Central Valley Project Improvement Act

Draft Programmatic Environmental Impact Statement

Technical Appendix

VOLUME FIVE

US Department of the Interior

Bureau of Reclamation

Sacramento, California

C—082694

C-082694

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(SEPTEMBER 1997)

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CENTRAL VALLEY PROJECT IMPROVEMENT ACT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

DRAFT TECHNICAL APPENDIX

Agricultural Economics and Land Use

September 1997

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LIST OF ABBREVIATIONS AND ACRONYMS

AFRP	Anadromous Fish Restoration Program
ARP	acreage reduction percentage
AW	applied water
BMP	best management practice
CAC	County Agricultural Commissioner
Census	U.S. Bureau of the Census
CES	University of California Cooperative Extension Service
COE	U.S. Army Corps of Engineers
CVGSM	Central Valley Ground-Surface Water Model
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
CVPTM	Central Valley Production and Transfer Model
DAU	detailed analysis unit
Delta	Sacramento-San Joaquin Delta
DFA	California Department of Food and Agriculture
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utility District
ESA	Endangered Species List
ET	evapotranspiration
ETAW	evapotranspiration of applied water
GATT	General Agreement on Tariffs and Trade
IMPLAN	regional economic input-output model
Interior	U.S. Department of the Interior
KCWA	Kern County Water Agency
kWh	kilowatt-hour
Merced ID	Merced Irrigation District
O&M	operation and maintenance
PCWA	Placer County Water Agency
PEIS	Programmatic Environmental Impact Statement
PG&E	Pacific Gas and Electric Company
PSA	planning subarea
psi	pounds per square inch
Reclamation	U.S. Bureau of Reclamation
RWQCB	Regional Water Quality Control Board
Service	U.S. Fish and Wildlife Service
SF	City and County of San Francisco
SFD	San Felipe Division
SMUD	Sacramento Municipal Utility District
SWP	State Water Project
TCC	Tehama-Colusa Canal
TID-MID	Turlock Irrigation District and Modesto Irrigation District
USDA	U.S. Department of Agriculture

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LIST OF ABBREVIATIONS AND ACRONYMS

WWD	Westlands Water District
YCFCWCD	Yolo County Flood Control and Water Conservation District
YCWA	Yuba County Water Agency

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CHAPTER I

INTRODUCTION

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Chapter I

INTRODUCTION

Agriculture is the largest consumptive user of Central Valley Project (CVP) water. Many of the provisions of Central Valley Project Improvement Act (CVPIA) directly affect water deliveries and costs to CVP agricultural users. Specifically, re-operation and dedication of water for environmental purposes will affect the availability of CVP water for irrigation. Tiered water pricing and various Restoration Fund charges increase the cost of CVP water to users, which can affect water use and land use decisions. The land retirement program, the water acquisition program, and opportunities for transfer of CVP water can also affect agricultural land and water use.

The agricultural economic analysis is designed to assess the interactions among crop and land use decisions, irrigation and water use, and crop revenues. Direct impacts on agriculture are used in other impact assessments. For example, changes in crop production and costs are used in the regional economics analysis to assess regional changes in income and employment; estimates of land use changes are also used to assess potential impacts on vegetation and wildlife.

The assumptions used in this analysis are summarized in Table I-1. These assumptions are designed to provide a programmatic assessment of the impacts of CVPIA on agricultural land use, water use, and economics. Most results are presented at a regional level of aggregation, consistent with the programmatic nature of this study. In cases where regional aggregation may obscure the magnitude of impacts to a particular group, discussion is provided about that group.

This technical appendix provides analysis of direct impacts on agricultural users, including land use, water use, gross and net revenue from irrigated crop production, irrigation and other production costs, and risk and uncertainty. Related economic impacts on farm workers, suppliers, and the other parts of the economy linked to agriculture are described in the Regional Economics Technical Appendix.

Subsequent to the analyses conducted for the PEIS, Reclamation and the Service discovered an inconsistency in the input hydrology that may cause the analysis to overestimate the flexibility of CVP operations. This inconsistency affects all PEIS simulations, including the No-Action Alternative, and due to the programmatic nature of the Draft PEIS, is expected to have minimal impact on the relative differences between the alternatives.

A summary of impacts for each alternative and supplemental analysis described in this Technical Appendix is provided in Table I-2.

TABLE I-1

SUMMARY OF ASSUMPTIONS FOR AGRICULTURAL ECONOMICS AND LAND USE ANALYSES

Alternative or Supplemental Analysis	Assumption
No-Action Alternative	Hydrology and water supplies are estimated from the No-Action Alternative surface water and groundwater analyses. CVP water is priced at cost-of-service, subject to ability to pay limits. 2020 level of demand for crop production is assumed.
1	Hydrology and water supplies are estimated from the Alternative 1 surface water and groundwater analyses. CVP water is priced using tiered rates, with cost-of-service for the first 80 percent of contract total, full cost rates for the last 10 percent tier, and the average of the two rates for the middle tier. Restoration charges and Friant surcharges are imposed. The ability-to-pay policy is maintained as applied to repayment of principal on capital and restoration charges. An additional 30,000 acres is assumed to be retired for drainage control. 2020 level of demand for crop production is assumed.
1a	Assumptions are the same as for Alternative 1 except that water deliveries from the hydrology analysis reflect the addition of a Delta component for dedicated water.
1b	Assumptions are the same as for Alternative 1.
1c	Assumptions are the same as for Alternative 1 except that CVP water prices begin at the full cost rates for the first 80 percent of contract total, with delivery between 80 and 90 percent priced at 110 percent of full cost rates, and deliveries more than 90 percent priced at 120 percent of full cost rates.
1d	Assumptions are the same as for Alternative 1 except that water deliveries from the hydrology analysis reflect the assumption of no shortages for Level 2 refuge supplies.
1e	Assumptions are the same as for Alternative 1 except that all CVP water is transferable subject to the charges and conditions specified in CVPIA.
1f	Assumptions are the same as for Alternative 1 except that all CVP water is transferable subject to the charges and conditions specified in CVPIA, plus an additional $50-per-acre-foot transfer fee paid to the Restoration Fund.
1g	Assumptions are the same as for Alternative 1 except that ability to pay is not used to limit CVP water prices.
1h	Assumptions are the same as for Alternative 1.
1i	Assumptions are the same as for Alternative 1.
2	Assumptions regarding water pricing, restoration charges, and land retirement are the same as for Alternative 1. Water deliveries from the hydrologic analyses reflect water acquisition for Level 4 refuge supplies and instream flow.
2a	Assumptions are the same as for Alternative 2.
2b	Assumptions are the same as for Alternative 2 except that all CVP water is transferable subject to the charges and conditions specified in CVPIA.

TABLE I-1. CONTINUED

Alternative or Supplemental Analysis	Assumption
2c	Assumptions are the same as for Alternative 2 except that all CVP water is transferable subject to the charges and conditions specified in CVPIA, plus an additional $50 per acre-foot transfer fee paid to the Restoration Fund.
2d	Assumptions are the same as for Alternative 2 except that CVP water prices begin at the full cost rates for the first 80 percent of contract total, with delivery between 80 and 90 percent priced at 110 percent of full cost rates, and deliveries more than 90 percent priced at 120 percent of full cost rates.
3	Assumptions regarding water pricing, restoration charges, land retirement, and Level 4 refuge water acquisition are the same as for Alternative 2. Water deliveries from the hydrologic analyses reflect additional water acquisition for instream flow and some pumping of acquired water for Delta export.
3a	Assumptions are the same as for Alternative 3 except that all CVP water is transferable subject to the charges and conditions specified in CVPIA.
4	Assumptions regarding water pricing, restoration charges, land retirement, Level 4 refuge water acquisition, and instream flow acquisition are the same as for Alternative 3. A Delta component of dedicated water is added and no pumping of acquired water for export is allowed.
4a	Assumptions are the same as for Alternative 4 except that all CVP water is transferable subject to the charges and conditions specified in CVPIA.

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TABLE I-2

SUMMARY OF IMPACT ASSESSMENT OF AGRICULTURAL ECONOMICS AND LAND USE

Affected Factors	No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
		Change from No-Action Alternative			
Changes in Irrigated Acres (acres)					
Sacramento River Region	2,020,000	-1,600 (-<1%)	-6,000 (-<1%)	-23,800 (-1%)	-23,300 (-1%)
San Joaquin River Region	2,558,000	-31,000 (-1%)	-64,900 (-3%)	-129,700 (-6%)	-148,500 (-6%)
Tulare Lake Region	2,009,000	-15,600 (-1%)	-14,100 (-1%)	-13,400 (-1%)	-18,800 (-1%)
San Felipe Division	25,000	-9,000 (-36%)	-9,000 (-36%)	-5,000 (-19%)	-9,800 (-39%)
Changes in Gross Revenue ($ Million/Year)					
Sacramento River Region	1,828	-3 (-<1%)	-3 (-<1%)	-11 (-1%)	-10 (-1%)
San Joaquin River Region	4,436	-31 (-1%)	-51 (-1%)	-78 (-2%)	-93 (-2%)
Tulare Lake Region	3,893	-14 (-<1%)	-12 (-<1%)	-10 (-<1%)	-14 (-<1%)
San Felipe Division	88	-31 (-36%)	-31 (-36%)	-17 (-19%)	-34 (-39%)
Water Supply Reliability and Risk	N/A	Reduced reliability and increased financial risk	Similar to Alternative 1	Similar to Alternative 1	Similar to Alternative 1
Water Conservation and Measurement	N/A	Higher Cost	Similar to Alternative 1	Similar to Alternative 1	Similar to Alternative 1
Cost of CVP Water and Groundwater	N/A	$46 million annual increase	$51 million annual increase	$44 million annual increase	$57 million annual increase
Localized Impacts	N/A	Negative impacts concentrated in areas of CVP water service delivery.	Negative impacts similar to Alternative 1. Additional impacts offset by revenue from water acquisition.	Negative impacts similar to Alternative 1. Additional impacts offset by revenue from water acquisition.	Negative impacts similar to Alternative 1. Additional impacts offset by revenue from water acquisition.

