CHAPTER VIII. ALTERNATIVES FOR IMPLEMENTING SALINITY CONTROL MEASURES IN THE SAN JOAQUIN RIVER BASIN

The 1995 Bay/Delta Plan contains salinity objectives for the San Joaquin River at Vernalis to protect agricultural beneficial uses of water in the southern Delta. The salinity objectives can be met either through provision of high-quality dilution water or through salinity control measures in agricultural lands and wetlands that drain to the San Joaquin River. The environmental effects of provision of dilution water are described in Chapter VI.

Salinity control measures can be used to achieve the Vernalis salinity objectives either alone or in combination with dilution water releases. The CVRWQCB is principally responsible for implementing salinity control measures in the San Joaquin Valley. The purpose of this chapter is to review the existing salinity control actions in the San Joaquin Valley and to analyze any new salinity control alternatives that are not presently being implemented or analyzed in some other forum. The information in this chapter will be used by the SWRCB to decide whether it should recommend further evaluation and implementation of salinity control measures to the CVRWQCB. A SWRCB decision to recommend evaluation of an action by the CVRWQCB does not require CEQA compliance. Nonetheless, the alternatives in this chapter are analyzed at the programmatic level to provide information to the SWRCB and to interested parties.

The chapter is divided into three sections: (A) background, (B) alternatives for implementing the objectives, and (C) environmental effects of the alternatives.

A. BACKGROUND

The background discussion is divided into three sections: (1) problem description, (2) regulatory history, and (3) existing salinity management programs.

1. Problem Description

The salinity problem in the San Joaquin River Basin is caused both by saline discharges, principally from irrigated agriculture, and by low flows due to water development. Detailed descriptions of the salinity problems in the San Joaquin River Basin were prepared by the SWRCB in a report entitled "Regulation of Agricultural Drainage to the San Joaquin River" (SWRCB 1987) and by the San Joaquin Valley Drainage Program in a report entitled "A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley" (SJVDP 1990). The following discussion summarizes parts of these reports.

The southern portion of California's Central Valley is comprised of two hydrologic basins, the San Joaquin River Basin and the Tulare Lake Basin, which are separate except during extremely high runoff events (Figure VIII-1). This report focuses on agricultural drainage in the San Joaquin River Basin.

The approximately seven-million acre San Joaquin River Basin extends from the Delta, south to the upper San Joaquin River, west to the Coast Range, and east to the Sierra Nevada. Three main tributaries to the San Joaquin River, the Merced, Tuolumne, and Stanislaus rivers, drain the east side of the basin. On the west-side, ephemeral streams drain the Coast Range, rarely contributing to the San Joaquin River flows. Approximately two million acres in the San Joaquin River Basin are devoted to irrigated agriculture.

Salinity and drainage problems are not new in the San Joaquin Basin. They developed rapidly as irrigated agriculture spread into arid lands, areas with naturally poor drainage and high water tables, and low-lying flood overflow lands. As early as 1886, elevated soil salinity and waterlogging related to agricultural operations were observed. By the turn of the century, these conditions reduced productivity and forced abandonment of some areas on the east-side of the basin. In an attempt to solve this problem, the U.S. Department of Agriculture demonstrated the use of subsurface tile drainage systems in 1909.

During the 1920s, the demand for reliable irrigation supplies resulted in the first comprehensive, statewide water analysis and plan. In 1929, the DWR published the California Water Plan in its Bulletin Number 3. The elements of the 1929 California Water Plan were known as the CVP (see Water Code §11100 et seq.). The primary objective of the plan was to store water from the northern Sacramento Valley where there was a water surplus and transport this water to irrigate lands in the San Joaquin Valley where there was a water shortage. The CVP included Shasta Dam, the Contra Costa Canal, the Delta Cross Channel, Tracy Pumping Plant, the Delta-Mendota Canal, Friant Dam, the Madera Canal, and the Friant-Kern Canal (see Figure VIII-2). The State approved the CVP in 1933 and issued bonds to finance its construction, but due to the Great Depression the bonds were not sold. Federal financing was eventually obtained, and the USBR was given responsibility for construction and operation of the above elements of the CVP. The federal CVP facilities serving the San Joaquin Valley were constructed between 1944 and 1951.

The CVP diverted high-quality San Joaquin River water into the Tulare Lake Basin and substituted the San Joaquin River supply with poorer quality water from the Delta. The CVP also facilitated expansion of irrigated agriculture into the arid uplands of the west-side of the San Joaquin Valley. Formerly, irrigated agriculture in these areas was limited due to poor quality or inaccessible ground water supplies. The availability of CVP water contributed to a new set of drainage and water quality problems.

With a reliable supply of surface water, groundwater pumping for irrigation was reduced and the groundwater basin began to refill. The semiconfined aquifer above the Corcoran Clay is now fully saturated in much of the west side of the San Joaquin Valley. Most of the soils in this area are derived from marine sediments of the Coast Ranges that contain salts and potentially toxic trace elements such as arsenic, boron, molybdenum and selenium. When these soils are irrigated, the substances are dissolved and leached into the shallow groundwater. Irrigation-induced leaching of the soil and accumulation of salts from imported water have concentrated dissolved salts in the upper portion of the semiconfined aquifer.

Figure VIII - 1
San Joaquin Valley showing San Joaquin River Basin, Tulare Lake Basin and Sacramento-SanJoaquin Delta

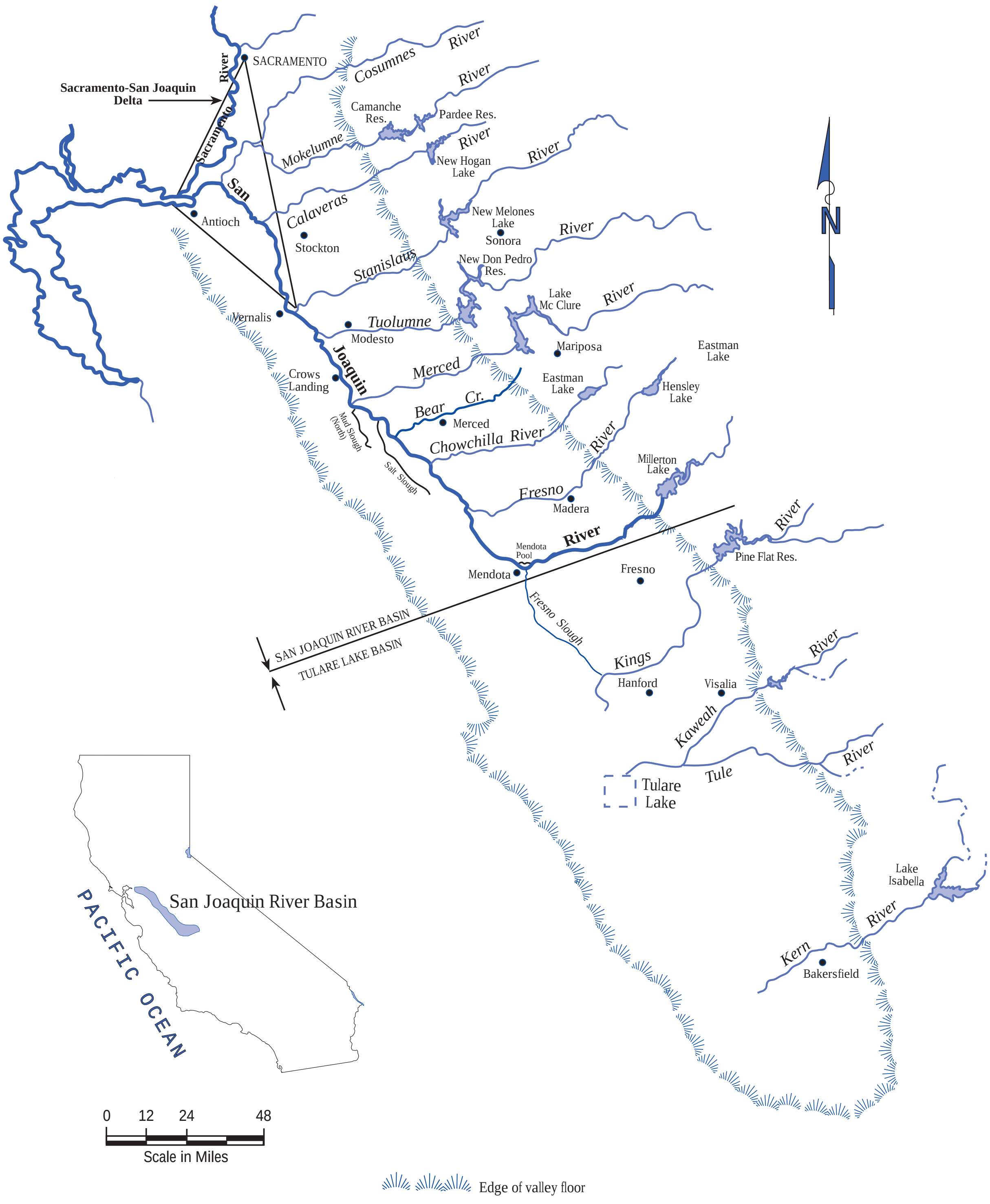
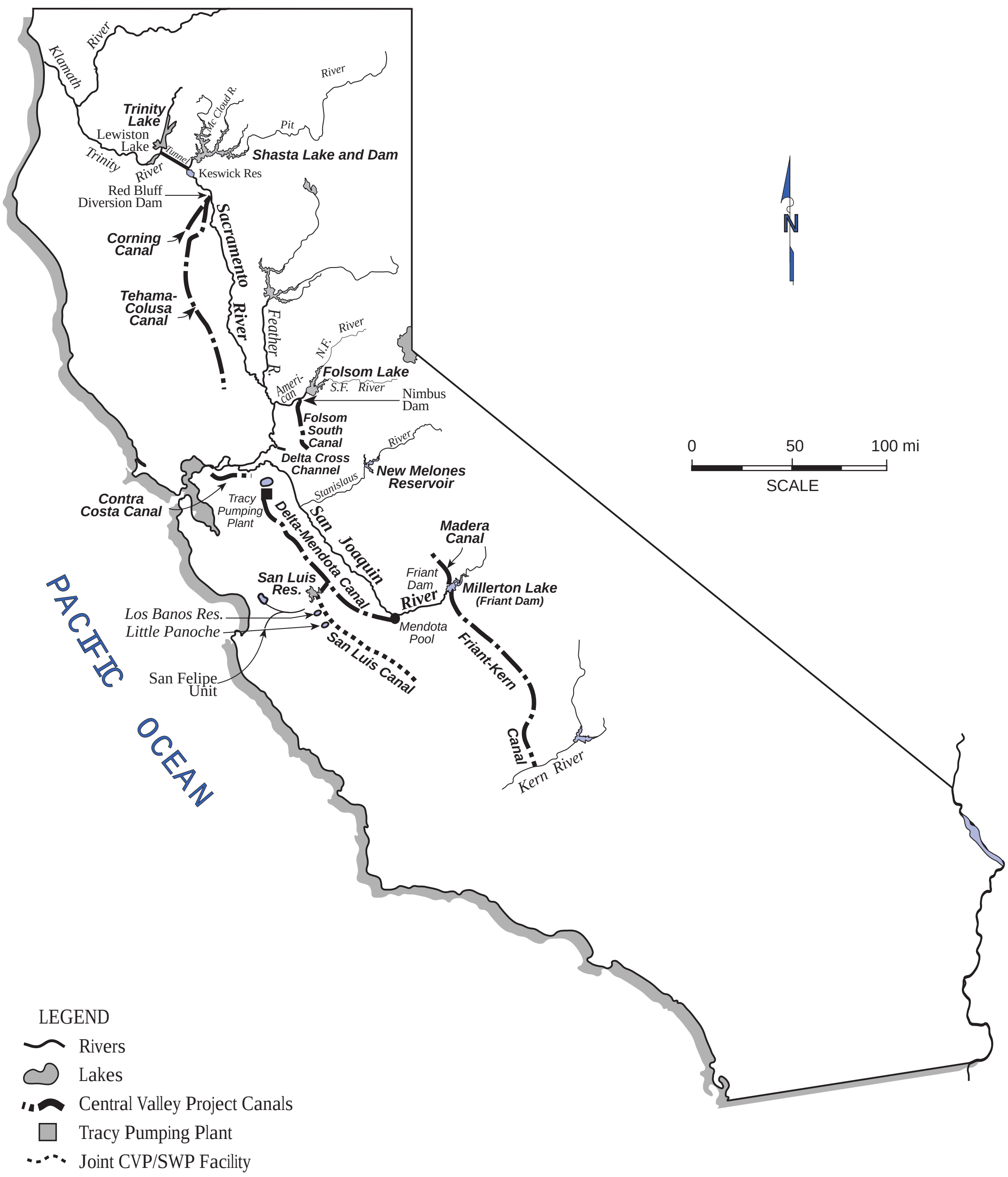


Figure VIII-2
Major Features of the Central Valley Project



In order to alleviate salt buildup in the soil and high water table conditions, growers in the west-side of the San Joaquin Basin began installing subsurface drainage systems in the 1950s to dispose of accumulated drain water to the San Joaquin River. The location of drainage problem areas and existing tile drained areas in the San Joaquin River Basin are shown in Figure VIII-3 (SWRCB 1987).

