Communications Process* will be implemented by the Coalition in 2007.

DIAZINON – TOTAL MAXIMUM DAILY LOAD

Landowner and crop advisor outreach was conducted in fall and winter 2005 prior to the dormant season sprays initiating in December 2005 and January 2006. These outreach presentations focused on the diazinon label changes and the finalized diazinon TMDL. Also included was information on available Best Management Practice options to protect surface waters from potential impacts of dormant season runoff of alternatives to diazinon, specifically pyrethroid insecticides. Presentations were given at the following events:

Date	Location/Event	Attendance
Sept. 22, 2005	Sacramento: PAPA CE meeting: growers/PCAs	150
Nov. 3, 2005	Woodland: CAPCA CE Meeting: PCAs	60
Nov. 3, 2005	Yuba City: Sutter Co. Ag Commissioner CE mtg: growers	35
Nov. 9, 2005	Yuba City: Sutter Co. Ag Commissioner CE mtg: growers	45
Nov. 17, 2005	Woodland: Western Plant Health Assn CE conference: PCAs	60
Dec. 7, 2005	Glenn: Glenn Co. Ag Commissioner CE Mtg: growers	75
Dec. 8, 2005	Colusa: Grower CE mtg: Growers, PCAs	45
Jan. 27, 2006	Woodland: Yolo County Ag Commissioner. CE Mtg: growers	75
Feb. 28, 2006	Chico: PAPA CE Meeting: PCAs/ Growers	150

Similar outreach efforts are planned with growers and PCAs in the winter of 2007 with presentations planned for meetings organized by: County Agricultural Commissioners in the major orchard growing regions; California Association of Pest Control Advisors (CAPCA); and Subwatershed groups who are members of the Sacramento Valley Water Quality Coalition.

ADOPTION OF ORCHARD BEST MANAGEMENT PRACTICES

Since the implementation of the Conditional Waiver for Discharges from Irrigated Lands in the central valley began in 2003, interest has increased in on-farm adoption of Best Management Practices (BMP's) designed to protect surface water quality. Dormant season insecticide treatment of orchard crops, which may coincide with storm water runoff and result in the transport of insecticides into surface waters, is an example of an agricultural practice of specific interest to the *ILP*. To evaluate the adoption of orchard management practices designed to minimize potential impacts of dormant season pesticide applications, a mail survey was conducted of 1378 orchard farmers from seven Sacramento Valley counties. The survey was conducted from November 2004 through February 2005 in Butte, Colusa, Glenn, Sutter, Tehama, Yolo, and Yuba counties of the Sacramento Valley.

A report describing the methods and results of the survey is included in Appendix G of this report (*Adoption of Orchard Best Management Practices (BMP's) in the Sacramento Valley*, Fulton and Lubell, 2006). The principal findings of the survey are presented below:

- Over one-half of the Sacramento Valley orchard producers surveyed indicated that they do not apply dormant sprays to their orchards every year. The authors conclude that this indicates that orchard farmers are using information and adopting BMP's that protect water quality at higher rates than a decade ago when dormant spray programs were more strongly emphasized to effectively manage economic pests and to manage food safety and worker safety concerns.
- Orchard producers who indicate applying dormant sprays every year report varying rates of adoption among conventional management practices, alternative pest management practices, and runoff control practices that protect water quality. Balance between economic risk/costs to the crop and protecting water quality appears to be a driving force behind adoption rates of various BMP's. Adoption rates appear to be higher for BMP's with which growers have a higher level of familiarity and greater confidence in their efficacy.

Results from the survey also provide a baseline measure of adoption rates of BMP's by orchard producers in the Sacramento Valley. This survey also provides a basic framework and some initial experience that should be considered for future efforts to track and document progress of adoption of BMP's for protecting water quality in the Sacramento Valley.

MANAGEMENT PRACTICES COMMUNICATIONS

Other outreach activities undertaken by the SVWQC include distribution of the *Watershed Coalition News*, developed by CURES, and the *Sacramento Valley Water Quality Coalition News* quarterly newsletters describing activities of the watershed coalitions and updates on Best Management Practice projects initiated in the region. Approximately 5,500 copies were distributed to growers through county Farm Bureaus, county Agricultural Commissioners, NCWA, and irrigation districts.

Actions Taken

LANDOWNER OUTREACH EFFORTS

Highlights of the outreach efforts conducted for specific subwatersheds during the 2006 Irrigation Season by the Coalition and its partners are listed in Table 21 below.