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TABLE I-2. CONTINUED

Supplemental Analysis 1a	Supplemental Analysis 1c	Supplemental Analysis 1d	Supplemental Analysis 1e	Supplemental Analysis 1f	Supplemental Analysis 1g
Similar to Alternative 1 Except for the Following					
Reduction in CVP water supply is replaced by additional 80,000 acre-feet of groundwater pumping in Central Valley and 2,000 acres of land fallowed in San Felipe Division.	About 570,000 acre-feet of CVP water unaffordable and not used. Results in 56,000 acres of land out of production in Sacramento River Region and 337,000 acre-feet of additional groundwater pumped in the San Joaquin River and Tulare Lake Regions. Large aggregate increase in the cost of CVP water. All impacts fall on CVP water service contractors.	Reduced CVP delivery largely in the San Joaquin River Region, replaced by additional groundwater pumping.	About 160,000 acre-feet of agricultural water sold in an average condition, and up to 900,000 acre-feet potentially sold in a dry condition. These quantities would correspond to about 44,000 acres and 256,000 acres fallowed. Water received by buyers would be significantly less due to conveyance loss and transfer of ET or irrecoverable loss only. Annual gains to sellers are estimated to be $10 million in an average condition, and up to $90 million in a dry condition.	Changes from Alternative 1 similar to 1e, but with less CVP water sold and more non-CVP water sold.	Up to 24,000 acre-feet of CVP water unaffordable and not used. Some land would go out of production in the Sacramento River Region but most of the water would be replaced with additional groundwater pumping.

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TABLE I-2. CONTINUED

Supplemental Analysis 2b	Supplemental Analysis 2c	Supplemental Analysis 2d	Supplemental Analysis 3a	Supplemental Analysis 4a
Similar to Alternative 2 Except for the Following			***Similar to Alternative 3 Except for the Following***	***Similar to Alternative 4 Except for the Following***
About 160,000 acre-feet of agricultural water sold in an average condition, and up to 900,000 acre-feet potentially sold in a dry condition. These quantities would correspond to about 50,000 acres and 252,000 acres fallowed. Water received by buyers would be significantly less due to conveyance loss and transfer of ET or irrecoverable loss only. Annual gains to sellers are estimated to be $15 million in an average condition, and up to $95 million in a dry condition.	Changes from Alternative 2 similar to 2b, but with less CVP water sold and more non-CVP water sold.	About 540,000 acre-feet of CVP water unaffordable and not used. Results in 53,000 acres of land out of production in Sacramento River Region and 350,000 acre-feet of additional groundwater pumped in the San Joaquin River and Tulare Lake Regions. Large aggregate increase in the cost of CVP water. All impacts fall on CVP water service contractors.	About 140,000 acre-feet of agricultural water sold in an average condition, and up to 840,000 acre-feet potentially sold in a dry condition. These quantities would correspond to about 42,000 acres and 244,000 acres fallowed. Water received by buyers would be significantly less due to conveyance loss and transfer of ET or irrecoverable loss only. Annual gains to sellers are estimated to be $11 million in an average condition, and up to $94 million in a dry condition.	About 160,000 acre-feet of agricultural water sold in an average condition, and up to 970,000 acre-feet potentially sold in a dry condition. These quantities would correspond to about 50,000 acres and 272,000 acres fallowed. Water received by buyers would be significantly less due to conveyance loss and transfer of ET or irrecoverable loss only. Annual gains to sellers are estimated to be $15 million in an average condition, and up to $102 million in a dry condition.

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CHAPTER II

AFFECTED ENVIRONMENT

Chapter II

AFFECTED ENVIRONMENT

INTRODUCTION

This chapter describes historical and recent conditions in agricultural production and land use in the Central Valley and the San Felipe Division (SFD). A short discussion of important data sources is followed by a summary of historical agricultural development and land use trends in the Central Valley. The discussion of recent conditions describes Central Valley agriculture and shows data used in the analysis of alternatives.

Two major tools used to analyze agricultural and associated regional impacts are the Central Valley Production Model (CVPM) and IMPLAN, a regional economic input-output model. Much of the discussion that follows describes data used to calibrate or verify those models.

DATA SOURCES

Agricultural economics and land use data and descriptions of Central Valley agriculture covering the 1920 to 1992 period were collected for three purposes:

- develop a historical perspective for agriculture and agricultural land use in the Central Valley
- describe recent trends and conditions in agriculture and land use in the Central Valley
- provide data used to analyze the agricultural economics of CVPIA alternatives in the CVPM

Data were collected or estimated in the following categories:

- irrigated acres and land use
- crop yields (production per acre) and prices
- crop production costs
- water availability
- water costs and prices
- crop water use and on-farm irrigation efficiency
- indicators of farm structure and ownership

The primary data sources are identified in the following paragraphs:

- **County Agricultural Commissioner Reports.** County Agricultural Commissioner (CAC) reports are required by the California Food and Agriculture Code. These reports are published annually and are available from the 1930s to the present for some counties. They provide detailed data on the harvested acreage, yield, and value of production for the principal crops produced in each county. These data are collected from county records and visual surveys. The reports record all harvested acreage (irrigated and dryland) but do not include non-producing irrigated acreage such as young orchards. For this study, reports for period

1985-1992 were obtained from the California Department of Food and Agriculture (DFA) in electronic format.

- **California Department of Water Resources (DWR) Bulletin 160 Reports.** These reports are published periodically to update California's water plan. Data on irrigated acres by planning subarea were collected from the 1966, 1974, 1983, and 1993 reports. DWR's smallest study area is a detailed analysis unit (DAU), which may coincide with the boundaries of a water service agency or may be defined by hydrologic features. A planning subarea (PSA) is made up of one or more DAUs and is used by the DWR Planning Division for water supply and demand analyzes and water use projections. DWR data collection methods include reviewing aerial photography of DWR planning subareas within the Central Valley, field checking data to verify cropping information tabulated from aerial photographs, and calculating the acreage surveyed. Bulletin 160-93 projects normalized irrigated acres for years 2000, 2010, and 2020.

- **U.S. Department of Commerce Census of Agriculture.** These agricultural census reports provide information by county. The data include the number and size of farms, extent of farmlands, cropland acreage, irrigated acreage, types of farm ownership, market value of production, production expenses, and acreage of principal crops. The Census of Agriculture is a legally-required report that is sent to each farmer in an area. The data were collected in 1964, 1969, 1978, 1987, and 1992.

- **Kern County Water Agency (KCWA) Annual Water Supply Reports and Westlands Water District (WWD) Annual Reports.** Data on irrigated acres were collected from KCWA and from WWD for the period 1985-1992.

- **Reclamation Crop Budgets and University of California Cooperative Extension Service (CES) Crop Budgets.** The CES has developed budgets for representative crops in many California counties and regions to be used by farmers as guides for making production decisions and determining potential returns. The budgets are based on typical production practices for the area and are detailed and documented. The U.S. Bureau of Reclamation (Reclamation) also prepares detailed crop budgets to determine repayment capacities of project costs. CES and Reclamation budgets are updated frequently.

- **Reclamation, DWR, and District Water Deliveries.** Data on water project deliveries for the years 1985-1992 were obtained from Reclamation operations data and State Water Project (SWP) reports. Information about deliveries of local water supplies came from the database of the Central Valley Ground-Surface Water Model (CVGSM), described the CVGSM Methodology/Modeling Technical Appendix. Additional data were provided by District reports and survey responses.

- **DWR Estimates of Crop Water Use and Irrigation Efficiency.** DWR estimated applied water (AW) and evapotranspiration (ET) of applied water, by crop, for analysis in Bulletin 160-93.

- **Survey of Water Districts.** Central Valley water districts were surveyed to obtain information on water delivery, costs, and pricing.

- **Reclamation Data on Land Use in Districts Receiving CVP Water.** These data, published annually in *Summary Statistics - Land, Water and Related Data,* show crop mix and water deliveries for lands receiving some CVP water.

Specific citations on these data sources appear in Chapter V of this appendix.

Data presented in this appendix are aggregated into four study area regions: the Sacramento River, the San Joaquin River, the Tulare Lake, and the Central Coast regions. (The SFD rather than the Central Coast Region is discussed in the "Recent Conditions" section of this chapter because Reclamation has data available on agricultural land use in the area and most of the future CVP contract water in the Central Coast Region will go to this area.) For the CVPM, data were desegregated into the 21 CVPM regions or detailed study areas. Each of the 21 CVPM study areas corresponds to one or more of DWR's DAUs. This disaggregation is discussed in the CVPM Methodology/Modeling Technical Appendix.

LAND USE DATA

Land Use Data for Analyzing Alternatives

Data on irrigated acres were collected from the CAC, DWR Bulletin 160-93, Census of Agriculture reports (U.S. Bureau of the Census [Census]), KCWA annual crop reports, and WWD annual crop reports. The CAC reports were the primary source for crop acres because the reports are available annually and give acres by individual crop. These data are used in calibrating the CVPM because they are calculated annually. Crops from the CAC reports were aggregated into 26 crop categories for the CVPM to make the data more manageable, the model runs more efficient, and the model output more usable. Crops were aggregated based on agronomic and marketing characteristics. Table II-1 shows the relationship of the crops reported in the CAC reports to the 8 IMPLAN categories and the 26 CVPM crop categories.

The CAC data are in units of harvested acres and include harvested dryland acres; they do not include acres irrigated but not harvested (i.e., nonbearing trees). Because the CVPIA directly impacts irrigated acreage, two adjustments to the CAC data were necessary. One adjustment excludes dryland acres; the second accounts for acres that were irrigated but not harvested.

Census of Agriculture data on dryland and irrigated acreage were used in adjusting the CAC data to obtain irrigated harvested acreage for the CVPM. Dryland crops grown in the Central Valley are wheat, barley, dry beans, and safflower, and a very small amount of alfalfa and miscellaneous hays. Irrigated harvested acres and total harvested acres from the 1987 and 1992 Census of Agriculture reports were allocated from counties to CVPM regions using allocation shares estimated from DWR data. Ratios of irrigated acres to total harvested acres were then calculated for each CVPM region. These ratios were used to adjust the CAC total harvested acres to obtain irrigated harvested acres.

TABLE II-1

AGGREGATION OF INDIVIDUAL CROPS INTO 8 IMPLAN CATEGORIES AND 26 CVPM CATEGORIES

IMPLAN Category	CVPM Category	County Agricultural Commissioner Reports Crops
Cotton	Cotton	Cotton
Hay, Pasture, & Alfalfa	Alfalfa	Alfalfa hay
	Pasture	Irrigated pasture
	Misc. hay	Grain hay, other silage, sudan hay, misc. hay
Rice	Rice	Rice, rice seed
Field & Grain	Field corn	Field corn, corn silage, misc. corn
	Wheat	Wheat
	Misc. grain	Barley, oats, sorghum, misc. grains, grain seeds
	Alfalfa seed	Alfalfa seed, misc. seeds, misc. field crops
	Oilseeds	Safflower, sunflower
	Dry beans	Dry beans, lima beans
Sugar Crop	Sugar beets	Sugar beets
Vegetables	Processing tomatoes	Processing tomatoes
	Misc. vegetables	Carrots, asparagus, lettuce, broccoli, peppers, misc. vegetables
	Melons	Cantaloupe, watermelon, other melons
	Onions	Dry onions, fresh onions, garlic
	Fresh tomatoes	Fresh tomatoes
	Potatoes	White potatoes
Fruits	Raisin grapes	Raisin grapes, table grapes
	Wine grapes	Wine grapes
	Citrus	Oranges, lemons, grapefruit, misc. subtropical fruit
	Peaches	Peaches, nectarines, pears, apples, cherries, misc. deciduous fruit
	Prunes	Prunes, plums, apricots
	Olives	Olives, figs, kiwi, avocados, pomegranates
Nuts	Almonds	Almonds, pistachios
	Walnuts	Walnuts

DWR data are important because they include all irrigated acreage, even acreage that is not harvested, and because they provide a projection to year 2020. Irrigated crop acres that are not harvested include nonbearing fruits and vines, recently established hay, some cover crops, and crops that are irrigated but not harvested due to crop failure or poor market conditions. To calculate adjustment factors for the CAC data, 1990 DWR total irrigated acres were allocated to the CVPM regions. These acres were then divided by the 1990 CAC report acres, as previously adjusted for dryland acres, to obtain ratios of total irrigated to harvested irrigated acreage. These ratios were applied to the other years of CAC data to obtain a measure of total irrigated acres for the CVPM. This process essentially adjusts all CAC data to the DWR data using the difference between the 1990 CAC and 1990 DWR data.