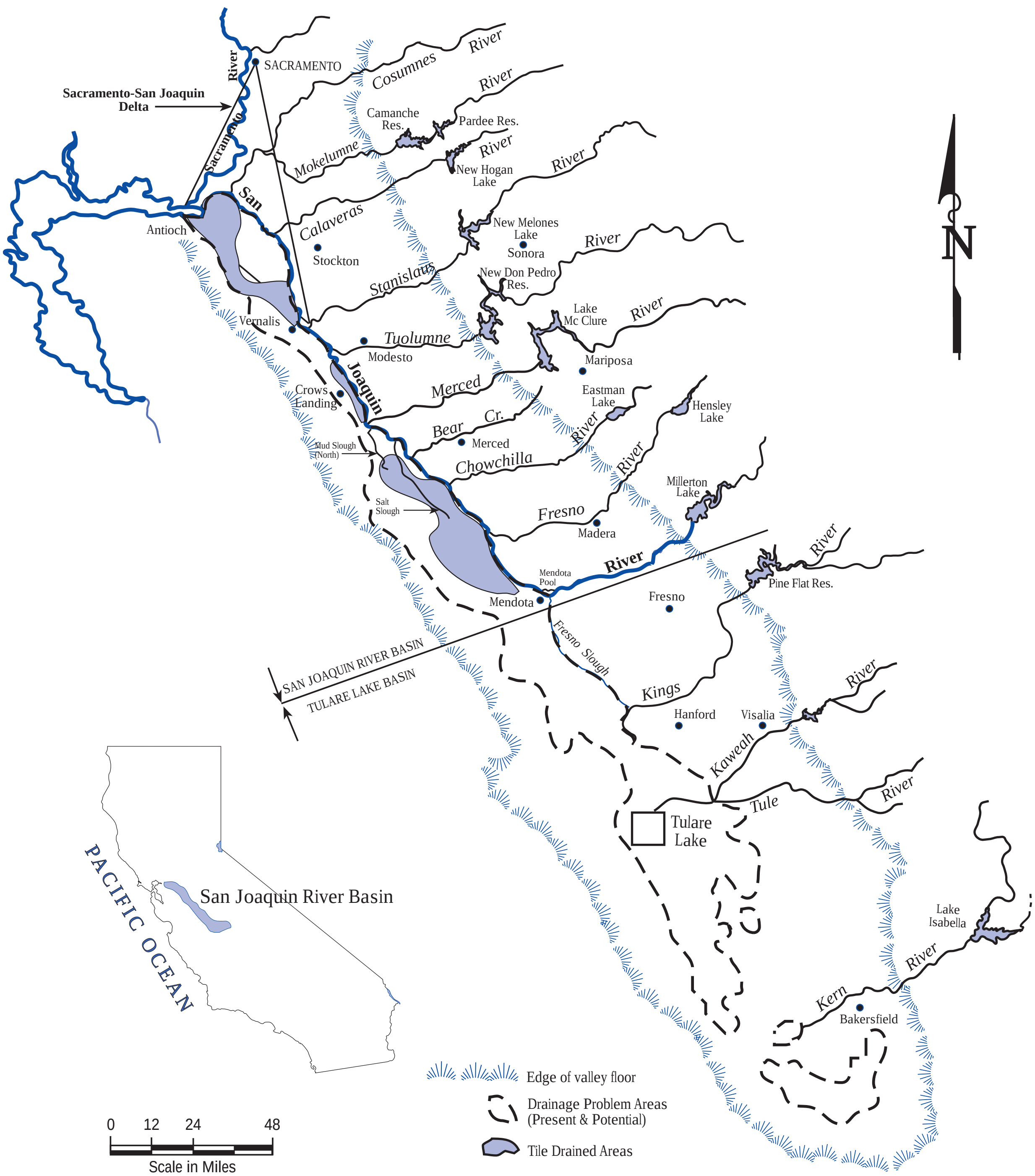
In the 1950s, state and federal agencies realized that planned water importation projects would worsen these problems. The authorization for the SWP and the San Luis Unit of the CVP included plans for a master drain to remove subsurface drainage from the San Joaquin Valley. During the 1960s, the USBR and the DWR collaborated on plans for staged construction of a San Joaquin Valley drain that would discharge in the Delta. The DWR eventually withdrew from the planning process because it was unable to develop a method for repayment of reimbursable costs that was acceptable to the future drain users. The USBR continued with plans to build a 188 mile San Luis Interceptor Drain. From 1968 to 1975, an 85 mile segment was built between the town of Five Points and Kesterson Reservoir. San Luis Drain construction was halted in 1975 because of federal funding problems, environmental impact concerns, and uncertainty about a final location for drain discharges. Consequently, the Interagency Drainage Program was formed to develop an economically, environmentally, and politically acceptable plan to handle these issues.

The Interagency Drainage Program's recommendations were published in 1979 (IDP 1979). The preferred plan was a 290 mile long drain extending from the Tulare Basin to the discharge point near Chipps Island in Suisun Bay. In 1981, the USBR requested the SWRCB to issue a permit for discharge of San Luis Drain effluent to Suisun Bay. The SWRCB then specified the information that the USBR would have to submit to support its application. Federal drainage studies began shortly thereafter.

By 1978, subsurface agricultural drainage blended with irrigation water began flowing in the San Luis Drain. This water was discharged into Kesterson Reservoir, which operated as a terminal evaporation facility. By 1981, the entire flow of the drain was subsurface drainage originating from approximately 8,000 acres in the Westlands Water District (5,000 acres with tile drains plus 3,000 acres influenced by the 42,000 acre collector system). Shortly thereafter, waterfowl deaths and embryonic deformities were observed at Kesterson Reservoir. These observations were traced to the presence of selenium at an average concentration of approximately 300 ppb in the drainage water. In response to a complaint from a landowner near Kesterson Reservoir, the SWRCB held a series of evidentiary hearings and, in 1985, adopted Order No. WQ 85-1. Among other provisions, this order established conditions for continued discharge to the reservoir. The USBR, however, announced that it would no longer accept subsurface drainage from Westlands Water District into the San Luis Drain, and Kesterson Reservoir was closed. Since then, the district has not discharged subsurface collector drain water beyond its boundaries.

There has not been substantial progress on construction of a drainage facility since this period. The existing status of the drainage facility is discussed in section A.3 of this chapter.

Figure VIII -3
Drainage Problem Area Including Existing Tile Drained Area in the San Joaquin River Basin



The drainage problem in the San Joaquin Basin is exacerbated by extensive water development, which has reduced the assimilative capacity of the San Joaquin River. The level of water development in the basin is illustrated in Table VIII-1, which lists the major reservoirs in the basin and their capacities. In 1980, the USBR and the South Delta Water Agency jointly prepared a report entitled "Report on the Effects of the CVP upon the Southern Delta Water Supply Sacramento-San Joaquin River Delta, California" (USBR 1980). The report states that construction of the CVP alone reduced the average annual flow in the San Joaquin River at Vernalis by somewhere in the range of 544 TAF to 943 TAF, which is as much as 29 percent of the average annual post-1947 flow at this location.

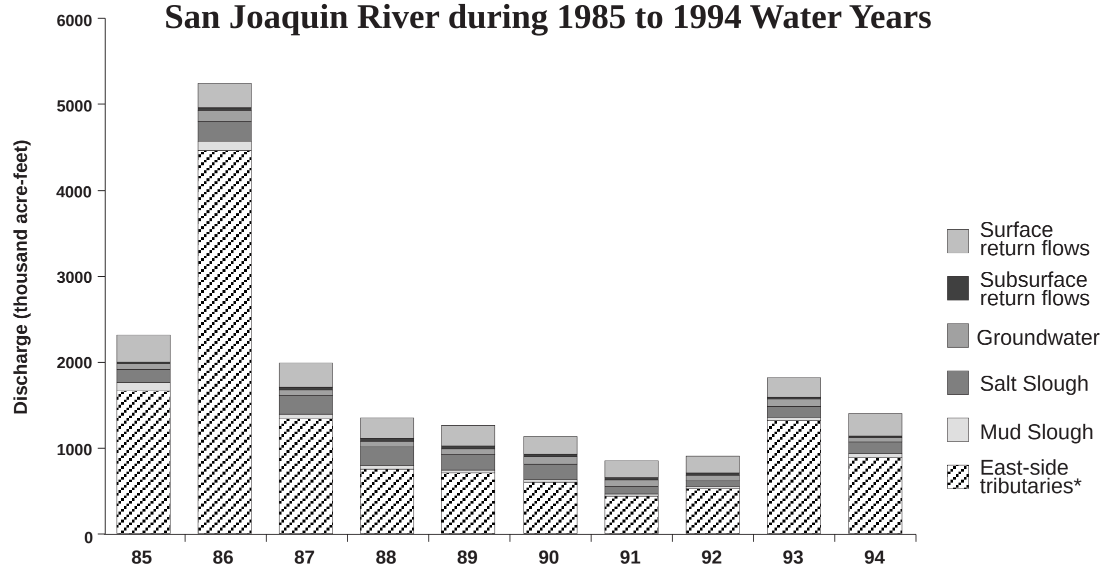
Table VIII-1
Major Reservoirs in the San Joaquin River Basin

Name	River	Date of Completion	Capacity (acre-feet)
Millerton	San Joaquin	1947	520,500
New Exchequer	Merced	1967	1,025,000
Hetch Hetchy	Tuolumne	1923	360,000
Cherry Valley	Tuolumne	1956	268,000
New Don Pedro	Tuolumne	1971	2,030,000
New Melones	Stanislaus	1979	2,400,000

a. **Salinity Sources**. The SJRIO model was used to estimate flow and TDS loading in the lower San Joaquin River (Lander Avenue to Vernalis). The magnitudes of flows and TDS loads from different sources in each year from 1985 through 1994 are shown in Figures VIII-4 and VIII-5. The average annual flow and TDS load contribution from these sources for the same period are shown in Figures VIII-6 and VIII-7. The east- side tributaries and the upstream segment of the San Joaquin River account for 69 percent of the flow but only 16 percent of the TDS load to the lower San Joaquin River. The Mud and Salt sloughs contribute only 11 percent of the flow but 44 percent of the TDS load to the San Joaquin River. Mud and Salt sloughs are composed of discharge from surface and subsurface return flows, wetland releases, ground water accretions, and flood flows. Additional sources of the TDS load are groundwater accretions (21%), surface return flows (16%), and subsurface return flows (3%) along the main stem of the San Joaquin River, downstream of Mud Slough. Recent studies show that March and April wetland releases from the southern half of Grassland Water District can account for ten percent of the TDS load in Salt Slough during these months (Grober et al, 1995). This represents approximately four percent of the total salt load in the San Joaquin River near Vernalis during these months just from a portion of the Grasslands Water District.