Table 21. Summary of Landowner Outreach Efforts

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
04/01/06	Shasta - Tehama	NRCS	Spring Water Conference	Shasta Fairgrounds	40
04/12/06	Lake / Napa	LCFB Board of Directors	Update on Ag Waiver	LCFB Office	18
04/13/06	Sacramento - Amador	Grape Growers	Herbicides	Plymouth	11
04/18/06	El Dorado	UCCE	Invasive weed alert and best management practices	311 Fair Lane, Placerville, CA 95667	30
04/20/06	Sacramento - Amador	Amador RCD	ILP Regulations	Jackson	7
04/24/06	Lake / Napa	Napa County Putah Creek Watershed Group	Steering Committee meeting	Napa County Farm Bureau	10
04/26/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Subwatershed Coordinator Meeting	Conference Call	13
04/28/06	El Dorado	UCCE	Contractor's best management practice workshop	311 Fair Lane, Placerville, CA 95667	30
04/28/06	El Dorado	UCCE	Home and Garden show booth	100 Placerville Dr. Placerville, CA 95667	5000
04/28/06	El Dorado	NRCS	Home and Garden show booth	100 Placerville Dr. Placerville, CA 95667	5000
04/28/06	El Dorado	RCD	Home and Garden show booth	100 Placerville Dr. Placerville, CA 95667	5000
05/10/06	Lake / Napa	LCFB Board of Directors	Update on Ag Waiver	LCFB Office	11
05/10/06	El Dorado	UCCE	Invasive weed identification and control workshop	311 Fair Lane, Placerville, CA 95667	30
05/10/06	Sacramento - Amador	Amador Irrigators	Spray	Jackson	15
05/11/06	El Dorado	Farm Bureau and RCD	Ag in the Classroom, Watershed Demonstration	100 Placerville Dr. Placerville, CA 95667	140
05/24/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Management Practices Outreach and Evaluation Subcommittee	Williams	11
05/31/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Subwatershed Coordinator Meeting	Conference Call	12

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
06/14/06	Lake / Napa	LCFB Board of Directors	Update on Ag Waiver	LCFB Office	15
06/21/06	NECWA (Pit River)	NECWA	NECWA Board Meeting	Burney, CA	15
06/22/06	NECWA (Pit River)	NECWA	Attended the Central Valley Water Board Meeting, Renewal of the Irrigated Lands Program	Regional Boards Rancho Cordova, CA	
06/22/06	Sacramento - Amador	Grape Growers	Spray	Plymouth	12
06/28/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Coalition Meeting	Woodland	38
07/12/06	Sacramento - Amador	Amador Irrigators	Test Results	Jackson	8
07/19/06	Shasta - Tehama	WSRCD	Monthly board meeting	Anderson, CA	20
07/20/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program/ Ag Commissioner, Solano RCD, Yolo County RCD and NRCS	Regional Board Members Tour	Yolo County	20
07/20/06	Sacramento - Amador	Lower Cosumnes RCD	Test Results	Elk Grove	10
07/26/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Subwatershed Coordinator Meeting	Conference Call	10
08/01/06	Shasta - Tehama	UCCE - Tehama, Glenn, Colusa, and Shasta Counties & Shasta County in conjunction with Cattlemen's Association	Mid-summer Educational Program. Three topics covered were the new waiver order, monitoring in our counties and the producer survey.	Shasta County	
08/01/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program & YCFC&WCD	Regional Board Staff Tour	Yolo County	6
Aug-06	NECWA (Pit River)	NECWA	NECWA Newsletter 2006	Coalition Wide	167
Aug-06	Solano / Yolo	Solano Irrigation District	Article on water quality Best Management Practices and available cost-share programs	Solano Irrigation District's "The Irrigator" newsletter	450 recipients
Aug-06	Colusa-Glenn	Glenn County Farm Bureau	Newsletter article on ag waivers 5 year extension	NA	860 Members
08/09/06	Lake / Napa	LCFB Board of Directors	Update on Ag Waiver	LCFB Office	19
08/09/06	Colusa-Glenn	Colusa-Glenn Subwatershed Program	Summary of testing results and ag waiver program in the area	Tri-Counties Newspaper Orland, Colusa, Willows papers	NA