Reclamation data are available by district, but these data were not used because they cover only lands receiving CVP water. District reports provided by WWD and KCWA were used in place of CAC- adjusted data for those regions.

Land Use Data for Recent Conditions

Land use data reported in the "Recent Conditions" section of this chapter are mostly from the same sources as used for the CVPM. That section shows raw data summarized from these

sources as well as data adjusted for the CVPM as described earlier. DWR's 1990 normalized acreage is provided for comparison with the CAC and Census of Agriculture data. Reclamation acreage data for the SFD are used to show crop mix in that region, and Reclamation data on water use and crop mix are displayed to show the importance of the CVP relative to the entire Central Valley. The Reclamation data are published data from the annual *Summary Statistics - Water, Land and Related Data* series.

Census of Agriculture acreage data are also reported in the "Recent Conditions" section. These data are important because they provide information on farm structure. Data for 1984 were used to verify 1984 CAC data. The average difference across crops and regions was 5.5 percent. The largest differences were in hay, pasture, and alfalfa (21 percent) and orchard crops (18 percent). The smallest differences were in cotton and sugar beets. Differences were likely due primarily to differences in the methods of data collection for the two sources. Other comparisons of land use data are included in the "Recent Conditions" section.

Land Use Data for Historical Perspective

For the "Historical Perspective" section of this chapter, acreage data for 1920-1955 were gathered as available from the Census of Agriculture. Over time, the amount and type of data compiled for that census changed so actual comparisons between years are not exact. However, for this document, the data source is satisfactory. This effort was limited because historical data were available only in hard copy and had to be hand-entered for each crop grown and for each county within the Central Valley. Therefore, the historical perspective information prior to 1955 should be considered representative of the general condition of agriculture in the Central Valley.

Data for 1958 to the present came from CAC reports. Data by county and crop were compiled annually using DWR electronic files and then aggregated into the three geographic regions. As discussed previously, the CAC data include dryland acreage but not land irrigated and not harvested. These discrepancies do not significantly affect the discussion. Data should be considered representative of the general condition of irrigated agriculture in the Central Valley following construction of the CVP.

For both the "Historical Perspective" and "Recent Conditions" sections of this chapter, cropping data were aggregated into eight categories that represent the major crops in the Central Valley. This aggregation simplifies presentation, illustrates the importance of each crop category with respect to acreage irrigated, and identifies the wildlife habitat value of farmland in the Central Valley (discussed in the Vegetation and Wildlife Technical Appendix). Crop categories were developed to match the needs of each of these criteria. In addition, the selected categories and acreage for 1992 were used as input to the IMPLAN model for the alternatives analysis phase of the PEIS. Crops reported and representative categories are presented in Table II-1. For the "Historical Perspective," fruit and nut acreages were combined into one category and sugar beets were combined with the field and grain acreage.

CROP YIELDS, PRICES, AND VALUE DATA

The CAC reports were the initial sources for crop yields and market prices for agricultural crops for the CVPM. The data were tabulated by county from 1958 to 1992 and then reviewed for

reasonableness and consistency. The large variations found among some adjacent counties probably resulted because small samples had to be used by the county commissioners to calculate the average yields and prices. Counties were then grouped into five areas from north to south, as shown in Table II-2.

TABLE II-2

GROUPING OF COUNTIES AND CVPM REGIONS FOR YIELD AND PRICING DATA

Yield and Price Area	Counties	CVPM Regions
1	Shasta, Tehama, Glenn, Butte, Colusa, Sutter, Yuba	1-5
2	Yolo, Placer, Sacramento, Solano, San Joaquin	6-9
3	Stanislaus, Merced, Madera	10-13
4	Fresno, Kings, Tulare	14-18
5	Kern	19-21

For each of the five areas, the most representative yields and prices were selected from the county data, based primarily on the acres of the crop grown in each county, and these yields and prices were then used for all the CVPM regions in that area. Deficiency payments adjusted for the program participation rates were added to the market prices for farm program crops (cotton, rice, wheat, field corn, and miscellaneous grains).

For crops that have significant dryland shares, the yields provided by the CAC data may be too small for irrigated conditions. However, no good data are available on dryland and irrigated yields by county. The CES provides crop budgets for dryland and irrigated crop production that show expected yields. Irrigated production typically yields two to three times dryland production. However, some dryland acreage, especially winter grains, is often not irrigated merely because there is enough rainfall to ensure a full yield. Irrigated yields were assumed to be twice dryland yields, and yield data from the CAC were adjusted using dryland irrigated shares provided by the Census of Agriculture.

The "Recent Conditions" section also provides data on value of production by county as supplied by the CAC. These data include value of livestock products that are related to the value of feed crop production. Census of Agriculture data on the value of all crops are also shown. Reclamation data are provided as an indication of the value of production from CVP-served lands in relation to the entire valley, and Reclamation data for the San Felipe Service Area are shown.

CROP PRODUCTION COSTS

A crop budget analysis was required to estimate variable and fixed production costs for the selected crops in the CVPM. The objective of the analysis was to determine the relative difference in the costs among the crops, and if possible among the regions for the same crop. The costs reflect typical growing conditions and typically sized farms for each crop but do not represent average conditions in a statistical sense.

Crop production cost information was obtained from four sources: the CES county crop budgets, Reclamation crop budgets prepared for the CVP Cost Allocation Study (March 1992) and updated for this study, DWR from a data survey of production costs, and cost estimates included in the California Agricultural Resources Model. This information was then compiled on a crop-by-crop basis. In general, the farm budgets prepared by Reclamation were selected as the basis for the production cost estimates used in the CVPM. One of the other sources was used only if a Reclamation budget was not available for the crop or crop variety. Cost estimates were then reviewed with Reclamation and DWR to select the most representative costs for a given crop.

Fixed costs were calculated using Reclamation farm budget instructions. It should be noted that the fixed costs do not include land costs or irrigation system costs. Irrigation costs were accounted for separately. Net returns represent returns to land and management.

The "Recent Conditions" section also displays cost data from the Census of Agriculture.

WATER SUPPLY DATA

Water supply data for 1985 through 1992 for use in the CVPM were obtained from several sources.

- **CVP Water.** Reclamation operations data provided the total amounts of CVP water delivered by region. Contract deliveries were obtained from Reclamation (1993, 1994). The difference between total deliveries and contract deliveries indicates deliveries for water rights settlement and exchange.

- **SWP Water.** SWP deliveries for both water contracts and Feather River water rights were obtained from DWR Bulletin 132-92. KCWA annual water supply reports provided more detailed information on SWP deliveries by district.

- **Local Surface Water.** The CVGSM was used as the primary source of local surface water supply data. Additional information from individual districts was used, as available, to supplement the CVGSM estimates. KCWA annual water supply reports provided detailed estimates for Kern County.

- **Groundwater.** The CVGSM was used as the primary source of groundwater use estimates. Additional information obtained from individual districts was used, as available, to supplement the CVGSM estimates. KCWA annual water supply reports provided estimates for Kern County, and WWD has made estimates of pumping within its boundaries. All of these estimates are imprecise, and the CVPM calibration procedure uses groundwater pumping as one of the adjustment parameters to achieve balance between water supply and demand.

WATER COST AND PRICING DATA

Associated with each surface supply is a unit water cost (in dollars per acre-foot) paid by purveyors to acquire water. This unit cost is analogous to a wholesale cost and is zero for water rights supplies. These data were obtained from Reclamation (1993, 1994) and DWR (various years).

In addition, surface water carries a district charge associated with the cost of delivering the water from the source to the farms. The district charge is the amount that local districts charge to recover their costs, and this charge applies to local, SWP, or CVP water.

The district charge is divided into a water charge, or markup (in dollars per acre-foot), and a land assessment (in dollars per acre), called a standby charge. Districts with more than one source of water will often charge everyone the same markup and assessment or may vary the charge to reflect internal delivery cost differences. CVPM is defined by region, so district charges are averaged over a region. They do not vary by source. The cost per acre-foot of water charged to growers is the sum of the wholesale cost and the markup. District charges and land assessments were obtained from a direct survey of more than 50 Central Valley water districts.

CROP WATER USE AND ON-FARM IRRIGATION EFFICIENCY DATA

DWR has estimated by DAU the AW and the crop use of AW (ETAW) for 14 crop categories. CVPM uses these estimates in all but a few cases. A few of the estimates implied an unrealistically high irrigation efficiency and were adjusted slightly.

Irrigation costs and performance characteristics (including irrigation efficiency) were estimated for 8 crop categories, 15 irrigation systems, 3 management levels, and 3 regions within the Central Valley. Not all combinations of these parameters were investigated. Some combinations such as drip irrigation on grain or linear-move sprinklers on orchards simply are not sensible and were excluded. For each crop category and region, the feasible technology-management combinations were plotted graphically. Any irrigation system that was clearly inferior was eliminated from the analysis. For each crop, a statistical relationship was estimated. Then DWR's estimate of water use, by crop and region, was used to determine the corresponding irrigation cost. The relationships between water use and irrigation system cost are described in the CVPM Methodology/Modeling Technical Appendix.

HISTORICAL PERSPECTIVE

INTRODUCTION

This section discusses the history of agriculture and agricultural land use in the Central Valley. Central Valley agriculture includes irrigated and dryland crops and livestock and poultry production. Most cropland, and the focus of the CVPIA, is irrigated agriculture. Historically, most dryland production in the Central Valley was eventually converted to irrigated cropland. Livestock production evolved around the plentiful and secure feed supplies provided by irrigation and was supported by local (California) demands for meat and dairy products created by a rapidly growing population.