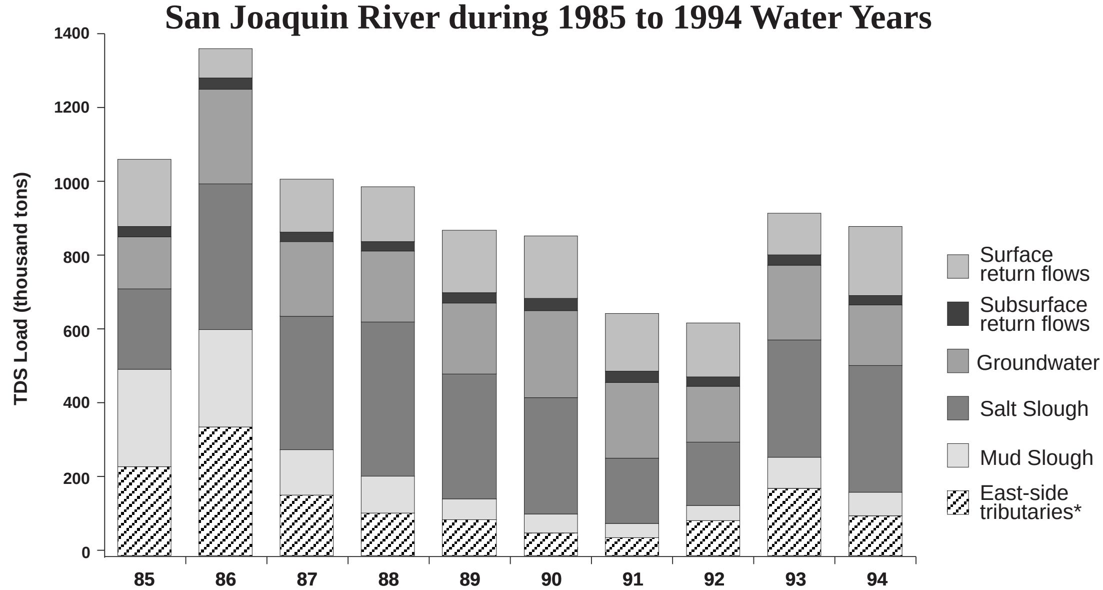
Salt Slough originates at Sand Dam near the confluence of Salt Slough Ditch and West Delta Drain and flows northwestward until it reaches the San Joaquin River approximately 3.5 miles

Figure VIII-4
Sources and Magnitude of Flow in the Lower San Joaquin River during 1985 to 1994 Water Years



* includes upstream segment of the San Joaquin River

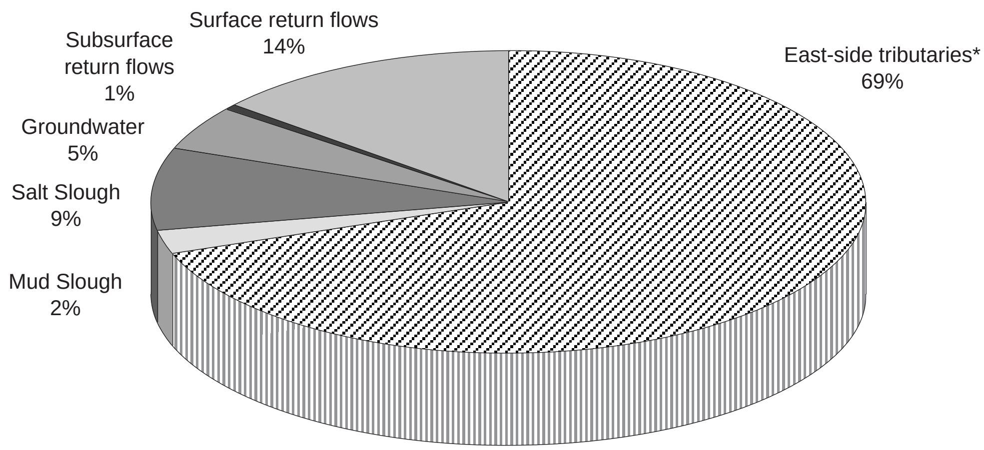
Figure VIII-5
Sources and Magnitude of TDS Load in the Lower San Joaquin River during 1985 to 1994 Water Years



* includes upstream segment of the San Joaquin River

Figure VIII-6
Lower San Joaquin River Flow

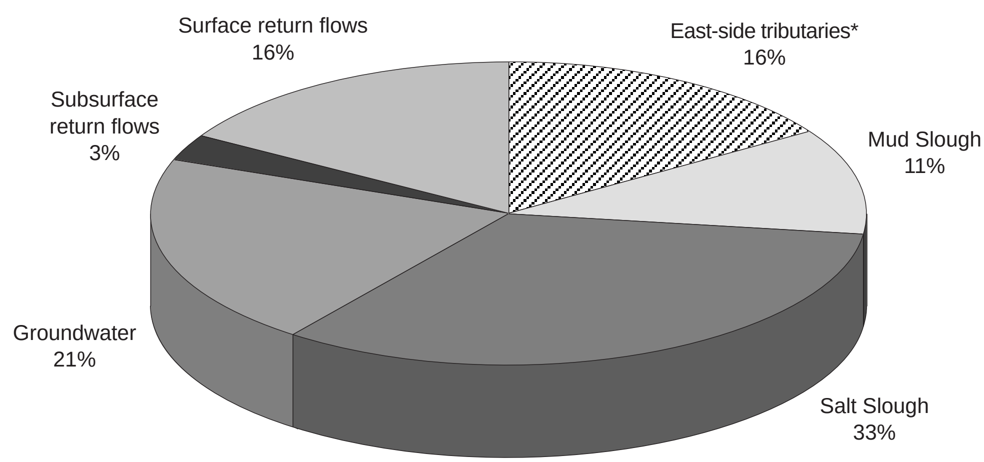
Average Annual Percent Flow From Different Sources for Water Years 1985 to 1994



** includes upstream segment of the San Joaquin River*

Figure VIII-7
Lower San Joaquin River TDS Loads

Average Annual Percent TDS Load From Different Sources for Water Years 1985 to 1994



** includes upstream segment of the San Joaquin River* downstream of Fremont Ford State Park. Salt Slough is a typical valley floor slough. It has a very small slope; it meanders and is generally shallow and slow moving except during periods of exceptionally high flow. The majority of the flow in Salt Slough originates in the San Luis Canal Company Water District; however, major inputs are received from the Central California Irrigation District, the Poso Canal Company, and the Grassland Water District. During the winter and early spring, its flows are a mixture of subsurface agricultural drainage, precipitation runoff, and discharges from local duck clubs and wildlife refuges. During the summer and fall months, its flows are made up of agricultural tailwater, irrigation spill water, and subsurface agricultural drainage. An inventory of discharges to Salt Slough has been prepared by the CVRWQCB (CVRWQCB 1989a), and 71 discharges are identified in this inventory. The majority of discharges enter Salt Slough prior to the south entrance of the San Luis National Wildlife Refuge, in the first 9.9 miles of the 20.7 miles length of Salt Slough. Most of these discharges carry tailwater drainage from areas planted in field crops. The discharges to Salt Slough north of this point are either from pasture land or duck ponds.

Mud Slough (North) flows in a northerly direction from Kesterson Ditch to the San Joaquin River, which it intersects approximately two miles upstream of the Merced River confluence. Like Salt Slough, during the winter and early spring, its flows are a mixture of subsurface agricultural drainage, precipitation runoff, and drainage from local duck clubs and wildlife refuges. During the summer and fall, its flows are made up of agricultural tail water, irrigation spill water, and subsurface agricultural drainage. There are 42 discharges into Mud Slough (North) (CVRWQCB 1989b). Numerous discharges are from wetland areas, either private duck clubs or federal refuges, and are seasonal discharges of low volume. The major discharges are from the tributaries: Kesterson Ditch, Fremont Canal, Santa Fe Canal, and Los Banos Creek. All four tributaries carry agricultural subsurface drainage and irrigation spill water at one time or another. The majority of the subsurface agricultural drainage reaches Mud Slough (North) via the Santa Fe Canal; the majority of the flows in Los Banos Creek are irrigation spill water.

Starting in October, 1996, all subsurface drainage that previously discharged to Mud or Salt sloughs through a series of wetland channels was routed via the Grassland Bypass Project into the northernmost portion of the San Luis Drain. The San Luis Drain discharges into Mud Slough (North) approximately nine miles upstream of the confluence with the San Joaquin River.

Table VIII-2
Average TDS Load at Vernalis* (Tons)

Period	1960-69	1970-79	1980-89
April-August	288,000	316,000	466,000
Annual	846,000	897,000	1,166,000

* Calculated using monthly average of daily EC or TDS and monthly average of daily flow at Vernalis from 1960 to 1989 (Grober 1996).

b. **Historical Salinity Conditions and Future Trends.** The increase in the salt load and concentration at Vernalis from the 1930s through the 1960s are documented in a 1980 report prepared jointly by the USBR and South Delta Water Agency (USBR 1980). More recent increases in the salt load at Vernalis are illustrated in Table VIII-2. This table shows that the April through August salt load in the 1980s was 62 percent higher than the load in the 1960s, and the corresponding annual load increase was 38 percent. This load increase, coupled with reduced flows due to water development, has reduced the quality of water available to water users diverting water from the lower San Joaquin River and the southern Delta. Salinity conditions at Vernalis for water years 1986 through 1995 are illustrated in Figure VIII-8. During this period, the USBR made releases of dilution water from New Melones Reservoir to meet a year-round water quality objective of 500 ppm TDS (approximately 800 mmhos/cm), as required by D-1422. This objective was often exceeded because of insufficient water in New Melones Reservoir to provide adequate dilution flows. The objectives adopted in the 1995 Bay/Delta Plan are also plotted in Figure VIII-8, and the percent of days these objectives would have been exceeded if they had been in effect in water years 1986 through 1995 is illustrated in Figure VIII-9. These plots show that additional control measures will be needed to ensure compliance with Vernalis water quality objectives, especially during the irrigation season.

The problem of increasing salt loads and concentration at Vernalis will worsen in the future unless some action is taken because the rate of accretion of salt in the basin exceeds the rate of excretion. The difference in these rates between 1950 and 1989 averaged approximately 446,000 tons per year and totaled 18,621,000 tons (Orlob 1991).

2. Regulatory History

This section describes the history of the SWRCB's and the CVRWQCB's regulation of salinity at Vernalis. Relevant plans and decisions include: (a) D-1275, (b) D-1422, (c) 1978 Delta Plan and D-1485, (d) 1991 Bay/Delta Plan, (e) 1995 Bay/Delta Plan and Order WR 95-6, and (f) CVRWQCB Basin Plans.

a. **D-1275**. In 1967, the SWRCB adopted D-1275, which approved the DWR's water right applications for the development and operation of the SWP. The decision requires that the permits are subject to the water quality criteria included in an agreement, dated November 19, 1965, among the Sacramento River and Delta Water Association, the San Joaquin Water Rights Committee, the DWR, and the USBR (SRDWA 1965) in so far as the criteria do not conflict with other terms included in the permits. The agreement states that, in the event New Melones Reservoir is operated to provide water quality control, the average TDS at Vernalis will be maintained at 500 ppm or less, provided that not more than 70 TAF shall be released in any calendar year for this purpose.

Figure VIII-8
San Joaquin River Near Vernalis

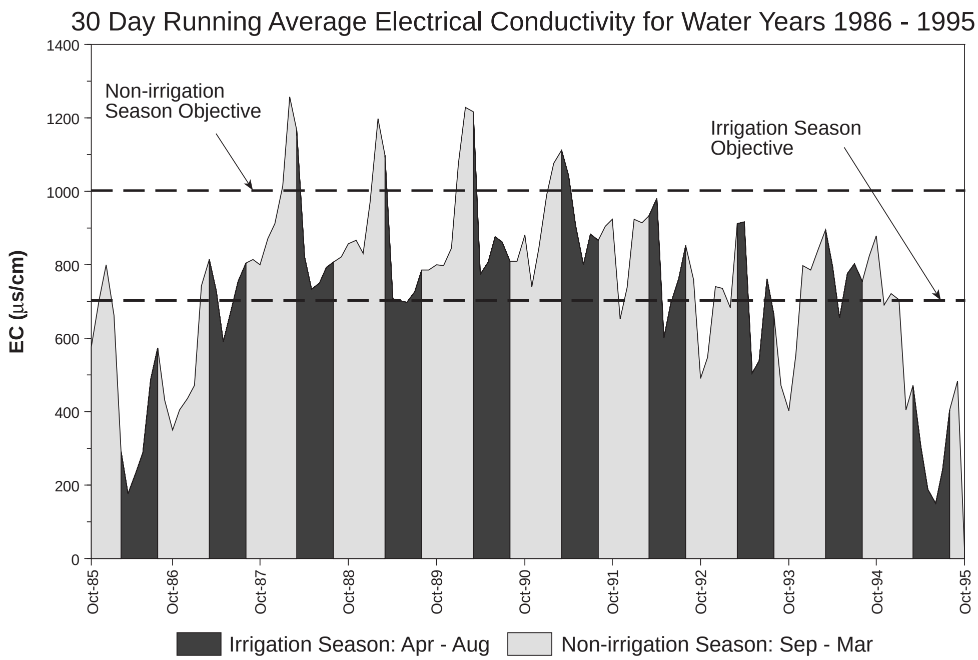
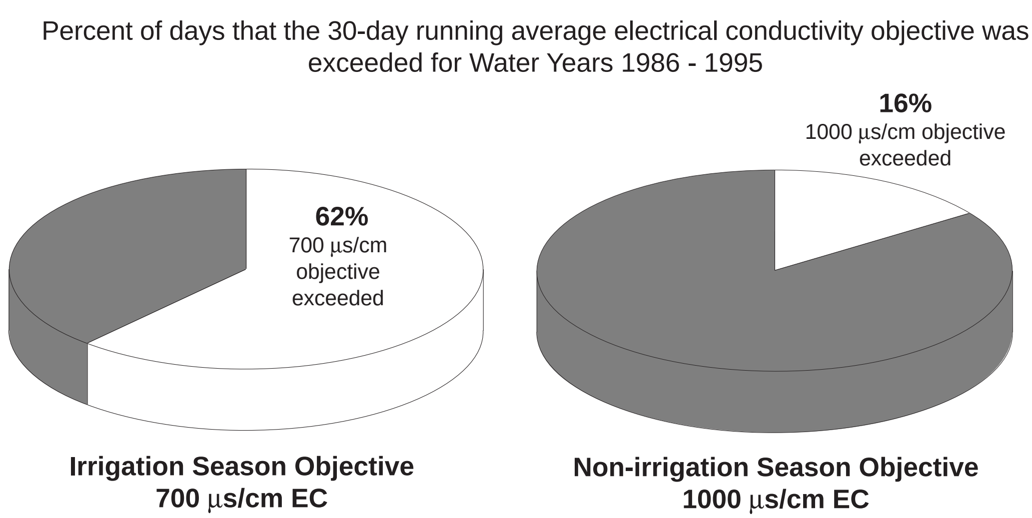