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
08/10/06	Lake / Napa	Napa County Putah Creek Watershed Group	Steering Committee meeting	Napa County Farm Bureau	7
08/17/06	Sacramento - Amador	Amador RCD	Test Results	Jackson	6
08/18/06	Lake / Napa	Napa County Putah Creek Watershed Group	Letter to non-responders	NA	16
08/21/06	Sacramento - Amador	Sacramento Irrigators	Test Results	Elk Grove	20
08/23/06	NECWA (Pit River)	NECWA	NECWA Board Meeting	McArthur, CA	12
08/29/06	El Dorado	UCCE	Codling moth control and orchard spray calibration field meeting	311 Fair Lane, Placerville, CA 95667	30
08/30/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Subwatershed Coordinator Meeting	Conference Call	11
09/01/06	Colusa-Glenn	Colusa-Glenn Subwatershed Program	Central Valley Coalition newsletter sent to all Colusa Glenn Subwatershed Program members.	NA	NA
09/06/06	PNSSNS	PNSSNS	Press releases were also sent to Ag Commissioners and Placer and Nevada Counties' Farm Bureaus.	NA	NA
09/06/06	PNSSNS	PNSSNS	Planned first membership meetings to be held February 2007.	NA	NA
09/06/06	PNSSNS	PNSSNS	PNSSNS contracted with CURES, Parry Klassen and Tamara Taliaferro to provide education and outreach at our membership meetings.	NA	NA
09/06/06	PNSSNS	PNSSNS	PNSSNS hired Linda Watanabe as Secretary to handle membership drive and executive administrative duties.	NA	NA
09/06/06	PNSSNS	PNSSNS	Produced first newsletter "Placer-Nevada- So. Sutter-No. Sacramento Information and Background" and distributed it via our membership packet.	NA	NA
09/06/06	PNSSNS	PNSSNS	Produced a membership packet which included letter from our president, survey, sign-up form and the newsletter.	NA	NA
09/07/06	Sacramento - Amador	SAWQA	Newsletter	Region	2000

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
09/13/06	Lake / Napa	LCFB Board of Directors	Update on Ag Waiver	LCFB Office	23
09/15/06	NECWA (Pit River)	Sacramento Valley Water Quality Coalition	Attended Water Forum Meeting	Yuba City	
09/19/06	Shasta - Tehama	STWEC	News releases to all area newspapers and Capital Press	Redding, Anderson, Red Bluff, Millsville, Sacramento	200,000
09/20/06	Shasta - Tehama	STWEC	Newsletter	Shasta & Tehama	1,500
09/27/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Participated in Subwatershed Coordinator Conference Call	Conference Call	9
09/28/06	Solano / Yolo	Yolo RCD	Article on Yolo and Solano counties' cost-share program for water quality Best Management Practices	Daily Democrat	
09/28/06	Sacramento - Amador	Lower Cosumnes RCD	State Lands	Elk Grove	6
09/29/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Submitted Participant List to Regional Water Boards		
10/01/06	El Dorado	Farm Bureau	Farm Bureau Newsletter, October 2006, article on Conditional Waiver	Mailing Distribution	1850
10/06/06	NECWA (Pit River)	NECWA	Distributed to NECWA Members and Local Newspapers- Watershed Coalition News Summer 2006		167
10/09/06	NECWA (Pit River)	NECWA	Follow up on News Release about Dec. 31st Deadline sent from Regional Boards to Newspapers- Contacted local newspaper to see if they received the article and emailed a copy to those who hadn't received.		7 Newspapers- Mountain Echo, Intermountain News, Modoc Record, Record Searchlight, Lassen Co. Times, Siskiyou Daily News, Mt. Shasta Herald
10/11/06	Lake / Napa	LCFB Board of Directors	Update on Ag Waiver	LCFB Office	14
10/12/06	Solano / Yolo	Dixon RCD	Presentation on Conditional Ag Waiver Program and the D/SRCD Water Quality Coalition	Solano RCD Watershed Partnership Projects Tour	40 attendees
10/13/06	NECWA (Pit River)	NECWA	Submitted to Local Newspapers- Notice Sent by Regional Board on December 31st Deadline for Irrigated Landowners to Join Coalitions.		5 Newspapers- Mtn. Echo, Intermountain News, Modoc Record, Record Searchlight, Lassen Co. Times