California's water supply problem is characterized more by the uneven distribution of water than by its absolute scarcity. Average annual precipitation in the North Coast Region is 53 inches, the Sacramento River Region averages about 36 inches, and the Tulare Lake Region averages about 15 inches per year (DWR, 1994). This precipitation comes at the wrong time of year (winter) for most crops, and it is very undependable from year to year. Sierra snowfall is also undependable,

falls in a location far from demands, and when uncontrolled can enter the Central Valley as torrential snowmelt over a short period in the spring.

The moderate climates, sunny summers, and diverse soils of the Central Valley and southern coastal regions are nearly ideal for many types of crops. The southern part of the Central Valley has especially good soils and long summers, but it is farthest from most of the water supply. Therefore, water storage was developed to store winter rainfall and snowmelt until summer and later years and to control flooding that occurred regularly in the spring. Reservoirs were also designed to generate hydropower. Electricity and pumping technology made Central Valley groundwater a practical water supply option. Diversion and water conveyance facilities were developed to transport water locally and from north to south to productive irrigated lands.

In 1874, an estimated 0.3 million acres were irrigated in all of California. Beginning in the 1920s, large reservoirs were built to capture runoff and store water for irrigation use during a longer growing season. In 1922, after the construction of several irrigation projects, the Central Valley alone had 2.9 million acres of irrigated land (Nady and Larragueta, 1983). By 1980, there were 7.1 million acres of irrigated agricultural land in the Central Valley, and this figure has remained fairly constant into the 1990s (Table II-3). The Central Valley is now one of the most productive agricultural regions in the world.

TABLE II-3

DEVELOPMENT OF IRRIGATED ACREAGE IN THE CENTRAL VALLEY, 1880-1990

Year	Irrigated Acreage
1880	0.3
1922	2.9
1930	3.0
1940	3.1
1950	4.4
1960	5.3
1970	6.4
1980	7.1
1990	7.2

NOTES:
All values in million acres.

The 1880 acreage figure is for all of California; the remaining years show Central Valley acreage only. Only a portion of the irrigated acreage is actually harvested.

SOURCES:
California State Engineer, 1880; Nady and Larragueta, 1983; DWR, 1994.

The following sections summarize irrigation development and land use for the period before 1920 and for the years from 1920 through 1992.

IRRIGATION DEVELOPMENT AND AGRICULTURAL LAND USE, PRE-1920

Recorded agriculture in the Central Valley began with Spanish settlers in the late 1700s. These settlers produced mostly dryland crops adequate for their own needs. Irrigation consisted of a few crude canals to transport water from nearby rivers and streams to the farms. When gold was discovered in the Sierra foothills of northern California in 1848, the mining boom created a new market for agricultural products, and more sophisticated water transportation systems (such as reservoirs, ditches, and flumes) were built to mine the gold. These water works were used to supply water for Sacramento Valley irrigation as gold mining activity decreased, although most crops were still dry-farmed. Irrigated agriculture began to increase significantly after the mid 1800s.

The following factors affected initial irrigation development in the Central Valley.

- **Surface water, groundwater, and weather conditions**. Although there is virtually no rain during the summer growing season, there are many rivers, streams, and groundwater aquifers in the Central Valley. Most of the water falls in the northern part of the valley. Less than adequate annual precipitation for agriculture, along with frequent droughts and floods, created the need for water development and flood protection.

- **Enactment of the Federal Swamp Act.** Passage of the Federal Swamp Act of 1849 allowed landowners to purchase swamp and overflow lands at a reduced cost and encouraged reclamation of the land for agriculture. Seasonal and periodic flooding was an important incentive for reclamation. In 1880, the State Engineer classified 1.1 million acres in the Sacramento Valley as swamp and overflow lands, with an additional 600,000 acres in the San Joaquin Valley and the Delta. Under the Act, applications to purchase swamp and overflow lands totaled 200,000 acres between 1902 and 1904, with a majority of the land located in Tulare Lake.

- **Railroads.** The construction of railroads within the state and the completion of the transcontinental railway allowed Central Valley produce to be transported within California and to markets as far away as the eastern U.S.

- **Increasing population within California.** The mining boom in the mid 1800s increased the non-farm population, providing the first big market for agricultural products. The non-farm population continued to increase as more industries and settlers moved into California.

- **Enactment of the Desert Land Act of 1877.** This act encouraged the development of irrigated agriculture in Kern County. Land within designated areas was purchased, and with proof that irrigation of the land was necessary, water rights were also acquired.

- **The availability of power.** Later, groundwater development began as steam and electric power became available throughout the Central Valley. Hydropower generation from local water storage projects provided cheap energy for pumping water supplies to irrigation facilities and fields.

Table II-4 summarizes early irrigation development in the Central Valley. Most development consisted of canals to divert water from existing streams and lakes. A few small dams were built in the 1910s.

TABLE II-4

EARLY IRRIGATION DEVELOPMENT IN THE CENTRAL VALLEY

Facility		Purpose
Sacramento River Region		
1885	Irrigation canals in existence: Tule Canal, Salt Drainage Canal	
1890s	Central Canal	To serve Central Irrigation District; system now operated by Glenn-Colusa and other adjacent irrigation districts
Early 1900s	Irrigation canal by Sutter Butte Canal Co.	To irrigate 80,000 acres adjacent to Feather River
1935 (?)	Orland project (construction of East Park Reservoir, Stony Gorge Reservoir, series of canals)	To irrigate about 20,000 acres using water from Stony Creek
San Joaquin River Region		
1885	Several irrigation canals in existence, including the San Joaquin and Kings River Canal (now called the Outside and Main Canal System)	Divert water from local rivers and streams
1909	Patterson Project (pumping plant and canals)	Irrigation of lands adjacent to the Merced, Kings, and Kern rivers
	Exchequer Dam	Irrigation and hydropower
1914	La Grange Dam	Irrigation and hydropower
	Don Pedro Reservoir	Irrigation and hydropower
Tulare Lake Region		
1885	Several irrigation canals in existence	Transport water from Kern and Buena Vista lakes and divert water from Kings River
SOURCE: Harding, 1960.		

Sacramento River Region

Early irrigation in the Sacramento River Region was limited by the success of dry farming. However, the elimination of hydraulic mining in the 1880s increased interest in irrigation as a means to continue use of the existing canals and stream diversions. In 1907, irrigation of 25,000 acres in the Sacramento Valley was recorded.

The start of the rice industry in 1912 greatly increased diversions from the Sacramento River. World War I caused the price of a 100-pound bag of rice to increase from $2.01 in 1912 to $5.93 in 1919. In 1919, there were 149,000 acres of rice. Because rice fields require so much water,

rice plantings caused diversions to double from 1,154,000 acre-feet in 1915 to 2,300,000 acre-feet in 1919 (Jackson and Paterson, 1977). Groundwater pumping using steam pumping plants also expanded irrigated agriculture in the Sacramento Valley.

San Joaquin River Region

Census of Agriculture data from 1890 indicate that more than 3 million acres of land were being farmed in the San Joaquin Valley, 1.67 million acres of which were improved. (Improved acres included cropland, pastureland, and land for buildings and roads.) A good crop could be produced only about once every 3 years because of water supply limitations (Reclamation, 1988). Dry farming was not as economical in the southern portion of the valley, and the need for water development was greater. Also, the San Joaquin River Region was subject to seasonal flooding, which limited development near the river.

Although irrigation was practiced in the region in the mid 1800s, larger scale irrigation did not develop until the railroads were constructed through the valley. The Southern Pacific Railroad lines to Modesto and Bakersfield were constructed in the 1870s, and lines to Fresno and the west side of the valley were completed in the early 1890s (Harding, 1960). Growers capitalized on the completion of the transcontinental railroad in 1879 to export vegetables and citrus grown in California to the east (California Nature Conservancy, undated). Shipments of fresh fruit across the Atlantic Ocean began in 1892.

Irrigation in the San Joaquin River Region generally developed from the south to the north, primarily because water shortages in the south made dry farming unreliable. Large areas of the region were acquired in Mexican land grants and by the Federal Swamp Act. To irrigate these large parcels, canals were first constructed to convey water from existing streams and lakes. Early reports indicate that more than 750 miles of main irrigation canals were constructed in Fresno County in the 1890s to divert flows from the Fresno, Kings, and San Joaquin rivers. These flows were used to irrigate more than 350,000 acres of land (DWR, 1982).

Between 1880 and 1900, artesian well systems were used for irrigation because reliable pumping systems were not yet available in the valley. Use of groundwater pumping then expanded rapidly; approximately 5,000 pumping systems were recorded in 1910, and 11,000 pumping systems were recorded by 1920. Within the next 10 years, the number of pumping systems in the San Joaquin Valley doubled again (Harding, 1960).

Tulare Lake Region

Fewer water storage and power generation projects were constructed in the Tulare Lake Region than in the San Joaquin River Region during this period (Table II-4). Less surface water was available for development, and more extensive water rights holdings made development difficult. In addition, groundwater was readily available. Artesian wells were used by early irrigators to supplement surface water supplies during drought and under low stream flow conditions (Harding, 1960). By 1910 overdraft conditions reduced water pressures, and the artesian wells no longer flowed. However, steam pumping plants for groundwater were introduced in the 1890s, and extensive groundwater development continued.

San Felipe Division

Data for irrigated agriculture were not available for this period.

IRRIGATION DEVELOPMENT AND AGRICULTURAL LAND USE, 1920-1992

Surface Water Development

Between 1920 and 1992, the Central Valley grew into one of the most productive and diverse agricultural regions in the world. Table II-5 lists reservoirs with storage capacities of 200,000 acre-feet or more built during that time. Most of this storage capacity is in the Sacramento River Region and the San Joaquin River Region, corresponding to the location of most of the valley's rivers and streams. Almost half of the capacity is part of the CVP and more than 10 percent of the capacity is owned by DWR as part of the SWP. In addition to these major reservoirs, numerous local water projects are operated by irrigation districts, water agencies, and private utility companies.

The SWP was authorized by California voters in 1960. Its major components are the Oroville Dam and Lake Oroville, with a storage capacity of more than 3.5 million acre-feet; the 444-mile California Aqueduct; the North Bay and South Bay aqueducts; and part of the San Luis Reservoir. Within the Central Valley, it delivers water to customers in Butte, Kings, and Kern counties.

The CVP is California's single largest water storage system. It delivers water to all Central Valley counties except Yuba. Its facilities include Shasta Dam and Shasta Lake, the largest reservoir in California with more than 4.5 million acre-feet of storage; 15 other reservoirs; and 590 miles of canals. Construction of the CVP was begun by the federal government in 1937. The last major reservoir completed was New Melones Reservoir in 1979.

Groundwater Development

Increasing groundwater withdrawals, especially from the 1940s through the 1960s, led to declining groundwater tables, subsidence, and permanent loss of aquifer storage capacity. During the 1960s and 1970s, Central Valley groundwater pumping accounted for more than 20 percent of the groundwater pumped in the U.S. In places, water levels declined 100 to 400 feet (Williamson et al., 1989).