Figure VIII-9
San Joaquin River Near Vernalis



b. D-1422. In 1973, the SWRCB adopted D-1422, which approved the USBR's water right applications to appropriate water from the Stanislaus River at New Melones Reservoir for power generation, preservation and enhancement of fish and wildlife, recreation, and water quality control. D-1422 requires the USBR to release water to maintain a mean monthly TDS of 500 ppm or less in the San Joaquin River at Vernalis. The decision notes that the USBR plans to release up to 70 TAF per year for this purpose, but it does not limit releases to this quantity.

c. 1978 Delta Plan/D-1485. In 1978, the SWRCB adopted both the 1978 Delta plan, which revised the water quality objectives for the Delta, and D-1485, which implemented the objectives. The 1978 Delta Plan established a two-phase approach regarding Vernalis salinity objectives. In the first phase, the existing objective of 500 ppm maximum 30-day running average of mean daily TDS would become effective after New Melones Reservoir is operational. The phase two objectives are 0.7 mmhos/cm and 1.0 mmhos/cm maximum 30-day running average of mean daily EC from April 1 through August 31 and from September 1 through March 31, respectively. The phase two objectives would become effective only upon completion of suitable circulation and water supply facilities. The plan stated that if contracts to ensure such facilities were not executed by January 1, 1980, the SWRCB would take appropriate enforcement actions to prevent encroachment on riparian rights in the southern Delta. The phase two objectives were based on the water quality needs of crops grown in the southern Delta. During the irrigation season of April 1 through August 31, the representative crop used to develop the objective was beans, and alfalfa was used as the representative crop for the rest of the year.

D-1485 conditioned the DWR and the USBR water right permits to implement most of the water quality objectives of the 1978 Delta Plan, but the Vernalis salinity objectives were not included in the decision. Therefore, the requirements of D-1422 remained in effect.

d. 1991 Bay/Delta Plan. The 1991 Bay/Delta Plan revised the water quality objectives in the 1978 Delta Plan. The magnitude of the Vernalis salinity objectives was not changed in the 1991 Bay/Delta Plan, but the implementation schedule was changed. The plan called for the year-round Vernalis salinity objective of 500 ppm TDS to be replaced by the seasonal objectives of 0.7 mmhos/cm and 1.0 mmhos/cm EC from April 1 through August 31 and from September 1 through March 31, respectively, no later than 1994. The plan also stated that, if a three-party contract is implemented among the DWR, the USBR, and the South Delta Water Agency, that contract would be reviewed prior to implementation of the objective and, after also considering the needs of other beneficial uses, revisions would be made to the objectives, as appropriate.

The 1991 Bay/Delta Plan included a program of implementation for the Vernalis salinity objective. This program included direction to the CVRWQCB to develop and adopt a salt load reduction program. The 1991 Bay/Delta Plan states that the salt load reduction program should include a plan to reduce annual salt loads by at least ten percent and to adjust the timing of salt discharges from low flow to high flow periods.

In 1991, the SWRCB did not adopt a water right decision implementing the provisions of the 1991 Bay/Delta Plan; therefore, the USBR continued to be responsible to meet the water quality objective of 500 ppm contained in D-1422.

e. **1995 Bay/Delta Plan and Order WR 95-6**. The 1995 Bay/Delta Plan revised the water quality objectives in the 1991 Bay/Delta Plan. The seasonal objectives at Vernalis of 0.7 mmhos/cm and 1.0 mmhos/cm EC from April 1 through August 31 and from September 1 through March 31, respectively, were however retained, and these objectives were effective immediately. The program of implementation of the 1995 Bay/Delta Plan includes several provisions related to the Vernalis salinity objectives. In the short-term, the plan recommends implementation of the recommendations from the San Joaquin Valley Drainage Program and coordination of drainage water releases with higher flows in the river to maximize the use of the assimilative capacity of the river. In the long-term, the plan states that the in-basin management of salts must be supplemented by the disposal of salts outside of the valley, and the USBR should reevaluate alternatives for completing a drain to discharge salts out of the basin.

On June 8, 1995, the SWRCB adopted Order WR 95-6, which makes the water rights of the SWP and the CVP consistent with their implementation of the 1995 Bay/Delta Plan. This action allows the SWP and the CVP to operate their facilities in accordance with the 1995 Bay/Delta Plan while the SWRCB prepares a long-term water right decision to implement the plan. Among other provisions, Order WR 95-6 requires the USBR to release conserved water from New Melones Reservoir to comply with 1995 Bay/Delta Plan salinity objectives at Vernalis. The order was to expire on December 31, 1998 or upon adoption by the SWRCB of a long-term water right decision implementing the 1995 Bay/Delta Plan, whichever occurred first. On December 3, 1998, the effective term of WR 95-6 was extended until December 31, 1999, when the SWRCB adopted Order WR 98-09.

f. **CVRWQCB Basin Plans**. The CVRWQCB adopted a number of basin plans in the period described above (CVRWQCB 1994). In general, the regional basin plans included the same salinity objectives at Vernalis that were in effect pursuant to SWRCB plans. In the event of any conflicts, the SWRCB-adopted salinity objectives superseded the Regional Board-adopted salinity objectives.

The existing CVRWQCB basin plan includes a program of implementation for objectives. Among other provisions related to salinity control, the plan states that there are two major options for the disposal of salts produced by irrigated agriculture: out-of-valley export and discharge to the San Joaquin River. The plan states that a valley-wide drain remains the best technical solution to the water quality problems of the San Joaquin River and the Tulare Lake Basins caused by agricultural drainage.

3. Existing Salinity Management Programs

Salinity objectives at Vernalis can be met either by release of fresh water to dilute the salinity loads, by reducing the salinity load entering the river, or by changing the timing of salt load releases to the river to maximize the use of the assimilative capacity of the river. In the past the principal method used to reduce salt levels has been dilution with fresh water from New Melones Reservoir. Recently, state, federal, and local public and private agencies began taking actions to reduce and control salt loads entering the San Joaquin River. This section summarizes the following principal programs and actions to reduce and control salt loads entering the river: (a) out-of-valley disposal, (b) water conservation, (c) drainage reuse, (d) evaporation ponds, (e) subsurface storage, (f) change in point of diversion in the Delta, (g) land retirement, and (h) regulated releases to the San Joaquin River.

a. Out-of-Valley Disposal. Implementation of in-basin measures, if the only means used to reduce salt loading to the San Joaquin River, will be effective only for the short-term. A long-term solution must include disposal of salts outside the valley, along with continuation of in-basin measures as an ongoing means of reducing drainage volumes and salt and trace element loads. At present, the San Joaquin River is being used to convey a substantial portion of the salt load out of the valley, but this disposal option is affecting the beneficial uses of the river.

The construction of an out-of-valley facility has a lengthy history, as described earlier in this chapter. The USBR recently began discussions with the SWRCB regarding actions needed to secure a permit from the SWRCB for the construction of an out-of-valley facility. These discussions led to the adoption of Resolution No. 96-029 by the SWRCB, which directed the USBR to use the CEQA and the NEPA process to evaluate alternatives for out-of-valley disposal.

b. Water Conservation. Water conservation can improve salinity conditions in the San Joaquin River both by leaving more water in the river for dilution flows and by decreasing the salt load imported into the basin through the CVP. Four principal legislative actions have been passed recently that encourage water conservation, three for agricultural water conservation and one for urban water conservation. These actions are discussed below:

1. The California Agricultural Water Management Planning Act (California Water Code Sections 10800 through 10855) requires all agricultural water suppliers delivering over 50 TAF of water per year to prepare an Information Report and identify whether the district has a significant opportunity either to conserve water or to reduce the quantity of drainage water through improved irrigation water management. The legislation affected the 80 largest agricultural water purveyors in California. The districts that have a significant opportunity to conserve water or to reduce drainage are required to prepare water management plans.

2. The Agricultural Water Suppliers Efficient Water Management Practices (EWMP) Act of 1990 (California Water Code Sections 10900 through 10904) requires the DWR to establish

an advisory committee consisting of members of the agricultural community, University of California, DFG, environmental and public interest groups, and other interested parties to develop a list of EWMPs for agricultural water users. On November 13, 1996, the committee completed a six year effort by releasing a "Memorandum of Understanding (MOU) regarding EWMP by Agricultural Water Suppliers in California" (AWSC 1996). The MOU, which is to be voluntarily signed by agricultural and environmental communities and by other interested parties, provides a mechanism for planning and implementing cost-effective EWMPs that benefit water suppliers. The MOU requires implementation of some EWMPs, and it sets out an evaluation process for other EWMPs that must have net benefits to the water supplier before they are implemented. The MOU also (a) requires preparation of water management plans by water suppliers, (b) establishes the Agricultural Water Management Council to oversee implementation of the MOU, and (c) provides a mechanism for evaluation and endorsement of the water management plans. The MOU was signed in May 1997 authorizing the Agricultural Water Management Council to implement the process.

3. The Reclamation Reform Act of 1982 (Section 210) and the CVPIA (PL 102-575, Section 3405e) require federal water contractors to prepare water conservation plans. In California, the USBR's Mid-Pacific Region developed a criteria and a set of guidelines to prepare water conservation/management plans and required all agencies (districts) that contract with the USBR for M&I water in excess of 2,000 acre-feet and/or for agricultural (irrigation) water to serve over 2,000 irrigable acres to submit water conservation plans. The CVPIA required the USBR's Mid-Pacific Region to revise its existing guidelines for reviewing conservation plans to include, but not be limited to, BMPs and EWMPs developed in California.

4. The Urban Water Management Planning Act (California Water Code sections 10610 through 10656) requires urban water suppliers that provide water to more than 3,000 customers or that supply more than 3,000 acre-feet of water annually (a) to prepare urban water management plans, (b) to submit the plans to the DWR for review, and (c) to implement the plans. These code sections also specify the minimum requirements for an acceptable plan. Many of these requirements are incorporated from the "Memorandum of Understanding Regarding Urban Water Conservation in California," dated September 1991. Most of the major urban water agencies in the state are signatories to this MOU. The primary purpose of the 1991 MOU is to expedite implementation of reasonable water conservation measures/best water management practices in urban areas and to establish assumptions for use in calculating estimates of reliable future water conservation savings resulting from proven and reasonable water conservation measures.

In addition to the legislative programs discussed above, agricultural water conservation is also encouraged through the SJVDP and through the actions of the CVRWQCB. The SJVDP Report (SJVDP 1990) recommends agricultural water conservation as one of the inbasin management methods for reducing the load of salt and other pollutants discharged to the water bodies in the San Joaquin Valley. In December 1991, eight State and Federal agencies, including the SWRCB, signed a Memorandum of Understanding to coordinate activities implementing the recommended plan.