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
10/18/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Coalition Meeting	Yolo Co. Farm Bureau-Woodland	28
10/25/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Participated in Subwatershed Coordinator Conference Call	Conference Call	14
10/26/06	Sacramento - Amador	Amador RCD	Budget	Jackson	8
10/27/06	Sacramento - Amador	Lower Cosumnes RCD	Budget	Elk Grove	6
11/01/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Seminar for Realtors, Lenders, and Title Companies	Woodland	95 invited, 35 attended
11/02/06	Butte-Yuba-Sutter	Sutter County Agricultural Department	Growers' Meeting: New field workers safety info, Controlling weeds in your orchard, Why we care about pesticides in our rivers, Fall aphid treatments in prunes, Enforcement response policy, Water quality update, Orchard sprayer demo	142 Garden Hwy. Yuba City, CA 95991	
Nov-06	NECWA (Pit River)	NECWA	Distributed to NECWA Members and Local Newspapers- SVWQC Fall Newsletter		167
Nov-06	Lake / Napa	Napa County Putah Creek Watershed Group	Letter to PCWG members, invite to Jan 18,2007 General Membership meeting, invoice for 2006/07 program		79
11/08/06	Lake / Napa	LCFB Board of Directors	Update on Ag Waiver	LCFB Office	18
11/08/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Large Grower Meeting: Irrigated Ag Lands	Woodland	
11/08/06	Butte-Yuba-Sutter	Primary: CSU Chico Others: Butte and Yuba Counties UCCE(1) and Ag. Commissioners; Butte Co. RCD/NRCS(2), CURES(3), B-Y-S Subwatershed Group(4)	5th Annual Field Crop Seminar: *Tentative* agenda items: BMP review, Filter strip implementation, Smart Sprayer display, sprayer calibration display	California State University Chico Farm 311 Nicholas Schouten Ln. Chico, CA 95928	
11/08/06	Lake / Napa	Napa County Putah Creek Watershed Group	Steering Committee meeting	Napa County Farm Bureau	9

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
11/08/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Large Grower Meeting: Irrigated Ag Lands	Woodland	151 invited, 28 attended
11/09/06	Sacramento - Amador	Grape Growers	Erosion Control	Plymouth	30
11/15/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Grower Meeting: Irrigated Lands Program Information	Woodland	700 invitations listed all 3 grower meetings, 43 attended
11/16/06	Lake / Napa	Mendocino College	Pest Management Seminar	Adventist Hall - Lakeport	90
11/16/06	Butte-Yuba-Sutter	Sutter County Agricultural Department	Growers' Meeting: Controlling weeds in your orchard, Controlling squirrels and voles, Why we care about pesticides in our rivers, Water quality update, Orchard sprayer demo	142 Garden Hwy. Yuba City, CA 95991	
11/16/06	Butte-Yuba-Sutter	Primary Rick GettysButte and Yuba Counties: RCD, NRCS, UCCE(1), Ag. Commissioner; CURES(3), B-Y-S Subwatershed Group(4)	PCA Meeting CAPCA Annual Meeting	Ordbend Hall Ord Community Hall 3241 Hwy 45 Glenn, CA 95943	
11/17/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Irrigated Ag Lands Landowners Meeting	Woodland	3129 to all landowners participating in program, 68 people attended
11/19/06	Lake / Napa	Regional Board	Nutrient TMDL Clear Lake	Board of Supervisors Chambers	20
11/27/06	Solano / Yolo	Dixon RCD	Presentation on Conditional Ag Waiver Program and the D/SRCD Water Quality Coalition	Landowners Association Meeting, Elmira	20 attendees
11/29/06	Coalition Wide	Sacramento Valley Water Quality Coalition	Participated in Subwatershed Coordinator Conference Call	Conference Call	
11/29/06	Butte-Yuba-Sutter	Primary: Butte County Farm Bureau Others: Butte County Ag. Commissioner, Butte County RCD(2), B-Y-S Subwatershed Group(4), CURES(3)	Irrigated Lands Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.	Durham Memorial Hall 9313 Midway Durham, CA 95938	