The worst problems occurred in the western and southern parts of the San Joaquin Valley where less surface water was available. The SWP and CVP replaced much groundwater with surface water, reducing and in places eliminating the overdraft.

From pre-development until 1977, the volume of Central Valley aquifer storage declined by about 60 million acre-feet. This loss was caused by dewatering of shallow sediments, permanent reduction of pore space (inelastic compaction), and compression of storage. The related phenomenon of subsidence, caused by compaction of clay, has caused ground surface levels to decline by more than 1 foot in more than half of the San Joaquin River Region and up to 20 feet

TABLE II-5

CENTRAL VALLEY SURFACE RESERVOIRS WITH CAPACITIES OF 200,000 ACRE-FEET OR MORE CONSTRUCTED BETWEEN 1920 AND 1992

Reservoir (Dam)	Area (acres)	Capacity (1,000 acre-feet)	Owner	Year Completed
Sacramento River Region				
Almanor	28,260	1,143	PG&E	1927
Shasta	29,500	4,552	Reclamation	1945
Folsom	11,450	977	Reclamation	1956
Berryessa (Monticello)	20,700	1,600	Reclamation	1957
Union Valley	2,870	277	SMUD	1963
Whiskeytown	3,200	241	Reclamation	1963
Hell Hole	1,250	208	PCWA	1966
Oroville	15,800	3,538	DWR	1968
New Bullards Bar	4,810	966	YCWA	1970
Indian Valley	4,000	300	YCFCWCD	1976
San Joaquin River Region				
Hetch Hetchy (O'Shaughnessy)	1,970	360	SF	1923
Pardee	2,130	210	EBMUD	1929
Millerton (Friant)	4,900	520	Reclamation	1947
Lloyd Lake (Cherry Valley)	1,540	269	SF	1956
Camanche	7,470	417	EBMUD	1963
New Hogan	4,410	317	COE	1963
Lake McClure (New Exchequer)	7,150	1,024	Merced ID	1967
San Luis	13,000	2,039	Reclamation	1967
New Don Pedro	12,960	2,030	TID-MID	1971
New Melones	12,500	2,420	Reclamation	1979
Tulare Lake Region				
Isabella Lake	11,400	568	COE	1953
Pine Flat	5,970	1,000	COE	1954

SOURCE:
DWR, 1994.

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or more in localized areas (Bertoldi et al., 1991). The costs of subsidence include damage to structures, failure of well casings, and more frequent surveying.

Central Valley Cropping Patterns and Irrigated Acres

Figure II-1 shows harvested cropland and irrigated harvested cropland acreages in the Central Valley and California for various census years from 1920 to 1992. In 1920 approximately 4 million acres of cropland was harvested in the Central Valley. Since 1920, the amount of cropland in the Central Valley has been affected by several factors. During the Depression of the 1930s, commodity prices and land prices fell, market demand declined, and many farmers were forced out of business. Harvested acreage in California remained constant, but acreage decreased in the Central Valley. World War II caused harvested acreage in California and the Central Valley to increase. This expansion was aided by the completion of several important water delivery projects in the 1940s (Table II-5). In addition, several food processing industries located in the valley, which improved markets.

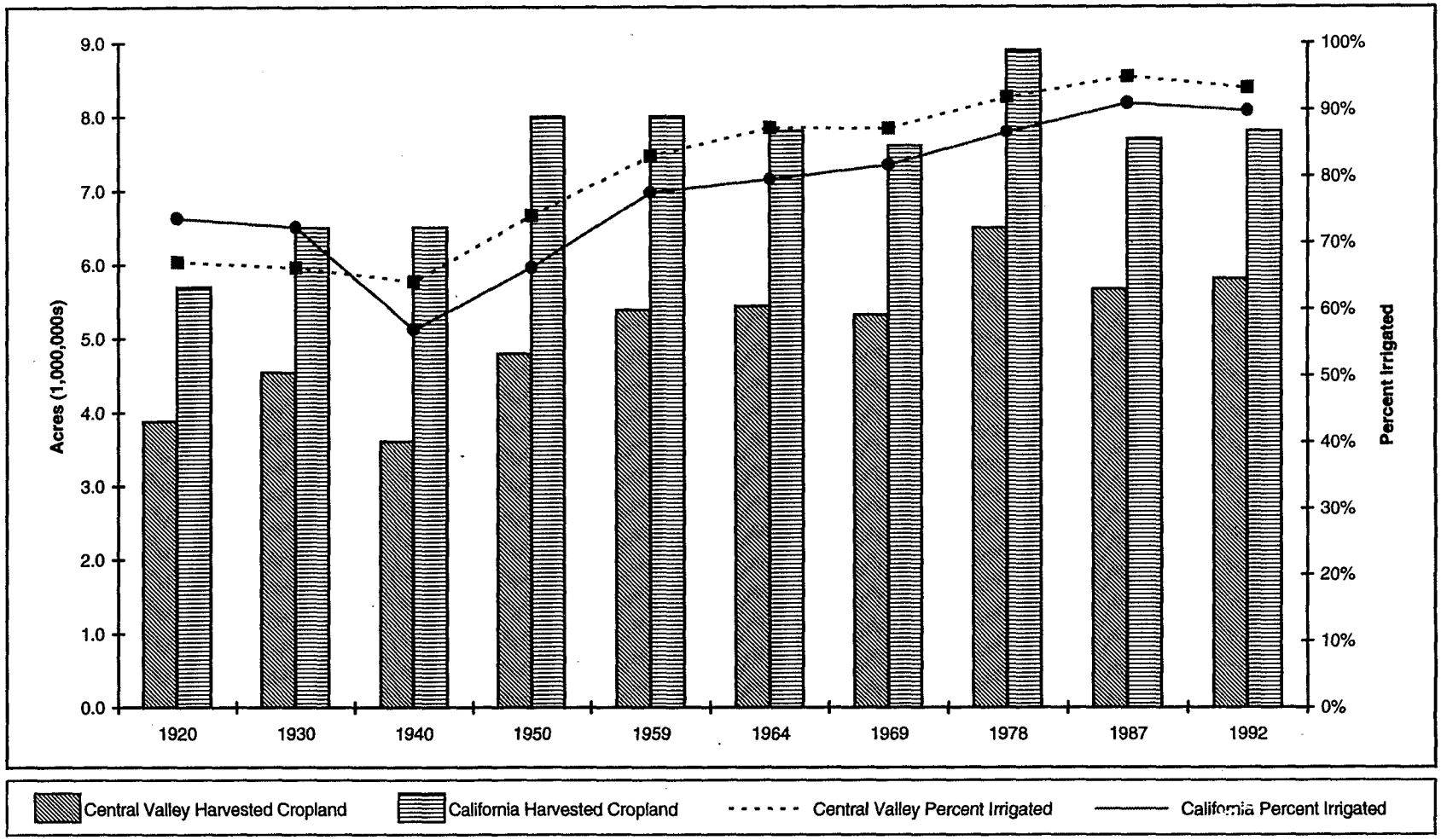
After the 1950s, increases in harvested acreage in the Central Valley were less dramatic until the 1970s when acreage increased because of higher prices received, commodity shortages, and little or no acreage reduction in federal farm programs. Large water projects continued to be built during the 1960s and 1970s. During the 1980s the agricultural industry was faced with major revisions in tax legislation, immigration reforms, and increases in farm program acreage reduction requirements that caused harvested acreage to decrease. The 1987-1992 drought led to restrictions in irrigation water supplies in some years (in 1991 and 1992 for SWP users and 1990-1992 for CVP users) and groundwater depletion restricted the use of groundwater for restoring the lost supplies in some areas.

Since 1964, about 90 percent of harvested cropland in the Central Valley has been irrigated. Census of Agriculture data indicate that irrigated harvested cropland in the Central Valley more than doubled from 1920 to 1992, from 2.6 million acres to 5.4 million acres, reaching a high of 6.3 million acres in 1978. (The DWR figure of 7.2 million acres in 1990 listed in Table II-3 is higher because of differences in reporting areas, the effect of the drought, and other reasons discussed in the "Recent Conditions" section of this appendix.)

Figure II-2 details cropping patterns in the Central Valley from 1920 to 1992. For 1930 through 1978, grains and field crops were dominant, followed by fruits and nuts. Hay crops had the next highest acreage, followed by cotton (which surpassed hay in 1978). Vegetables and rice each represented less than 10 percent of harvested acres. From 1978 through 1992, the cropping pattern became more evenly distributed among these crop types. In 1992, fruits and nuts represented about 30 percent of the acreage and grains and field crops about 25 percent. Cotton was the next largest crop, followed by hay, vegetables, and rice.

Regional Cropping Patterns

Figure II-3 shows harvested cropland acreages for the Sacramento River, the San Joaquin River, and the Tulare Lake regions. Note that these estimates do not include lands irrigated but not harvested (such as non-bearing trees and vines). Census estimates are provided to show the long-term trend in acreage. Census estimates of irrigated acreage in the Central Valley tend to be



NOTE:
Data points on the x-axis are not equally spaced over time.
SOURCE:
Census, various years.