On December 8, 1988, the CVRWQCB adopted Resolution 88-195 approving amendments to the water quality control plan for the San Joaquin River Basin. The amendments require that parties discharging or contributing to the generation of agricultural subsurface drainage submit drainage operation plans. The amendment further states that the principal best management practice for the control of subsurface drainage is water conservation. On September 21, 1989, the SWRCB approved the basin plan amendments by adoption of SWRCB Resolution No. 89-88. The SWRCB at that time directed the CVRWQCB to issue waste discharge requirements if the drainage operation plans are not implemented in a timely fashion. The CVRWQCB has continued to pursue the drainage operation plan approach, and the main element of the plans has been water conservation efforts.

c. Drainage Reuse. The SJVDP recognized that, if drainage water could be economically reused, it would be a resource. The reuse of drainage water for power plant cooling, energy producing solar ponds, salts and mineral recovery, fish and wildlife habitat, and aquaculture has limited potential in the San Joaquin Valley. Reuse of drainage water by irrigating salt-tolerant crops or by blending with normal irrigation supplies are the only reuse options that appear promising at this time. Consequently the SJVDP emphasized reuse of drainage water on progressively more salt-tolerant crops to reduce the drainage volume for easy containment and/or disposal. Volume reduction through reuse would also substantially reduce disposal costs and treatment costs, if treatment became necessary. Several studies are being done to explore the potential of drainage reuse. Studies have been done by Ayars and others (Ayars 1994, 1996) on the west-side of the San Joaquin Valley to demonstrate that, rather than discharge tile drainage, some of the tile drainage can be retained in the soil profile to meet crop water requirements by subirrigation. Application of this technique reduces drainage volume, salt loading of surface waters, and irrigation water requirements. When the ground water is saline, the potential of its reuse will be limited by the crop tolerance for salinity.

The Department of Food and Agriculture, in cooperation with University of California and several other agencies, has studied the feasibility of drainage reduction by using tile drain effluent to irrigate eucalyptus trees and halophytes (Tanji 1991). The strategy is currently being practiced by at least two farmers on the west-side of the San Joaquin Valley and additional farmers may adopt this practice in the future (Cal Poly 1994).

Researchers at Cal Poly (Cal Poly 1994) report that the districts in the west-side of the San Joaquin Valley can promote reuse of drainage water by not accepting any tailwater from its members and accepting tile water only when the electrical conductivity of the tile water is greater than five mmhos/cm. District recycling facilities should be in place to allow recycling of tail water, tile only if water quality allows. Recycling pipelines or ditches must terminate at irrigation water inlets to the districts so that drainage water will be reused in all areas.

d. Evaporation Ponds. Evaporation ponds are discussed as an agricultural drainage in-basin management option in the SJVDP report. These ponds can be used independently or in conjunction with eucalyptus trees/halophyte plants.

Evaporation ponds are not common in the San Joaquin River Basin. However, evaporation ponds are the only means available for storage and disposal of drainage water in the Tulare Lake Basin. Evaporation ponds can generate several possible problems depending on the quality of water discharged to the ponds and the management of the ponds (CVRWQCB 1996): (1) they can pose a threat to wildlife; (2) they can contribute to the impairment of ground water; and (3) they take lands out of production.

e. Subsurface Storage. Subsurface storage refers to holding of tile drainage water in the tile laterals, subsurface submains (if any), and soil profile above tile lines but below rootzone when assimilative capacity of the San Joaquin River is low and discharging it when the assimilative capacity of the San Joaquin River is high. Subsurface storage may promote compliance with water quality objectives at Vernalis and save water by reducing water quality releases from New Melones Reservoir. If salinity levels in tile drainage water are below crop salt tolerance levels, some of the stored water may be used through capillary rise (upflux) to meet a part of crop irrigation requirements thereby leading to a reduction of drainage volumes. A recent USBR report (USBR 1991) discusses methods of retrofitting existing systems with valves and/or weirs or designing new systems that include these valves/weirs to create temporary storage above tile lines and below the rootzone. Subsurface storage has no adverse effects on wildlife; its effect on salt build up in the rootzone and crops may have to be closely monitored.

There are several limitations that may be encountered for subsurface storage. First, the leaching process is slow and consequently salts cannot be moved quickly to take advantage of assimilative capacity in the San Joaquin River. Second, stored salts may impact crop production. Third, additional water supplies may be needed to leach salts, especially over a series of dry years. Last, lateral seepage from upslope areas may interfere with the project.

f. Change in Point of Diversion in the Delta. Water exported from the Delta has a higher salt concentration than water diverted from the Sacramento River. Therefore, changing the point of diversion for exports to the San Joaquin Valley from the Delta to the Sacramento River can substantially reduce the load of salt imported to the basin. This reduction will in turn reduce the salt load discharged to the San Joaquin River.

The CALFED Bay/Delta Program's strategy is to develop a through-Delta conveyance alternative based on the existing Delta configuration with some modifications, evaluate its effectiveness and add additional conveyance and/or other water management actions if necessary to achieve CALFED goals and objectives. For example, inability to meet CALFED program goals for drinking water quality or fishery recovery using this strategy could lead to a decision to move forward with modifications to this strategy including a change in point of diversion to the Sacramento River (CALFED 1998). The environmental review process for this program is scheduled for completion in late 1999.

g. Land Retirement. The recommended drainage management actions in the SJVDP Report (1990) included the selective retirement of irrigated lands that are characterized by low productivity, poor drainage, and high selenium concentrations in shallow groundwater. Based on these recommendations, Section 3408(h) of the CVPIA authorized a federal land retirement program. Land retirement, or taking lands out of irrigated agricultural production, may reduce irrigation drainage problems, depending on how the freed up irrigation water is reallocated. Other associated benefits would be lowering of the water table, and opportunities to use the CVP water, which was previously used on the retired lands, for other beneficial uses including protection of fish and wildlife resources in the San Joaquin River. The Water Quality Common Program of CALFED also describes land retirement as a possible method available to address drainage problems.

The federal program is expected to retire a total of 100,000 acres of irrigated farm land. The actual amount of land retired and the duration of the program will be dependent upon the number of willing sellers and budget constraints. All lands that receive CVP water are eligible to participate, but lands selected for retirement will probably be located south of the Delta. Also in 1992, California Water Code section 14900 was adopted authorizing the DWR to implement the State land retirement program. As currently envisioned, the land retirement will be accomplished cooperatively by the DOI and DWR through a process in which willing sellers volunteer to remove their lands from irrigation production in return for monetary compensation. The State land retirement program is not currently funded; however, the federal government is moving forward with implementing its land retirement program. The USBR, in consultation with DWR, developed and released ‘Interim Guidelines – Land Retirement Program’ in 1997 (USBR 1997). The Guidelines address procedures for soliciting lands eligible for retirement, criteria for selecting lands for retirement, the role of the local water districts in setting priorities for retirement, control of land and water resources that may be acquired, and post-retirement management of land and water resources. The USBR is currently implementing a demonstration project to evaluate the environmental benefits and constraints of land retirement.

h. Controlled Discharges to the San Joaquin River. SWRCB Order WQ 85-1 (SWRCB 1985), which was adopted principally for the purpose of directing cleanup of Kesterson Reservoir, required the CVRWQCB to adopt and implement basin plan amendments to evaluate wetland releases and drain discharges to the San Joaquin River. In addition, the SWRCB's 1991 Bay/Delta Plan and 1995 Bay/Delta Plan directed the CVRWQCB to implement a program to reduce the annual salt load discharged to the San Joaquin River by at least 10 percent and to adjust the timing of salt discharges from low flow to high flow periods.

In response to these directives, the CVRWQCB intensified monitoring of drainage discharges, completed hydrological investigations of discharges to the San Joaquin River, Mud Slough, and Salt Slough, and required the preparation of drainage operation plans. The CVRWQCB is also beginning a basin planning process to adopt and implement salinity objectives at upstream locations on the San Joaquin River.

The control and regulation of wetland releases and drain discharges to the San Joaquin River is also recommended in the San Joaquin River Management Program (SJRMP) plan (SJRMP 1995). This program was established by Assembly Bill 3603 (California Water Code sections 12260 through 12273) and its focus is to establish a consensus based plan to improve conditions in the San Joaquin River.

Controlled timing of agricultural drainage and wetland releases to the San Joaquin River can maximize the assimilative capacity of the river. From September 1 through March 30, the salinity objectives at Vernalis are higher (1.0 mmhos/cm instead of 0.7 mmhos/cm) and flows are often higher. In addition, a pulse flow objective from April 15 through May 15 often results in high flows during this period. Moving agricultural drainage and wetland releases to these periods should help meet the salinity objectives. Adequate coordination may require formation of regional drainage bodies, execution of agreements with dischargers, issuance of waste discharge requirements that restrict the discharge of drainage water to the river, or adoption of time specific waste discharge prohibitions. Many tile drain systems will require modification in order to control the timing of discharges from the systems.

The successful regulation and control of drain water discharge to the San Joaquin River would be aided by a real-time monitoring program being developed by the DWR, the USBR and the CVRWQCB.

B. SALINITY CONTROL ALTERNATIVES UNDER CONSIDERATION

There are several salinity control actions that the SWRCB could undertake in the San Joaquin River basin to improve salinity conditions in the San Joaquin River. The previous section described eight methods that are presently being used or analyzed to manage salt loads in the San Joaquin Basin: (1) out-of-valley disposal, (2) water conservation, (3) change in point of diversion in the Delta, (4) land retirement, (5) controlled releases to the San Joaquin River, (6) drainage reuse, (7) evaporation ponds, and (8) subsurface storage.

The first four methods (out-of-valley disposal, water conservation, change in point of diversion in the Delta, and land retirement) are either under consideration in another forum or are already being implemented. On April 18, 1996, the SWRCB adopted Resolution No. 96-029, which directed staff of the SWRCB and the USBR to complete a workplan for a CEQA/NEPA document that analyzes alternatives for out-of-valley disposal. Water conservation efforts are ongoing through implementation of the recent legislation discussed in the previous section of this report. Change in point of diversion may eventually be a part of the CALFED Bay/Delta Program, depending on the outcome of the initial phase of the program. The DWR and the USBR are working together to fund and manage the land retirement program. Further consideration in this process would be duplicative.

The fifth method, controlled releases to the San Joaquin River, is under the direct regulatory authority of the SWRCB and the CVRWQCB and is not being evaluated or implemented by other agencies. Therefore, alternatives to control the timing of releases from wetlands and tile drains are analyzed in this report. Water Code section 13243 authorizes the SWRCB or the CVRWQCB, in a water quality control plan or in waste discharge requirements, to specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted. The CVRWQCB also has authority, under Water Code section 13260, et seq., to require persons discharging waste that could affect the quality of the state's water to report on the discharges and to obtain waste discharge requirements before continuing the discharges.

The last three methods (drainage reuse, evaporation ponds, and subsurface storage) are implementation methods for controlled releases to the San Joaquin River or, in the case of drainage use, also a water conservation measure. In this programmatic analysis only one of these methods to implement the controlled releases to the San Joaquin River, subsurface storage, will be evaluated. If the SWRCB elects to direct the CVRWQCB to evaluate controlled releases in more detail, the CVRWQCB will prepare a CEQA document that considers all reasonable implementation methods.

The hydrology used in the analysis of all the alternatives, including the reference case, assumes full implementation of the 1995 Bay/Delta Plan. This reference case hydrology is different than the base case hydrology used in the rest of this report, which assumes D-1485 regulatory conditions. The reason for the difference is that the principal focus of this analysis is to determine whether, after implementation of the Bay/Delta Plan, dilution water requirements from New Melones Reservoir could be reduced through implementation of salinity control actions.
The four salinity control alternatives described below are: (1) Salinity Control Alternative 1 - reference case, (2) Salinity Control Alternative 2 - controlled timing of wetland releases, (3) Salinity Control Alternative 3 - controlled timing of tile drain releases; and (4) Salinity Control Alternative 4 - combination of Alternatives 2 and 3.

1. Salinity Control Alternative One - Reference Case

In the reference case, no water quality action is taken. The wetland releases and agricultural subsurface drain discharges continue to flow into the San Joaquin River in accordance with present practices. A summary of the present practices is provided below.

a. <u>Grassland Area Wetlands</u>. Grassland Resource Conservation District (GRCD) comprises more than 74,700 acres within the Grassland area. Located within the GRCD is the Grassland

Water District (GWD), a CVP contractor that delivers water to private lands and to the three public wildlife areas within its boundaries: San Luis National Wildlife Refuge, Los Banos Wildlife Management Area, and the North Grassland Wildlife Management Area. Land within the GWD is used primarily for duck hunting clubs and seasonal grazing of livestock. Although the properties within GWD are managed separately, the overall management objective is to enhance natural food plant production and to protect wetland habitat for migratory and resident waterfowl. Historically, about 70 to 80 percent of GRCD lands were flooded from mid-September to mid-January to provide waterfowl habitat. Water was released from the seasonally flooded areas from mid-January through April to the San Joaquin River via Mud and Salt sloughs. Prior to discharge, salt concentrations in the wetlands rise due to evaporation and to leaching from the naturally saline soils. Consequently, the spring releases from wetlands add to the overall San Joaquin River salt load.