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
11/29/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Grower Meeting: Irrigated Lands Program Information	Clarksburg	17 people attended
11/30/06	Butte-Yuba-Sutter	Sutter County Agricultural Department	UC Growers' Meeting New field workers safety info, Controlling squirrels and voles, Dos and Don'ts of spray adjuvants, Fall aphid treatments in prunes, Closed mixing systems - why and how	142 Garden Hwy. Yuba City, CA 95991	
12/01/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Water Quality Brochure	Yolo County	4000 printed. Will be mailed in 2007
12/04/06	Shasta - Tehama	STWEC	Radio Interview	Redding	15,000
12/04/06	Colusa-Glenn	Ag Commissioner	Colusa County Ag Dept growers meeting - results and BMPs for Chlorpyrifos, Diazinon, pyrethroids	Colusa	34
12/05/06	Butte-Yuba-Sutter	Primary: B-Y-S Subwatershed Group(4), Others: Butte County RCD, NRCS(2), Ag. Commissioner; CURES(3),	Butte Yuba Sutter Subwatershed Coalition Annual Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.	Butte County Fairgrounds 1991 E Hazel Gridley, CA 95948	
12/05/06	Butte-Yuba-Sutter	Butte-Yuba-Sutter Subwatershed Water Quality Coalition	Butte Yuba Sutter Coalition Annual Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.	Butte County Fairgrounds 1991 E Hazel Gridley, CA 95948	Approximately 2000 on distribution list
12/05/06	Colusa-Glenn	Ag Commissioner	Glenn County Ag Dept growers meeting - results and BMPs for Chlorpyrifos, Diazinon, pyrethroids	Ordbend	123
12/06/06	PNSSNS	PNSSNS	Currently contacts with organizations such as Placer County Wine & Grapes Assoc. or Auburn Ravine Horse Assoc. are being developed.		

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
Dec-06	Butte-Yuba-Sutter	Sacramento Valley Water Quality Coalition	E. Coli letters sent to landowners in area with high E.coli counts (counts provided by the City of Biggs Waste Water Treatment Plant)	Biggs, CA	6
Dec-06	Solano / Yolo	Dixon RCD	Article on the D/SRCD Water Quality Coalition	Dixon RCD Newsletter	200 recipients
12/08/06	Lake / Napa	Resource Management Committee/ County of Lake	Irrigated Lands Program Report	Board of Supervisors Chambers	30
Dec-06	Solano / Yolo	Solano Irrigation District	Article on water quality Best Management Practices and available cost-share programs	Solano Irrigation District's "The Irrigator" newsletter	450 recipients
12/09/06	Lake / Napa	Common Ground Workshop - organic ag.	Water Quality Regs.	Big Valley Grange	70
Dec-06	Solano / Yolo	Dixon RCD	Article on the D/SRCD Water Quality Coalition	Dixon RCD newsletter	200 recipients
Dec-06	Solano / Yolo	Solano Irrigation District	Article on water quality Best Management Practices and available cost-share programs	Solano Irrigation District's "The Irrigator" newsletter	450 recipients
12/12/06	Solano / Yolo	Dixon RCD	Presentation on Conditional Ag Waiver Program and summary of water quality monitoring results	Pesticide Applicators Meeting, Solano County Ag Commissioner's Offices	50 attendees
12/12/06	Butte-Yuba-Sutter	Primary: B-Y-S Subwatershed Group(4), Others: Sutter County RCD, NRCS(2), Ag. Commissioner; CURES(3),	Butte Yuba Sutter Subwatershed Coalition Annual Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.	Yuba-Sutter Fairgrounds 442 Franklin Ave. Yuba City, CA 95991	
12/12/06	Butte-Yuba-Sutter	Butte-Yuba-Sutter Subwatershed Water Quality Coalition	Butte Yuba Sutter Coalition Annual Meeting: Water quality monitoring results, BMP implementation, Grass filter strip implementation program, Sprayer Calibrations, NRCS-EQIP funding, etc.	Yuba Sutter Fairgrounds 442 Franklin Ave. Yuba City, CA 95991	Approximately 2000 on distribution list
12/12/06	Solano / Yolo	Dixon RCD	Presentation on Conditional Ag Waiver Program and summary of water quality monitoring results	Pesticide Applicators Meeting, Solano County Ag Commissioner's Offices	50 attendees
12/13/06	Lake / Napa	Ag. Grower Rules & Regs. Workshop	Kelly Briggs - Speaker	Board of Supervisors Chambers	60