FIGURE II-1
IRRIGATED HARVESTED CROPLAND IN THE CENTRAL VALLEY AND CALIFORNIA
1920-1992

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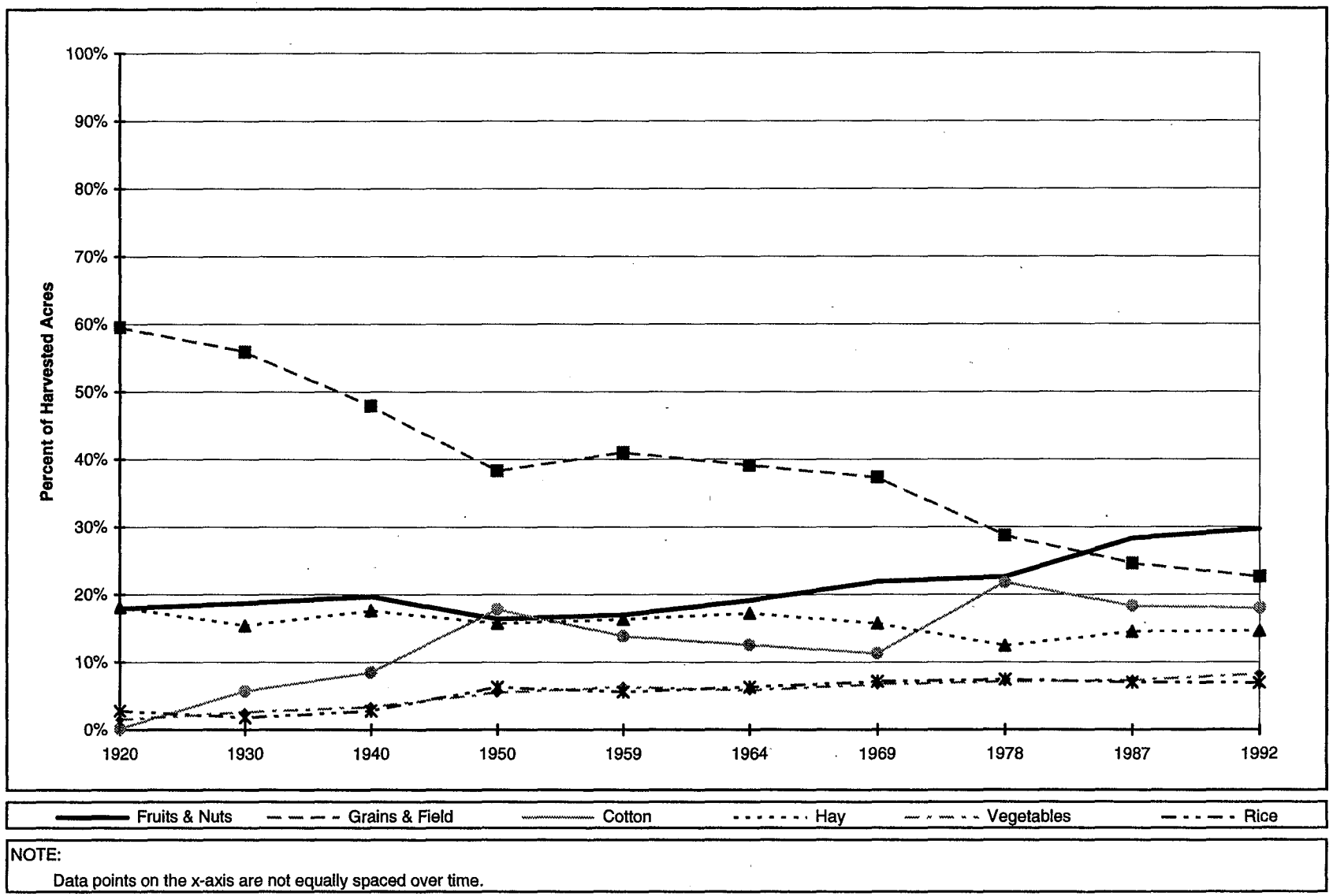

NOTE:
Data points on the x-axis are not equally spaced over time.

FIGURE II-2
CENTRAL VALLEY CROP ACRES AS PERCENTAGES OF TOTAL HARVESTED CROPS
1920-1992

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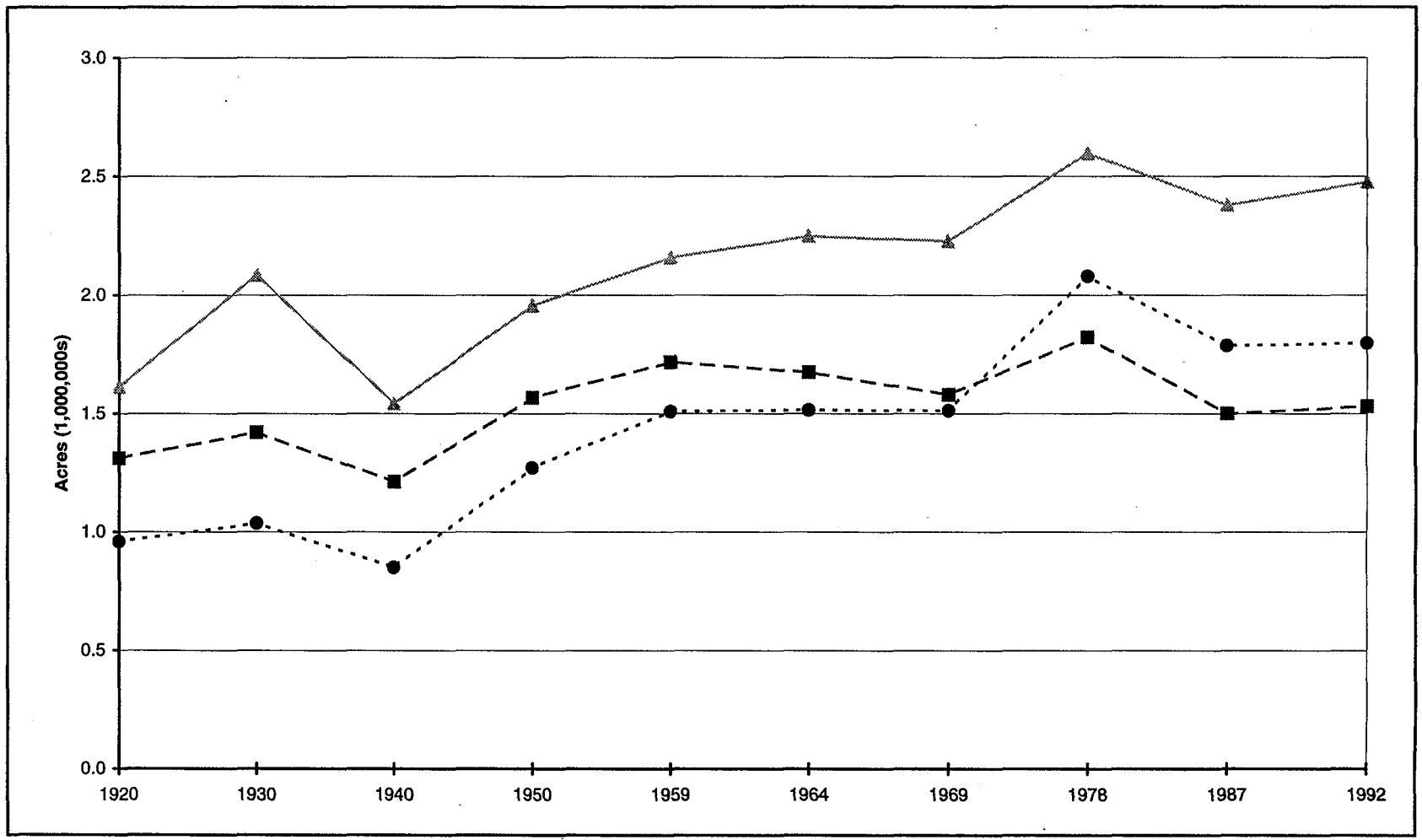
C—082732



Sacramento River Region | San Joaquin River Region | Tulare Lake Region

NOTE:
Data points on the x-axis are not equally spaced over time.

FIGURE II-3
HARVESTED CROPLAND IN THE CENTRAL VALLEY
1920-1992

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lower than state or county estimates, which are summarized later in this chapter. In general, changes in acreages from 1920 to 1992 followed the same pattern as changes in the Central Valley as a whole. The San Joaquin River Region now has the most irrigated harvested cropland and total harvested cropland acreage, followed by the Tulare Lake Region, which passed the Sacramento River Region in the 1970s.

Sacramento River Region. Harvested cropland in the Sacramento River Region increased from 1.3 million acres in 1920 to 1.5 million acres in 1992, to 1.7 million acres in 1959 and 1964 and a high of 1.8 million acres in 1978. The region has historically produced mostly field and grain crops, but harvested acreage fell from almost 900,000 acres in 1920 to around 500,000 acres, or 33 percent, recently. Rice, which was less than 10 percent of acreage until 1950, now accounts for 25 percent of harvested acres. This increase is largely due to subsidies provided by the federal rice program and export opportunities. Exports have decreased substantially in recent years. Fruit and nut acreage has increased gradually, from 16 percent of harvested acres in 1920 to 23 percent in 1992. Vegetables and hay crops have historically made up about 20 percent of harvested acreage; vegetables have grown from 2 percent in 1920 to 8 percent in 1992. Except for a few acres in 1930, there was no cotton grown in the Sacramento River Region during this period.

San Joaquin River Region. Harvested cropland in the San Joaquin River Region increased by 50 percent from 1920 to 1992 to about 2.5 million acres. Acreage peaked in 1978 at 2.6 million acres. Cropping patterns changed substantially from 1920 to 1992. Fruit and nut acreages increased from 20 percent to over 30 percent, grains and field crop acreages decreased from almost 60 percent to 20 percent, and cotton acreage increased from less than 1 percent to around 20 percent. Cotton acreage increases were primarily brought about by federal price support programs and export opportunities. Vegetables also increased from 2 percent of harvested acreage in 1920 to 11 percent in 1992. Hay acreage remained fairly constant at about 19 percent. Rice acreage in the San Joaquin River Region was not significant in 1992, and has never been above 2 percent of harvested acreage.

Tulare Lake Region. Harvested acreage in the Tulare Lake Region almost doubled from about 1.0 million acres in 1920 to 1.8 million acres in 1992. The most significant increase occurred between 1969 and 1978, when one-half million acres was brought into production. It was during this time that the SWP, which serves a large part of the region, was constructed. From 1920 to 1992, fruit and nut acreage more than doubled, grains and field crops decreased by more than half, and cotton acreage increased from about 2,000 acres to well over 600,000 acres. From 1973 to 1981, there were very few or no acreage reduction requirements for cotton; in 1978, cotton acres in the region reached 880,000. Hay acreage has historically fluctuated near 15 percent of total harvested acres. Vegetables were less than 1 percent of acres in 1920; in 1992 they represented 5 percent. Rice acreage was insignificant.

San Felipe Division. Data on harvested acres within the SFD are available for the San Benito County Water Conservation and Flood Control District and the Santa Clara Valley Water District for 1985 to 1990. As the numbers in Table II-6 show, the area has about 25,000 acres of harvested cropland and grows primarily vegetables and fruits and nuts. These crops make up 75 percent of all harvested acres. Harvested acreage in San Benito and Santa Clara Counties as a

whole was 79,000 in 1987 and 72,300 in 1992 (Census, 1989 and 1994). Irrigated acres for the same two counties were reported as 55,000 acres in 1987 and 47,000 acres in 1992.

TABLE II-6

HARVESTED ACRES IN SAN FELIPE DIVISION

Crops	1985	1986	1987	1988	1989	1990
Vegetables	8,920	9,140	9,050	11,910	12,255	12,445
Fruits and Nuts	8,470	8,150	8,245	7,460	3,841	7,498
Grains and Field Crops	4,600	4,550	4,600	3,550	2,980	3,400
Hay and Pasture	1,200	1,400	1,600	1,500	1,850	1,850
Total	**23,190**	**23,240**	**23,495**	**24,420**	**20,926**	**25,193**

SOURCES:
Reclamation, 1988, 1990.