The GWD's water supplies come from several sources. A 1953 settlement over disputed San Joaquin River water rights in the Grassland area makes 50 TAF annually of CVP water available to the GWD from the Delta-Mendota Canal. Delivery of this water is limited by contract to the September 15 to November 30 period. Until 1985, agricultural drainage and operational spills from upslope irrigators provided up to 148 TAF annually of additional water for the Grassland wetlands. Concerns regarding the quality of the drainage water caused the GWD to cease accepting drainage water in 1985. Interim supplies were then obtained through a series of temporary contracts with the CVP. The passage of the CVPIA in 1992 provided the GWD with firm water supplies. The CVPIA requires the Secretary of the Interior to immediately provide firm water supplies of suitable quality to specified wetland habitat areas. The GWD, the state's wildlife management areas, and the federal wildlife refuges presently receive approximately 168 TAF under the CVPIA, and deliveries are to be increased to 250 TAF by the year 2002.

With the advent of CVPIA water, Grassland wetland managers adopted new management practices. Fall flooding begins in mid-September, timed to coincide with early arriving waterfowl and is complete by late October. Typical application rates range from 1.5 to 3 acre-feet per acre per year. Water levels averaging 8 inches are maintained throughout the winter in the ponded areas. In the past, many duck clubs released their water in mid-January at the end of hunting season. Now, managers prefer to hold water longer and release it more gradually.

Actual timing of releases depends on weather conditions and which plant species are being encouraged. The average monthly release schedule, as modeled for the reference condition, is summarized in Table VIII-3. These reference conditions represent moderate to worst case wetland discharges and are not necessarily representative of all years.

The average TDS of the historic wetland releases (prior to implementation of the CVPIA) is assumed to be 1900 mg/l based on limited information for the southern subarea of GWD. The

Table VIII-3
Average Monthly Wetland Releases (acre-feet)

Month	Historic	CVPIA*	Total
October	1,000	1,000	2,000
November	1,000	2,000	3,000
December	2,000	5,000	7,000
January	3,000	5,000	8,000
February	3,000	7,000	10,000
March	7,000	10,000	17,000
April	6,000	10,000	16,000
May	2,000	7,000	9,000
June	1,000	4,000	5,000
July	1,000	2,000	3,000
August	1,000	1,000	2,000
September	1,000	1,000	2,000
Total	29,000	55,000	84,000

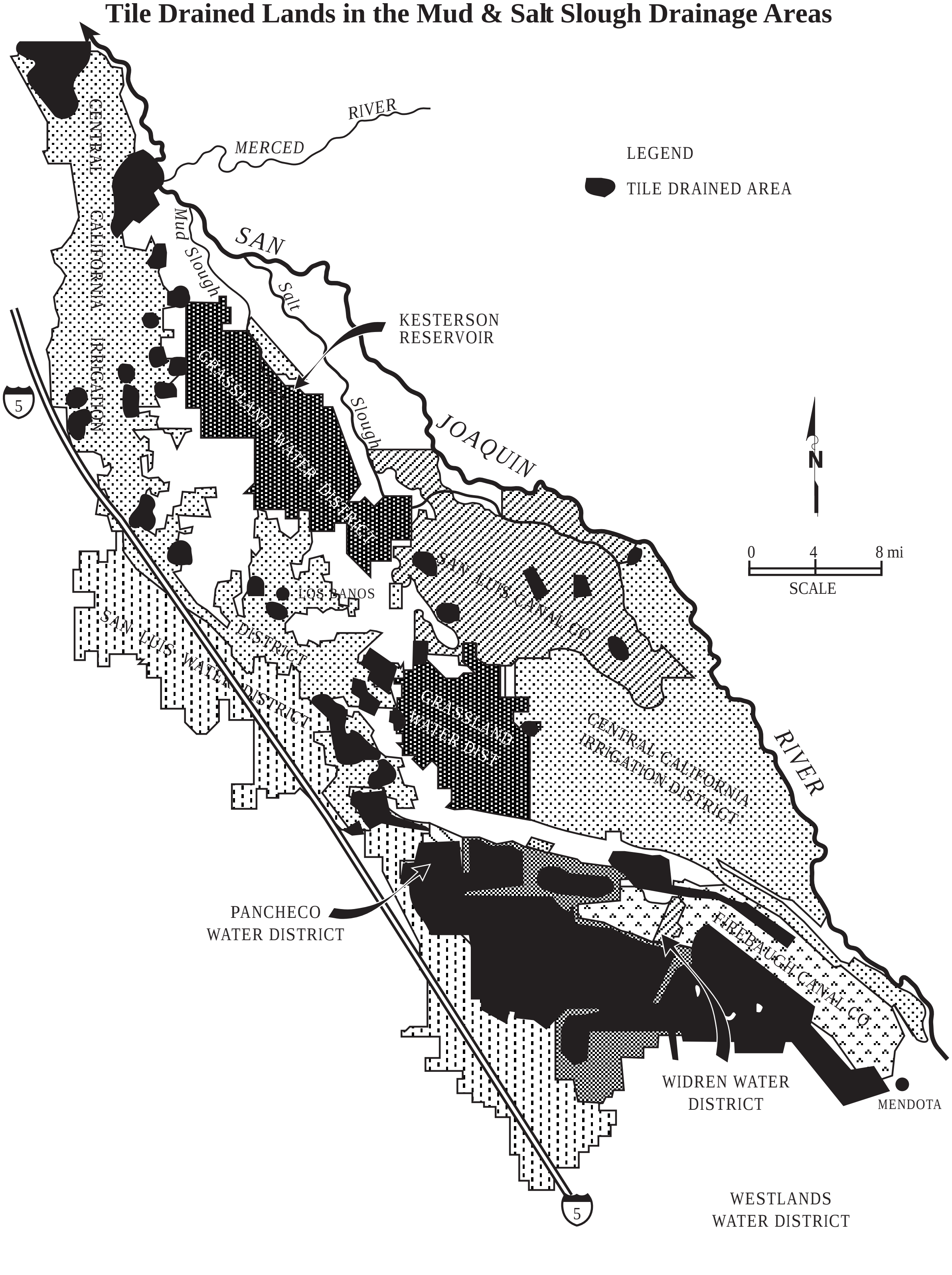
* This term represents the additional wetland releases caused by the recent introduction of CVPIA water.

average TDS attributed to the discharge of CVPIA wetland supplies is set at roughly half that of the historical wetland release (960 mg/l) to account for reduced evapoconcentration and salt mobilization that would be likely with these additional supplies.

b. Agricultural Drainage. Subsurface tile drainage systems have been installed in many areas on the west-side of the San Joaquin River basin to lower the water table and allow needed periodic leaching of the soils. Figure VIII-10 shows areas with tile drains on the west-side of the San Joaquin River Valley (SWRCB 1987). Many more acres will need tile drainage to remain productive in the future.

Approximately 50,000 acres of the tile drained area discharge to Salt and Mud sloughs. The quantity of the average discharge is estimated to be 19,145 AF per year. The districts discharging this water are Broadview Water District, Central California Irrigation District, Firebaugh Canal District, Wildern Water District, Charleston Drainage District, Pacheco Drainage District, and Panoche Water District. Prior to 1985, much of this water was applied to wetlands within the GWD. Provision of CVP water for the wetlands has eliminated this use of the drainage water. Since October 1996, all tile drainage from this area is conveyed via a portion of the San Luis Drain

Figure VIII-10
Tile Drained Lands in the Mud & Salt Slough Drainage Areas



to Mud Slough where it then flows into the San Joaquin River. This routing of drainage water is referred to as the Grassland Bypass Project. No tile drainage water is commingled with wetlands water supplies.

In addition to the sources of tile drainage water described above, 10,010 acres discharge directly to the San Joaquin River. The quantity of the average discharge is estimated to be 7,806 AF per year. The districts/areas discharging directly to the river are Newman Drainage District, Spanish Grant Drainage District, Reclamation Districts 1602, 2099, and 2100, Patterson Water District, West Stanislaus Irrigation District, El Soyo Water District, and the McCracken Road Drain (Grober 1997).

The average monthly tile discharge to the San Joaquin River from all of the sources named above, as modeled in this chapter, is shown in Table VIII-4.

Table VIII-4
Tile Drain Discharges (acre-feet)

	Reference Conditions			
Month	Via Mud & Salt Sloughs	Directly to San Joaquin River	Total	Reoperation Conditions if Implemented
January	1,687	241	1,928	0
February	2,262	484	2,746	0
March	2,471	699	3,170	0
April	2,269	933	3,202	7,013
May	2,047	933	2,980	7,013
June	1,935	933	2,868	0
July	1,717	933	2,650	0
August	1,490	853	2,343	0
September	879	699	1,578	5,342
October	699	545	1,244	5,342
November	644	312	956	956
December	1,045	241	1,286	1,286
Total	19,145	7,806	26,951	26,952

2. Salinity Control Alternative 2 - Controlled Timing of Wetland Releases

Under this alternative, the CVRWQCB implements a regulatory program or coordinates a cooperative program in which wetland operators within GWD shift all of their historical and recent CVPIA releases during the months of March and April to the month of February. This program is implemented whenever the salinity objectives at Vernalis during the month of March are likely to be exceeded. This reoperation requires one month of foresight because a February release is being made based on forecasted March water quality. Such foresight may be possible because the availability of reservoir dilution flows may be reasonably estimated based on forecasted watershed runoff.

The shift of all releases from the months of March and April to February can adversely affect the diversity of waterfowl food in the managed wetlands because different plants are favored depending on when the land is drained. In order to avoid this effect, 10 TAF of additional CVPIA water is provided in both March and April to maintain a flow through system in the wetlands. This additional 20 TAF of CVPIA water is the difference between CVPIA Level 2 and Level 4 supplies to the Grassland Area Refuges in the spring and consequently is available for the management of wetlands.

The wetlands reoperation affects releases during the months of February, March, and April only; the releases during other months are unchanged. Table VIII-5 shows modeled wetland releases for the three relevant months for the reference (Alternative 1) and the reoperated (Alternative 2) conditions.

The average TDS concentration of the discharge of each of these sources of water can differ. For modeling purposes, the assumption is made that the average concentration of historical wetland releases, CVPIA water and additional CVPIA water is 1,900 mg/l, 960 mg/l, and 600 mg/l, respectively (Grober 1997).

Table VIII-5
Wetland Releases for Reference and Reoperation Conditions (acre-feet)

	Reference Conditions				Reoperation Conditions			
Month	Historic	CVPIA	Add - CVPIA	Total	Historic	CVPIA	Add - CVPIA	Total
Feb	3,000	7,000	-	10,000	16,000	27,000	-	43,000
March	7,000	10,000	-	17,000	0	0	10,000	10,000
April	6,000	10,000	-	16,000	0	0	10,000	10,000

3. Salinity Control Alternative 3 - Controlled Timing of Tile Drain Discharges

Under this alternative, the CVRWQCB implements a regulatory program or coordinates a cooperative program in which parties with tile drainage systems hold the drainage for limited periods when assimilative capacity is not available in the San Joaquin River. The parties would have flexibility in deciding how to temporarily cease their discharge. For illustrative purposes, the assumption in this programmatic analysis is that the parties store their drainage in laterals, submains, sumps, and the soil column for up to three months. Under this alternative, tile drainage is stored in January, February, and March and released in April and May when the Vernalis salinity objective is exceeded in January. The pulse flows required by the Bay/Delta Plan in April and May will dilute the release in these months. Tile drainage may be unnecessarily stored in February and March at times when objectives are not actually exceeded in these months under these operations criteria. Similarly, tile drainage may not be stored in February and March when objectives are exceeded. Tile drainage is also held in June, July, and August and released in September and October when the Vernalis salinity objective is exceeded in June, July, or August. Tile drainage may be unnecessarily stored in June, July, or August under these operating rules because exceedance of the salinity objective in any month results in storage of tile drainage for all three months. These modeling criteria are used to simplify the analysis. Actual implementation of this alternative would probably be based on real-time data and somewhat greater benefits could be obtained.