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
12/14/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Grower Meeting: Irrigated Lands Program Information	Woodland	
12/14/06	Butte-Yuba-Sutter	Sutter County Agricultural Department	UC Growers' Meeting Dos and Don'ts of spray adjuvants, Review of phermone use in walnuts & peaches, Prune research review - building a better berm for long-term tree health, Closed mixing systems - why and how	142 Garden Hwy. Yuba City, CA 95991	
12/14/06	Shasta - Tehama	UCCE	UCCE Workshop	Corning	100
12/14/06	Shasta - Tehama	UCCE	Irrigated Lands Program	Cottonwood	60
12/14/06	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Grower Meeting: Irrigated Lands Program Information	Woodland	held AM and PM meetings, 20 people in AM and 25 in PM attended
12/15/06	Butte-Yuba-Sutter	Primary: CSU Chico Others: Butte County UCCE(1), RCD, NRCS(2), Ag. Commissioner; CURES(3), B-Y-S Subwatershed Group(4)	Growers' Meeting: BMP implementation, Grass filter strip implementation program, Smart Sprayer demonstration, sprayer calibration demonstration, etc.	California State University Chico Farm 311 Nicholas Schouten Ln. Chico, CA 95928	
6/2006 - 7/2006	Lake / Napa	Lake County Farm Bureau	Various water quality articles Farm Bureau Newsletter	Mail	850
8/17/2006 & 8/18/2006	Coalition Wide	UCCE - Tehama, Glenn, Colusa, and Shasta Counties	Farm Water Quality Field Days - management practices to minimize off-site movement of sediments and pesticides associated with sediments in irrigation tailwater from row crops	UC Davis Farm, Chico State Farm	
Apr-06 - Dec-06	Shasta - Tehama	STWEC	Monthly meetings	Cottonwood	5 to 10
Fall 2006	PNSSNS	PNSSNS	To be readily identifiable, a logo is currently being designed. We expect to choose our final logo the first week in January 2007.	N/A	N/A

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
Fall/ Winter 2006-07	PNSSNS	PNSSNS	To be readily accessible, a website is being designed. PNSSNS teamed up with the Lincoln High School Future Farmers of America and senior Michael Thomas is working on our website. We expect to have a completed website in January 2007.	N/A	N/A
June through December 2006	Solano / Yolo	Dixon and Solano RCD Water Quality Coalition	Mailings of enrollment information and forms for the Conditional Ag Waiver Program and Water Quality Coalition newsletters	Throughout Solano County	Approximately 1000 mailings
June through November 2006	Solano / Yolo	Solano RCD	Meetings with thirteen landowners and managers to provide information on water quality Best Management Practices and available cost-share programs	Throughout Solano County	13 landowners or managers
Monthly	NECWA (Pit River)	NECWA	Rod McArthur, NECWA Board Member, attends monthly meetings of the Big Valley Water Users, Fall River RCD and Pit River Alliance representing NECWA	Big Valley, McArthur	Varies
Monthly	NECWA (Pit River)	NECWA	Craig McArthur and Ted DeBraga, NECWA Board Members, attend monthly meetings with the local Cattleman's representing NECWA	Big Valley, McArthur	
Monthly	El Dorado	Chamber of Commerce	Conditional Waiver Update Report	542 Main Street. Placerville, CA 95667	14/ meeting
Monthly	El Dorado	County Ag Council	Conditional Waiver Update Report	311 Fair Lane, Placerville, CA 95667	35/ meeting
Monthly	El Dorado	Farm Bureau	Conditional Waiver Update Report	2460 Headington Road. Placerville, CA 95667	15/ meeting
Monthly	El Dorado	El Dorado County Agricultural Watershed Group	Conditional Waiver Update Report	311 Fair Lane, Placerville, CA 95667	10-15/ meeting
October 06 / November/ December	Lake / Napa	Lake County Farm Bureau	Various water quality articles Farm Bureau Newsletter	Mail	850
On Going	NECWA (Pit River)	NECWA	Archiving of Historical Data on the Upper Pit River Watershed	NA	
Ongoing	El Dorado	Farm Bureau	Conditional Waiver Update Report	http://www.edcfb.com/site/pdf/EDCAWG%20article%2011-05.pdf	unknown