FARM PROFILES

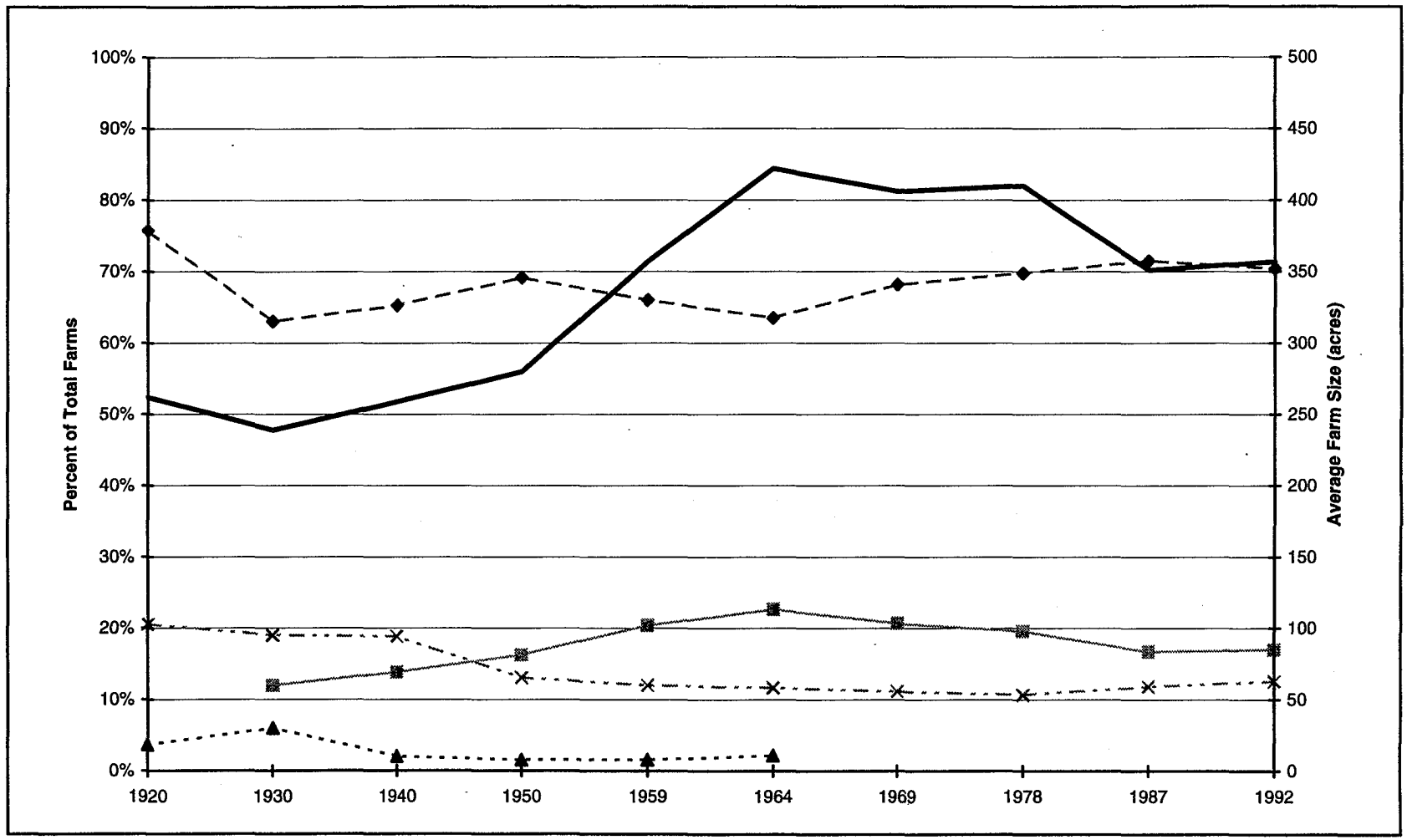
Table II-7 shows the number of farms, extent of farmlands, and the average farm size for the Central Valley for 1920 to 1992. During this period, the number of farms in the Central Valley decreased from about 50,000 to a little more than 40,000. The amount of land being farmed increased from about 13 million acres in 1920 to almost 15 million acres in 1992. The decrease in the number of farms and the increase in land being farmed resulted in an increase in average farm size of almost 100 acres. Average farm size is plotted in Figure II-4.

TABLE II-7

NUMBER OF FARMS, EXTENT OF FARMLANDS, AND FARM SIZES IN THE CENTRAL VALLEY 1920-1992

Year	Number of Farms	Land in Farms (1,000 acres)	Average Farm Size (acres)
1920	48,662	12,751	262
1930	57,787	13,832	239
1940	54,233	14,068	259
1950	52,991	14,844	280
1959	49,599	17,689	357
1964	42,514	17,933	422
1969	41,909	16,999	406
1978	39,551	16,231	410
1987	43,850	15,384	351
1992	41,203	14,727	357

SOURCES:
Census, 1922, 1932, 1942, 1952, 1961, 1966, 1971, 1980, 1989, 1994.



Full Owners | Part Owners | Managers | Tenants | Average Farm Size

NOTE:
Data points on the x-axis are not equally spaced over time.

FIGURE II-4
FARM OWNERSHIP AND AVERAGE FARM SIZE IN THE CENTRAL VALLEY
1920-1992

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The largest number of farms (58,000) were operated in 1930; then the number decreased until 1987. The 1987 increase was due in part to downsizing in response to the Reclamation Reform Act. Land in farms increased from 1920 to 1964 to a peak of 18 million acres and average farm size reached a high of 422 acres. Land in farms has decreased since 1964.

Table II-8 and Figure II-4 show farm ownership patterns. Most farms are operated by full or part owners. Therefore, most farm operators in the Central Valley live in the region.

TABLE II-8

FARM OWNERSHIP IN THE CENTRAL VALLEY 1920-1992

Year	Number of Farms	Full Owners		Part Owners		Managers		Tenants	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
1920	48,662	36,869	76	0	0	1,784	4	10,009	21
1930	57,787	36,435	63	6,907	12	3,467	6	10,978	19
1940	54,233	35,405	65	7,501	14	1,098	2	10,229	19
1950	52,991	36,646	69	8,616	16	821	2	6,908	13
1959	49,599	32,732	66	10,133	20	783	2	5,951	12
1964	42,214	26,807	64	9,560	23	916	2	4,931	12
1969	41,909	28,574	68	8,663	21	0	0	4,672	11
1978	39,551	27,605	70	7,730	20	0	0	4,216	11
1987	43,850	31,352	71	7,322	17	0	0	5,176	12
1992	41,203	29,011	70	7,016	17	0	0	5,176	13

SOURCES:
Census, 1922, 1932, 1942, 1952, 1961, 1966, 1971, 1980, 1989, 1994.

The San Joaquin River Region has historically had the largest number of farms, followed by the Sacramento River and the Tulare Lake regions. However, the San Joaquin River Region also has the smallest farm sizes.

About three-fourths of the cropland in the Sacramento River Region has historically been used for rice, hay, grains, and other field crops. In the Tulare Lake Region, about 65 to 80 percent of cropland has been used for cotton, hay, and grains and field crops. These crops require larger operations to be economically viable. Therefore, farms in these regions are larger. Most farms in all regions are operated by full or part owners rather than tenants.

AGRICULTURAL PRODUCTION COSTS AND REVENUES

Agricultural production costs and revenues have changed over time for a wide variety of reasons and have caused crop mix to change. One of those reasons has been the shift over time from a labor-intensive to a capital-and-energy-intensive industry. This change was created primarily by technological innovation in labor-saving machinery, meaning that a larger share of costs goes for machinery and services provided by contractors and other specialists. Modern agriculture also pays a larger share of its costs for energy and chemical inputs than in the past.

Agricultural costs are affected by inflation in several ways. Energy cost inflation in the late 1970s was a substantial problem for agriculture. Higher interest rates often follow inflation. As a capital-intensive industry, agriculture can be more affected by changes in interest rates than the economy as a whole. Inflation in land values is a benefit to the existing farmer because land is an important source of collateral needed to borrow money.

Agricultural prices have changed with productivity, demand, markets, comparative advantage, and federal agricultural policies. California and the rest of the world enjoyed substantial increases in agricultural productivity over this period measured as production per unit of land or per unit of cost. Increased productivity has caused prices of most crops to decline in real terms (after adjustment for inflation). California has exploited its comparative advantage in the production of many crops, especially fruits, nuts, and vegetables, by increasing the share of acreage planted to these crops over time. The other important increases in acreage have involved rice and cotton. Farm programs have often provided price and risk incentives to increase production of these crops. Federal trade policies and international trade agreements have also affected California's competitive position vis-a-vis other nations.

Table II-9 and Figure II-5 show the growth in crop revenues in the Central Valley and the U.S. from 1920 to 1992. Revenues were fairly constant until 1950 when they began increasing as more irrigated cropland was brought into production. Beginning in 1969, revenues increased dramatically as more acreage was planted to fruits and nuts, vegetables, and cotton.

TABLE II-9

CROP REVENUES IN THE CENTRAL VALLEY
1920-1992

Year	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Central Valley	U.S.	Central Valley % of U.S.
1920	116	134	53	303	7,144	4
1930	111	169	116	396	7,033	6
1940	102	177	111	390	7,884	5
1950	133	240	202	575	11,996	5
1959	244	454	373	1,071	13,516	8
1964	315	571	449	1,335	16,738	8
1969	334	566	396	1,296	17,445	7
1978	791	1,427	1,125	3,343	45,908	7
1987	989	2,358	1,835	5,182	55,595	9
1992	1,048	2,508	1,930	5,486	61,662	9

NOTE:
All revenues are in million dollars, indexed to a 1992 level using USDA's index of prices received by farmers (1967=100).
SOURCES:
Census, 1922, 1932, 1942, 1952, 1961, 1966, 1971, 1980, 1989, 1994.