Table VIII-4 shows the discharges that occur under the reference conditions and the discharges that would occur if the tile drainage was being released according to the reoperation criteria above. For purposes of the modeling analysis, the assumption is made that the average TDS concentration of drain discharges through Mud and Salt sloughs and directly to the river are 4,754 mg/l and 1,812 mg/l, respectively. These figures are based on a flow weighted average of tile drainage TDS concentrations from the areas (Grober 1997).

4. Salinity Control Alternative 4 - Combination of Alternatives 2 and 3

This alternative combines the operational measures in both Alternative 2 and Alternative 3. The CVRWQCB implements a regulatory program or coordinates a cooperative program in which (1) wetland operators within GWD shift all of their historical and recent CVPIA releases during the months of March and April to the month of February, and (2) parties discharging subsurface agricultural drainage hold the drainage when assimilative capacity is not available in the San Joaquin River.

C. ENVIRONMENTAL IMPACTS OF IMPLEMENTING SALINITY CONTROL ALTERNATIVES

As described above, the USBR is responsible, pursuant to D-1422, for meeting the Vernalis salinity objectives by releasing dilution water from New Melones Reservoir. The focus of this analysis is to determine whether the need for dilution water releases can be significantly reduced by implementing the salinity control alternatives. The description of the environmental impacts of implementing the salinity control alternatives is divided into the following five sections: (1) description of modeling process, (2) reduction in required releases from New Melones Reservoir, (3) San Joaquin River EC, (4) construction-related effects, and (5) crop production.

1. Description of Modeling Process

SJRIO is the principal model used in this analysis (Grober 1997). However, the derivation of the simulated hydrology for the major eastside tributaries to the San Joaquin River for the reference case begins with a DWRSIM study in which all Bay/Delta Plan flow objectives are met (see Chapter IV for a description of the SJRIO and DWRSIM models). In this DWRSIM study, New Melones Reservoir is operated to meet instream flow and contractual obligations, as described in Chapter IV, and additional releases are made to meet Vernalis flow and salinity objectives. When insufficient water is available from this reservoir to meet all of these obligations, releases are made from New Don Pedro Reservoir and Lake McClure in equal amounts.

The resulting DWRSIM hydrology (DWRSIM 1997) for eastside streams is used as input to SJRIO, and the Vernalis flow is calculated using SJRIO. Adjustments are made to eastside stream flows in SJRIO, excluding the Stanislaus River, until the DWRSIM and SJRIO calculated flows at Vernalis are identical over the entire 73 year hydrologic sequence. Stanislaus River flows are next adjusted in SJRIO by removing releases called for in DWRSIM for salinity control. The final SJRIO hydrology for the reference case is then obtained by increasing the Stanislaus River flows as necessary to meet the salinity objectives at Vernalis using the SJRIO algorithm to calculate dilution water requirements to meet the Vernalis salinity objectives. For a detailed description of other assumptions used to develop the hydrology, see Grober 1997.

It is not possible to calibrate SJRIO salinity results at Vernalis with DWRSIM salinity results at Vernalis. The algorithms used to calculate salinity in the two models are significantly different. Table VIII-6 provides a comparison of the dilution release requirements calculated under SJRIO and DWRSIM. The table shows that the 73 year average annual difference in dilution water release requirements is approximately 20 TAF. Other relevant observations from Table VIII-6 include: (1) the maximum release in many months is much greater in SJRIO than in DWRSIM; (2) the percentage of time that dilution releases are required in July and August is much less in SJRIO than in DWRSIM; (3) SJRIO indicates that dilution water for salinity control is needed from January through August, but DWRSIM indicates that with limited exceptions dilution water for salinity control is needed only from May through August with very little water required in May.

2. Reduction in Required Releases from New Melones Reservoir

The first step in the analysis is to determine whether discharges from wetlands and tile drains have a significant effect on the quantity of dilution water required to meet the Vernalis salinity objectives. This issue was examined by using SJRIO to model the effect on releases at New Melones Reservoir of completely eliminating: (1) the wetland discharges, (2) tile drain discharges, and (3) both wetland and tile drain discharges. These three studies are limiting cases used to analyze the maximum expected effect of the drainage. The results of this analysis are provided in Table VIII-7, which shows that New Melones Reservoir release are reduced by an average of 23 TAF when wetland discharges are eliminated, 35 TAF when tile drain discharges are eliminated, and 46 TAF when both sources of drainage are eliminated. These reductions in dilution releases are calculated on an annual average basis over the 73 years of modeled hydrology. These model results are sufficiently large to warrant modeling of the reoperation alternatives described in section B of this chapter.

Table VIII-6
Comparison of SJRIO and DWRSIM Dilution Release Requirements (TAF)

Description		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Tot
SJRIO Reference Case	avg	0	0	0	3	3	2	7	3	19	17	14	0	68
	max	0	1	13	34	35	34	78	67	102	84	60	0	-
	%	0%	1%	3%	22%	15%	11%	19%	14%	49%	56%	53%	0%	-
DWRSIM Releases	avg	0	0	0	0	0	0	0	1	9	18	20	0	48
	max	0	0	3	6	10	0	0	7	27	27	26	0	-
	%	0%	0%	9%	14%	8%	0%	0%	14%	50%	86%	97%	0%	-
Difference	avg	0	0	0	3	3	2	7	2	10	-1	-6	0	20

Notes: (1) % refers to the percent of months in which dilution water is required to meet the Vernalis objectives.
(2) The row labeled "difference" provides the average change between the two models.

The effect of the reoperation alternatives, Salinity Control Alternatives 2, 3, and 4, on dilution release requirements from New Melones Reservoir are also provided in Table VIII-7. This table shows that, with respect to dilution water release requirements, there is no demonstrable long-term benefit to Alternative 2, the wetlands reoperation alternative, as formulated. Small benefits may be possible with other reoperation alternatives, but the need to drain the wetlands in the spring in order to encourage appropriate plant growth (discussed in section B.1.a of this chapter) limits the range of possible alternatives.

Table VIII-7 shows that reoperation of tile drains pursuant to Alternative 3 could generate average annual savings of 21 TAF from New Melones Reservoir. Average water savings occur during the months of January, February, March, June, July, and August while additional releases would be required during the months of April and May. The modeled observation that additional average releases are required in April and May is questionable for two reasons. First, the model operates on a monthly average basis; therefore, the effect of the April 15 through May 15 pulse flow is attenuated. The need for dilution water releases during a pulse flow period is unlikely. Second, reoperation of tile drains moves the discharges into the pulse flow period, reducing the quantity of reservoir releases required to achieve the pulse flow. The model indicates that an average of 2 TAF and a maximum of 9 TAF of tile drain discharges are moved into the April/May period as a result of reoperation, but the resulting reduction in reservoir release requirements is not included in Table VIII-7.

Table VIII-7 also shows that Alternative 4, combined wetlands and tile drain reoperation, generates the same water savings from New Melones Reservoir as Alternative 3, reoperation of tile drains alone. Consequently, there is no water savings benefit for combined reoperation.

The results cited above indicate that Alternatives 2 and 4 do not achieve the objective of the project - reduction of releases from New Melones Reservoir for salinity control at Vernalis. Therefore, these alternatives are not analyzed further in this report. The remaining analysis is limited to Alternative 3.

3. San Joaquin River Water Quality

The SJRIO-modeled EC conditions at Vernalis and Crows Landing under Alternatives 1 and 3 are provided in Figures VIII-11 through VIII-14. (See Figure VIII-1 for the location of Crows Landing.) Figures VIII-11 and VIII-12 provide the 73 year average monthly EC, and Figures VIII-13 and VIII-14 provide the average EC of each month in water years 1984 through 1994. Figures VIII-11 and VIII-13 show the effect of implementation of Alternatives 1 and 3 on the EC conditions at Vernalis. As expected, relative to Alternative 1, Alternative 3 results in reduced EC in months when the drainage is retained and increased EC when the drainage is released. The EC is unchanged in November and December. Sufficient dilution water from the Stanislaus River is assumed to be available at all times in this analysis; therefore, the EC objectives are always achieved at Vernalis.

Figures VIII-12 and VIII-14 show the effect of implementation of Alternative 3 on the EC conditions at Crows Landing in comparison to Alternative 1. These figures show the same EC pattern as FiguresVIII-11 and VIII-13. However, the EC at Crows Landing is significantly higher than the EC at Vernalis. There are no EC objectives on the San Joaquin River upstream of Vernalis, and there are no requirements to provide dilution water on the San Joaquin River upstream of its confluence with the Stanislaus River. Comparison of the EC at Crows Landing with the EC objectives at Vernalis indicates that, if the Vernalis objectives were adopted at Crows Landing, they would seldom be achieved. The CVRWQCB staff is presently evaluating the issue of appropriate EC objectives in the San Joaquin River.

Table VIII-7
Comparison of Reference Case Dilution Release Requirements with Limiting Cases of Elimination of Wetland and Tile Discharges, and with the Alternatives (TAF)

Description		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Tot
Alternative 1 (Reference)	avg	0	0	0	3	3	2	7	3	19	17	14	0	68
	max	0	1	13	34	35	34	78	67	102	84	60	0	-
	%	0%	1%	3%	22%	15%	11%	19%	14%	49%	56%	53%	0%	-
Elimination of Wetland Releases	avg	0	0	0	1	1	0	1	1	15	14	12	0	45
	max	0	0	4	20	22	12	32	48	93	79	56	0	-
	%	0%	0%	1%	11%	11%	5%	10%	7%	41%	44%	52%	0%	-
Difference	avg	0	0	0	2	2	2	6	2	4	3	2	0	23
Elimination of Tile Discharges	avg	0	0	0	1	1	1	2	1	11	10	6	0	33
	max	0	0	3	17	15	15	47	39	85	69	40	0	-
	%	0%	0%	1%	10%	10%	7%	11%	5%	36%	38%	36%	0%	-
Difference	Avg	0	0	0	2	2	1	5	2	8	7	8	0	35
Elimination of Wetlands and Tiles	Avg	0	0	0	0	0	0	0	1	8	8	5	0	22
	max	0	0	0	4	5	0	7	29	77	65	36	0	-
	%	0%	0%	0%	4%	3%	0%	1%	4%	30%	34%	32%	0%	-
Difference	avg	0	0	0	3	3	2	7	2	11	9	9	0	46
Alternative 2 (Wetlands Reoperation)	avg	0	0	0	3	7	0	5	3	19	17	14	0	68
	max	0	1	13	34	66	13	60	67	102	84	60	0	-
	%	0%	1%	3%	22%	16%	5%	15%	14%	49%	56%	53%	0%	-
Difference	avg	0	0	0	0	-4	2	2	0	0	0	0	0	0
Alternative 3 (Tile Reoperation)	avg	0	0	0	1	1	1	10	7	11	10	6	0	47
	max	19	1	13	17	23	33	86	111	85	69	40	1	-
	%	5%	1%	3%	10%	11%	8%	23%	19%	36%	38%	36%	1%	-
Difference	avg	0	0	0	2	2	1	-3	-4	8	7	8	0	21
Alternative 4 (Wetlands and Tile)	avg	0	0	0	1	2	1	9	7	11	10	6	0	47
	max	19	1	13	17	61	15	86	111	85	69	40	1	-
	%	5%	1%	3%	10%	12%	7%	22%	19%	36%	38%	36%	1%	-
Difference	avg	0	0	0	2	1	1	-2	-4	8	7	8	0	21

Notes: (1) % refers to the percent of months in which dilution water is required to meet the Vernalis objectives.
(2) The row labeled "difference" provides the average change from Alternative 1 (reference case) in TAF. Positive values denote improved conditions and negative values denote degraded conditions.

The effect of the implementation of Alternative 3 on selenium levels was not modeled, but the monthly average concentration and the load of selenium and other trace elements in the San Joaquin River will decrease in months with restrictions on discharges and they will increase in months with allowed discharge. This effect is problematic because the CVRWQCB has adopted waste discharge requirements for the Grassland Bypass Project that set monthly load limits for selenium discharges. The CVRWQCB may have to reexamine this approach if it implements a program like Alternative 3.

4. Construction Related Effects

The specific tile drain reoperation proposed in Alternative 3 is not presently practiced in the San Joaquin Valley. Therefore, pilot studies would have to be completed before full implementation of the alternative. However, controlled drainage systems, constructed for the purpose of reducing the volume of tile drainage that leaves an irrigated area have been studied (USBR 1987, USBR 1989). The type of reoperation proposed in this report has many similarities to the controlled drainage systems evaluated by the USBR, and the analysis in this section is based on the USBR evaluations.