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
Quarterly	Coalition Wide	Sacramento Valley Water Quality Coalition	Water Coalition News distributed Valley Wide		3,000 Quarterly
Sept-06 Nov-06	PNSSNS	PNSSNS	Three sets of press releases were sent to Lincoln News Messenger, Sentinel News, The Union, Appeal-Democrat, Press Tribune and the Sacramento Bee. At this writing, Lincoln News Messenger, Press Tribune for Roseville and Granite Bay papers, and Appeal-Democrat have confirmed publication in "Community Briefs" before the Dec. 31st deadline.	NA	NA
Spring 2006	Coalition Wide	Sacramento Valley Water Quality Coalition	Sacramento Valley Water Quality Coalition Newsletter	Coalition Wide	305
Spring 2006	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Irrigated Lands Waiver Newsletter, Volume 1, Issue 2	Yolo County	4,000
Spring, Summer, Fall	Colusa-Glenn	Colusa County FB	Article on Waiver		1000
Summer 2006	Coalition Wide	Sacramento Valley Water Quality Coalition	Sacramento Valley Water Quality Coalition Newsletter	Coalition Wide	310
Summer 2006	NECWA (Pit River)	NECWA	Contacted irrigated landowners and talked with them about the importance of joining the coalition. Took in several new members.	NECWA	*Not provided*
Summer 2006	NECWA (Pit River)	NECWA	Contacted existing members that have not resigned their membership and talked with them about the importance of staying with NECWA.	NECWA	*Not provided*
Summer 2006	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Irrigated Lands Waiver Newsletter, Volume 1, Issue 3	Yolo County	4,000
Summer and Fall 2006	Solano / Yolo	Solano RCD	Article on water quality Best Management Practices and available cost-share programs	Solano RCD "Lay of the Land" newsletter	450 recipients

Date	Subwatersheds	Organization	Topics	Location	# of People in Attendance or on Distribution List
Winter 2006	Solano / Yolo	Yolo County Farm Bureau Education Corporation - Subwatershed Program	Irrigated Lands Waiver Newsletter, Volume 1, Issue 4	Yolo County	4,000
Year 2006	El Dorado	Ag Commissioner	The Department of Agriculture Pesticide Enforcement staff discusses with each one of these permittees the Irrigated Ag Lands Waiver. We hand out informational materials developed by the Farm Bureau and the Water Board and the Coalition.	NA	El Dorado County Department of Agriculture issued 632 pesticide permits in 2006.
Year 2006	El Dorado	RCD/Ag Commissioner	Each permittee receives at least two maps of their property, one highlighting topography and one with aerial photography. The maps are utilized to identify sensitive sites on the property and in the adjacent environment. Water Bodies are highlighted on these maps.	NA	El Dorado County Department of Agriculture issued 632 pesticide permits in 2006.
Year 2006	NECWA (Pit River)	NECWA	Provided contact information for other Northern California alliances, State Boards and meeting notices to our general membership.	NA	167
Year 2006	NECWA (Pit River)	NECWA	Chico Pedotti and Dick Mackey, NECWA Board Members, are on the Modoc RCD Board and represent NECWA	Alturas, CA	

Conclusions and Recommendations

The Coalition submits this 2006 Irrigation Season Semi-Annual Monitoring Report (SAMR) under the Water Board's Irrigated Lands Program (*ILP*). The 2006 Irrigation Season SAMR provides a detailed description of our monitoring results as part of our ongoing efforts to characterize agricultural and wetlands related water quality in the Sacramento River Basin.

To summarize, the results from the irrigation monitoring in 2006 are generally positive and suggest that there are not major water quality problems with agricultural and managed wetlands discharges in the Sacramento River Basin. Specifically, toxicity was observed in less than 3% of the toxicity tests performed in 2006 irrigation season. For the sites with observed toxicity, the Coalition and its subwatersheds took the appropriate actions to attempt to evaluate causes and sources of toxicity and to address these issues. By its nature, the SAMR focuses in detail on the small number of sites and samples that exhibited toxicity and exceedances of conventional and microbiological parameters, as well as the actions that were taken and are planned by the Coalition and its members to address these issues.

This SAMR characterizes potential water quality impacts of agricultural drainage from a broad geographic area in the Sacramento Valley from May through September 2006. To date, a total of four Coalition storm season sampling events and eleven irrigation events have been completed. For the period of record in this Semi-Annual Report (May – September 2006), samples were collected during five scheduled Coalition events at 30 locations, plus some additional samples collected for follow-up evaluations.

From May through September 2006, 192 water column toxicity tests were conducted with three aquatic species on 65 samples from 15 sites. There were two statistically significant water column toxicity exceedances with reductions of *Ceriodaphnia* survival greater than 20% compared to control. In total, only 1% of all tests and 3% of water samples exhibited a statistically significant reduction in water flea or fish survival or algal cell growth. The frequency of significant toxicity observed during this irrigation season was lower than the previous storm season and lower than reported for the previous irrigation season annual report. No samples caused toxicity to the fathead minnow (*Pimepheles promelas*) or algae (*Selenastrum*). Chemical results were evaluated for all of the cases of observed toxicity, and in none of these cases was the toxicity explained by concentrations of detected pesticides or other water quality parameters. For the two samples that triggered TIE procedures to investigate the cause of toxicity, toxicity was not persistent (i.e., there was no significant toxicity in the untreated baseline TIE sample), indicating a rapid breakdown of the source of toxicity, and therefore probably a short duration of toxicity in ambient waters.

There were three statistically significant sediment toxicity exceedances (including one replicate sample) for the 11 total sediment samples tested with *Hyalella azteca*. Follow-up samples collected at the two sites indicated that toxicity was not persistent or significantly reduced after 60 days. There were no detectable organophosphate or pyrethroid pesticides in the two follow-up samples, and the specific cause of sediment toxicity was not determined.

Currently registered pesticides detected in irrigation season 2006 samples did not exceed applicable objectives, and were not associated with toxicity. The only detected pesticide that exceeded applicable water quality objectives was DDE(p,p'), a breakdown product of a legacy organochlorine pesticide (DDT). Several of the pesticides specifically required to be monitored by the ILP have not been detected in any water sample, including paraquat, and all of the pyrethroid pesticides. This indicates that monitoring of these pesticides in water is unlikely to provide meaningful results regarding sources or needs for changes in management practices. Based on these results, the Coalition requests that the Water Board consider dropping these pesticides from water column monitoring, and monitoring them only in sediment or not at all.

The majority of exceedances of adopted numeric objectives consisted of pH, conductivity, dissolved solids, and *E. coli*. Although agricultural runoff and irrigation return flows may contribute to exceedances of these objectives, all of these parameters are significantly affected by natural processes and sources that are not controllable by agricultural management practices. Causes of the observed exceedances of water quality objectives for pH were not investigated by the Coalition because effective methods had not yet been identified. However, follow-up strategies to evaluate causes of pH and dissolved oxygen exceedances were implemented by the Coalition in the 2006 irrigation season. Causes of *E. coli* exceedances are also being investigated through a regional study of bacterial DNA sources. The Coalition also continues to participate in the *ILP* Technical Issues Committee (TIC) workgroups to develop procedures and guidelines for evaluation of exceedances. The TIC is charged with developing recommendations for amendments to the current *ILP* Monitoring and Reporting Program requirements and procedures.

The Coalition monitoring included some Phase 2 monitoring elements during the 2005 irrigation seasons, concurrent with the Phase 1 irrigation season monitoring, and has added and continued these elements for many of the current monitoring sites. The Phase 2 elements monitored include additional pesticide analyses, trace elements, and nutrients. Planned future monitoring will routinely include the full range of required *ILP* parameters as appropriate for specific sites.

Substantial progress has been made by the Coalition toward full compliance with the *ILP*. The Coalition has developed a Watershed Evaluation Report (WER) which set the priorities for development and implementation of the Monitoring and Reporting Program Plan (MRPP). The Coalition successfully developed the MRPP and QAPP required by the *ILP*, and these documents have been approved by the Water Board. Subsequent revisions requested by the Water Board have been incorporated into these documents and were implemented during the 2006 irrigation season monitoring.

The Coalition implemented the approved monitoring program in coordination with its subwatershed partners, and has initiated follow-up activities to address observed exceedances. The Coalition has also completed a Management Practice Action Plan (provided in Appendix G) designed to communicate information and monitoring results within the Coalition, to track implementation of management practices in the watershed, and to evaluate effectiveness of management practices. Throughout this process, the Coalition has kept an open line of communication with the Water Board and has made every effort to fulfill the requirements of the *ILP* in a cost-effective and scientifically defensible manner. This SAMR is documentation of the success and continued progress of the Coalition in achieving these objectives.

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APPENDICES

APPENDIX A: Field Log Copies (Provided in Separate Volumes)

APPENDIX B: Lab Reports and Chains-of-Custody (Provided in Separate Volumes)

APPENDIX C: Tabulated Monitoring Results

APPENDIX D: Communication Reports

APPENDIX E: Pesticide Use Trends

APPENDIX F: Site-Specific Drainage Maps

APPENDIX G: SVWQC Management Practices

- IMPLEMENTATION COMMUNICATIONS PROCESS
- ADOPTION OF ORCHARD BEST MANAGEMENT PRACTICES (BMP'S) IN THE SACRAMENTO VALLEY (FULTON AND LUBELL, 2006)