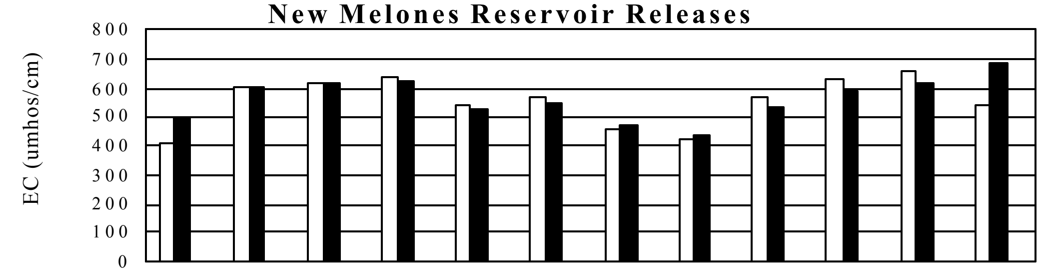
Controlled drainage can be accomplished by including control points in the tile line of a new system or retrofitting an existing system. Each control point in the tile laterals and submains contains a weir to control the level of water stored in the soil profile above the tile lines. A conceptual diagram of a controlled drainage system is shown in Figure VIII-15. Terminal sumps may also need to be expanded to provide short-term additional storage.

Retrofitting an existing drainage system will require construction activities. Installing a new controlled drainage system will also require construction activities; however, the type of construction activities required for a new controlled drainage system is the same as for a drainage system without any water level control features. Alternative 3 does not affect the decision of any particular individual to install a drainage system. Such a decision would be based on the water table conditions of the irrigated land. Therefore, with respect to construction-related effects, Alternative 3 could affect only existing tile drained areas.

Retrofitting tile drainage systems will take place in areas presently under cultivation. The retrofitting activities are compatible with and will have environmental effects similar to those caused by existing farming operations. Consequently, these activities will have no significant construction-related environmental effects.

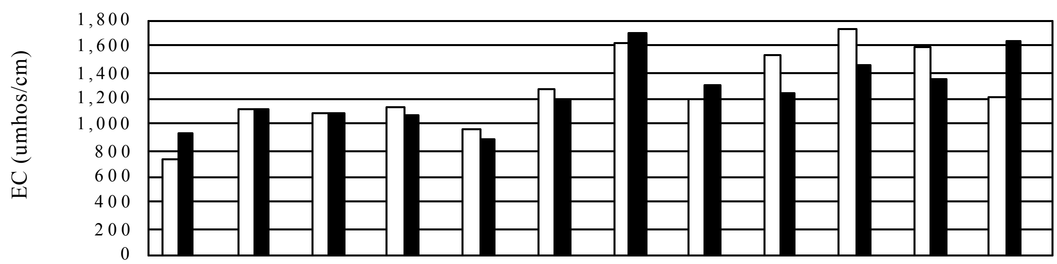
The cost of retrofitting a tile drain system has also been evaluated by the USBR (USBR 1987, USBR 1989). The cost depends on site conditions and the layout of the existing system; areas with steep slopes and narrow tile spacings will have higher costs. In 1987, the estimated costs were $25 to $50 per acre for design, $12 to $90 per acre for installation of drainage control measures, and $24 to $40 per acre per year for management consulting during the first year of operation with cost reduction in succeeding years. Some indirect benefits, such as reduced water and fertilizer use due to the potential for subsurface irrigation, may offset some of the retrofitting costs.

Figure VIII-11
Comparison of Average EC at Vernalis After New Melones Reservoir Releases



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
□ 73-Year Period Avg.	405	601	617	640	539	568	459	424	569	630	657	539
■ Critical Period Avg	499	601	617	627	522	546	470	435	534	591	615	685
Difference	94	0	0	-13	-17	-22	11	11	-35	-39	-42	146

Figure VIII-12
Comparison of Average EC at Crows Landing



	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
□ 73-Year Period Avg.	727	1,112	1,084	1,141	964	1,262	1,617	1,201	1539	1743	1592	1222
■ Critical Period Avg	947	1,112	1,084	1,070	892	1,198	1,702	1,301	1246	1457	1345	1638
Difference	220	0	0	-71	-72	-64	85	100	-293	-286	-247	416

Figure VIII-13
Comparison of Monthly Average EC at Vernalis During Water Years 1984-1994

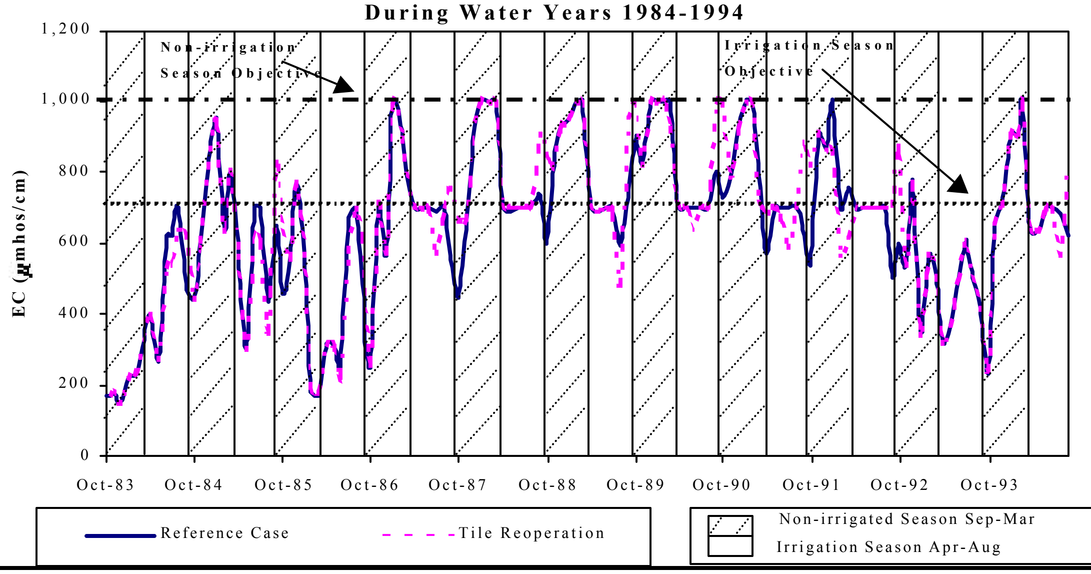


Figure VIII-14
Comparison of Monthly Average EC at Crows Landing During Water Years 1984-1994

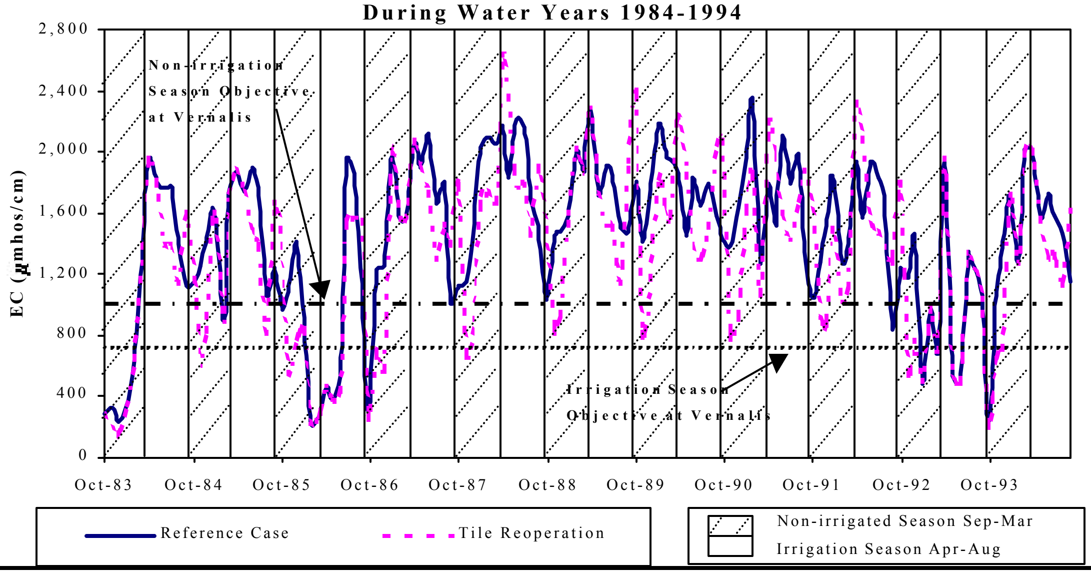
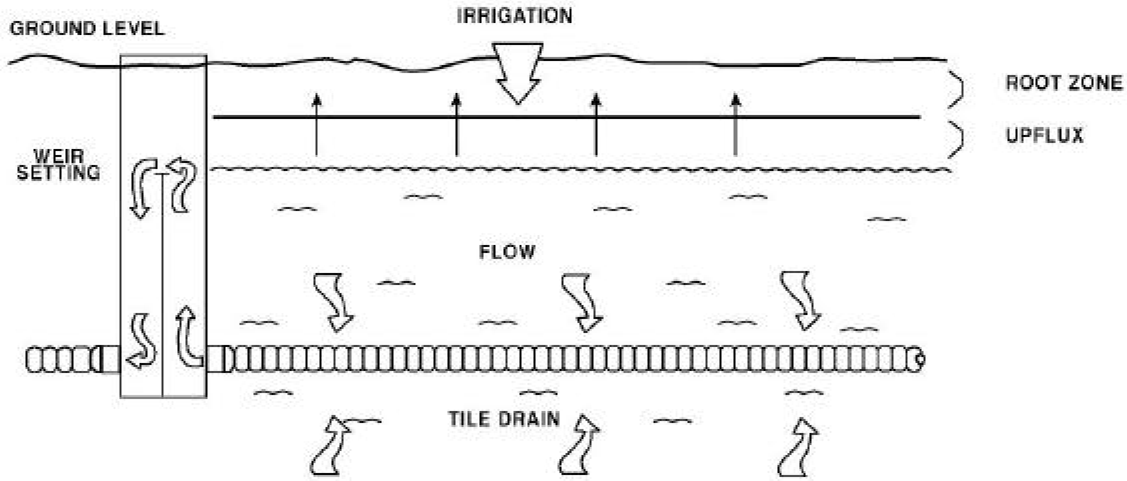


Figure VIII-15
Conceptual Operation of Controlled Drainage



The USBR reported in 1991 that the total construction cost for a new controlled drainage system over 320 acres ranged from $476 to $697 per acre, depending primarily on soil texture and tile drain spacing (USBR 1991). Generally fine-textured soils require closer drain spacing and consequently higher costs for drainage systems than do coarse textured soils. The annual operation and maintenance cost for the drainage systems was $24 per acre.

5. Crop Production

The storage of tile drainage for three months in the soil profile above tile lines and subsurface mains can affect crop production through two mechanisms: (1) the water table can rise into the root zone; and (2) salt can accumulate in the root zone.

Under most circumstances, the rising water table conditions can be controlled through monitoring and management-the costs of which are identified in the previous section. Control is more difficult on sloping lands. The rising water table can also be a resource under some conditions. The USBR studies showed controlled drainage provided 15 percent of tomato crop water requirements and 35 percent of cotton water requirements through upflux. Ground water quality, crop salt tolerance, and ground water depth limit crop water use from a shallow water table. However, for a substantial portion of this water savings to be realized, irrigation must be applied uniformly. Similar findings have been reported by Ayars (Ayars 1994, Ayars 1996). He found that irrigation depths could be reduced to make better use of the high water table created by controlled drainage. Most irrigation practices do not account for ground water contributions to crop water use. Neglecting such a contribution will result in waterlogging due to over-irrigation. Nonetheless, in order to mitigate for problems caused by a rising water table, Alternative 3 may have to allow some drainage to occur if water tables rise too high. The CVRWQCB will examine this issue if the SWRCB directs further evaluation of this alternative.

Under some circumstances, the potential salt accumulation problems can also be controlled through monitoring and management. Controlled drainage can limit the leaching process and may contribute to soil salinity build up and reduced crop productivity. However, Alternative 3, as formulated, allows drainage to be discharged for at least six months of the year, and this level of drainage can help maintain a salt balance. This issue will have to be evaluated further by the CVRWQCB if the SWRCB directs further evaluation of this alternative.

In summary, a controlled drainage system requires careful monitoring and management to be successful. The costs of this effort are identified in the previous section and will have to be considered as part of any decision to implement this alternative.

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