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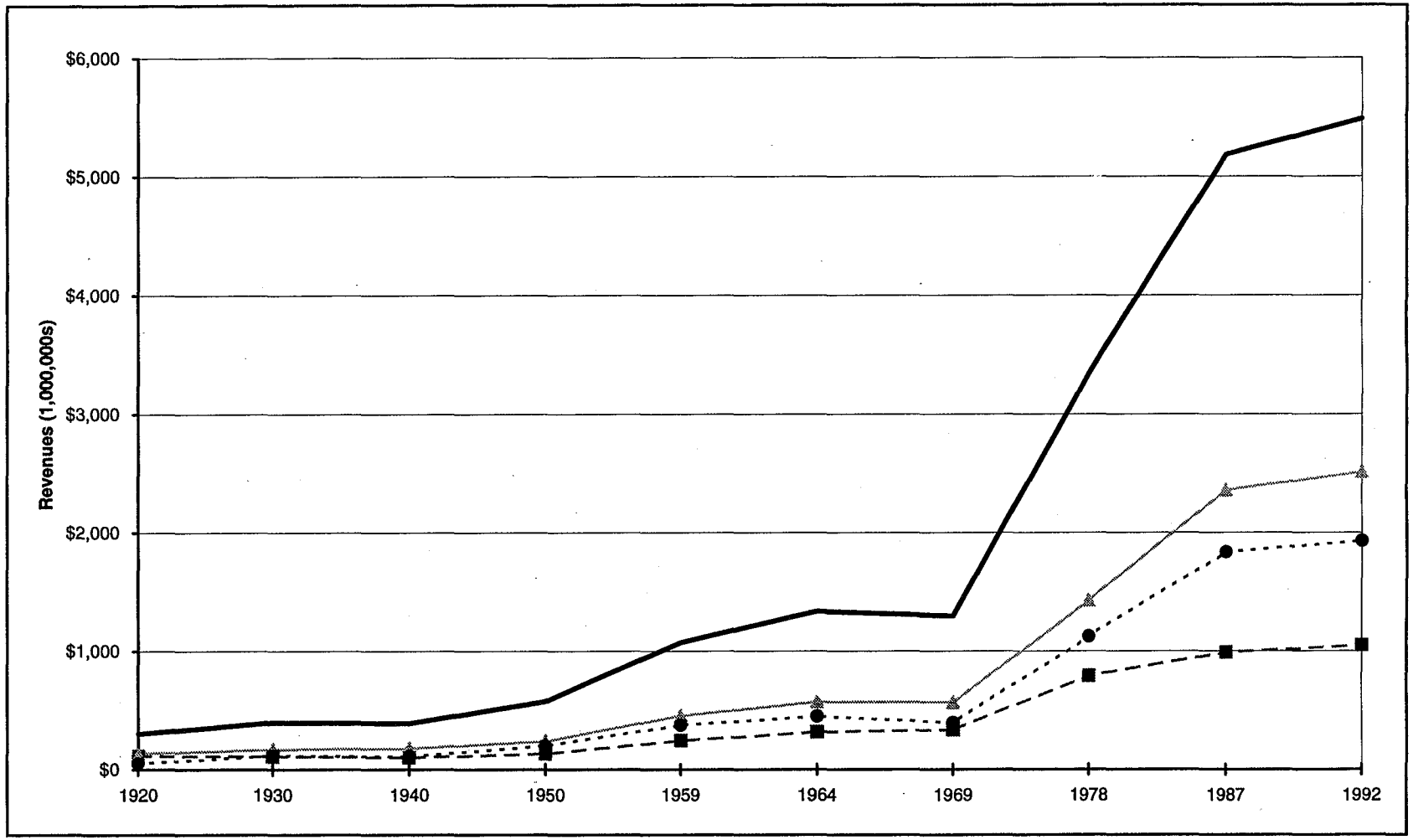

Sacramento River Region | San Joaquin River Region | Tulare Lake Region | Central Valley

NOTE:
Data points on the x-axis are not equally spaced over time.

FIGURE II-5
CROP REVENUES IN THE CENTRAL VALLEY
1920-1992

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CENTRAL VALLEY AGRICULTURE IN NATIONAL AND INTERNATIONAL MARKETS

The Central Valley's share of U.S. crop revenues has more than doubled from 4 percent in 1920 to 9 percent in 1992 (Table II-9). The valley is an important producer of fruit, nut, and vegetable crops in the U.S. and the world. At least 90 percent of U.S. production of grapes, almonds, walnuts, plums and prunes, and pistachios comes from the Central Valley.

Cotton, rice, grapes, and almonds are important Central Valley exports. In 1974, rice grown on more than 250,000 acres was exported. In 1980, rice exports required more than 300,000 acres or about 70 percent of total rice acres (DWR, 1983). Exports of rice totaled $318 million in 1980 dollars. The increase in oil prices in the 1970s created higher synthetic fiber prices; therefore, the worldwide demand for natural fibers, including cotton, increased. Also, the opening of new trade markets in China provided a new market for Central Valley cotton. In 1974, 693,000 acres in California was used to grow cotton for export markets. By 1980 more than 1.4 million acres of land was required to produce cotton for export. Lint cotton exports totaled $1.1 billion (1980 dollars) in 1980.

California exports its fruit, nut, and vegetable products worldwide. By 1980, exports of almonds alone totaled $430 million in 1980 dollars.

RECENT CONDITIONS

INTRODUCTION

The Central Valley is an important agricultural region for both California and the U.S. It contains almost 80 percent of the irrigated land in California. In 1993, the 19 Central Valley counties contributed more than 60 percent, by value, of California's agricultural production and included 6 of the top 10 agricultural counties in California (see Table II-10). Agriculture in the Central Valley is an important employer and affects the regional economy through the expenses of farmers as well as production of many crops that require processing or transportation after harvest.

The Central Valley accounts for almost all of the U.S. production of many fruit and nut crops such as almonds, pistachios, walnuts, nectarines, and plums and prunes. In addition, it produces almost 10 percent of the total U.S. market value of crop production, 40 percent of the nation's fruits and nuts, 20 percent of our cotton, and 15 percent of U.S. vegetables (Census, 1994). The Central Valley grows virtually all of California's cotton and almonds, and almost three-fourths of its grapes and oranges.

Values of crop production per acre can range from $200 to $15,000 or more. In comparison to the nation as a whole, a large share of Central Valley irrigated lands is used to produce high-value crops. "High-value crop" is a relative but useful term. High-value crops tend to be used for direct human consumption. They generate more revenue per acre, but they also require more

labor and other inputs. Changes in acreages of high-value crops generally have a larger economic impact per acre on agriculture and related industries than do changes in low-value crops.

The Central Valley is represented in tables and figures by either the three hydrologic basins (Sacramento, San Joaquin, and Tulare) or by the 19 counties that constitute the valley floor: Butte, Colusa, Fresno, Glenn, Kern, Kings, Madera, Merced, Placer, Sacramento, San Joaquin, Shasta, Solano, Stanislaus, Sutter, Tehama, Tulare, Yolo, and Yuba.

TABLE II-10

RANKING OF CENTRAL VALLEY COUNTIES BY TOTAL VALUE OF PRODUCTION IN 1993

1993 CA Rank	County	1993 Production ($1,000)	Percent of Total CA Value	Cumulative Percent	Leading Crops
1	Fresno	3,014,412	13.1	13.1	Grapes, cotton, tomatoes, milk, cattle & calves
2	Tulare	2,359,551	10.2	23.3	Milk, grapes, oranges, cattle & calves, cotton & seed
3	Kern	1,884,749	8.2	31.5	Grapes, cotton & seed, almonds, citrus, carrots
5	Merced	1,201,025	5.2	36.7	Milk, almonds, chickens, cotton, alfalfa
6	Stanislaus	1,147,126	5.0	41.7	Milk, almonds, chickens, walnuts, cattle & calves
7	San Joaquin	1,053,364	4.6	46.3	Milk, grapes, almonds, tomatoes, walnuts
12	Kings	836,860	3.6	49.9	Cotton lint, milk, cattle & calves, cottonseed, turkeys
13	Madera	615,047	2.7	52.6	Grapes, almonds, cotton lint, milk, pistachios
18	Sutter	292,108	1.3	53.9	Rice & seed, walnuts, peaches, prunes, tomatoes & seed
19	Butte	278,030	1.2	55.1	Almonds rice, walnuts, prunes, kiwifruit
20	Colusa	273,518	1.2	56.3	Rice, almonds, processing tomatoes, wheat, rice seed
21	Glenn	249,134	1.1	57.4	Rice, almonds, dairy products, prunes, cattle & calves
23	Yolo	235,805	1.0	58.4	Tomatoes, alfalfa hay, rice, safflower, wheat
24	Sacramento	228,651	1.0	59.4	Milk, pears, cattle & calves, wine grapes, ornamental nursery stock
28	Solano	177,705	0.8	60.2	Processing tomatoes, sugar beets, cattle & calves, nursery stock, alfalfa hay
32	Yuba	117,452	0.5	60.7	Rice, peaches, prunes, walnuts, cattle & calves
34	Tehama	100,365	0.4	61.1	Walnuts, prunes, almonds, cattle & calves, pasture & range
Total Central Valley		**$14,064,902**			
Total California		**$23,094,133**			

SOURCE:
DFA, 1994.

Many studies differentiate the Sacramento-San Joaquin Delta (Delta) Region from other Central Valley regions because of its unique soil and water supply problems. This is an inland delta encompassing parts of western San Joaquin County; southern Sacramento, Yolo, and Solano counties; and eastern Contra Costa County. The Delta Region is not treated as a separate region in this study.

The 2020 PEIS Alternatives include 88,000 acre-feet of CVP agricultural contracts in the San Felipe Division of the CVP, which is outside the Central Valley. This area is referred to as the SFD in this technical appendix. Recent agricultural production in the SFD has averaged about 25,000 irrigated acres of mostly vegetables and fruits. Because the SFD's agricultural production is relatively small, the Central Valley is the focus of this section.

THE CENTRAL VALLEY PROJECT IN PERSPECTIVE

Central Valley agriculture receives irrigation water from the CVP, the SWP, local water rights and water projects, and groundwater. Most of this water is delivered to farmers through irrigation districts and other water agencies. Figure II-6 shows irrigation water deliveries by source for the years 1985-1992, as compiled for the CVPM. Deliveries average about 22.5 million acre-feet per year, with the SWP providing about 10 percent, local surface water rights about 30 percent, and groundwater about 35 percent. During the drought of 1985-1992, groundwater use increased to almost 50 percent of irrigation water delivered to make up for decreases in deliveries from other sources.

The CVP normally supplies about 25 percent of Central Valley water to approximately 200 water districts, individuals, and companies through water service contracts, water rights settlement, and exchange contracts. The term "project water" refers here to water developed by the project and delivered pursuant to repayment and water service contracts. The CVP supplies project water through about 4.5 million acre-feet of contracts, of which about .5 million acre-feet is M&I water. CVP water deliveries for irrigation have recently ranged from 2 to just under 4 million acre-feet, 10 to 15 percent of the valley's total water supply.

Exchange and settlement contracts account for the remaining 10 percent of the CVP's 25 percent share of Central Valley irrigation deliveries. These contracts represent water rights that predate the CVP. Deliveries under settlement and exchange water contracts can be reduced in a critical year only, and these contractors must be notified of any shortages by February 15 of each year. (Reclamation defines a critical year as one in which the forecast inflow into Shasta Lake is less than or equal to 3.2 million acre-feet, or a critical year can also be declared based on shortage in the current and previous year.) The CVP also makes releases from storage for instream flows, Delta water quality, and other obligations that affect agriculture, and CVP power production and flood protection is a benefit to agriculture in the valley.

Table II-11 shows 1989 project water supply and irrigated acreage by type of service and CVP division.

The CVP has recently provided full, supplemental, or temporary project water supplies to more than 2 million acres in the Central Valley, or about 30 percent of the 7.2 million acres irrigated valley-wide (Reclamation, 1988; DWR, 1993). In 1988, the project supplied 3.7 million acre-feet or 1.73 acre-feet per acre of developed water to those lands receiving any CVP project water. In 1989, about 4.1 million acre-feet was supplied or about 1.85 acre-feet per irrigated acre. This water supply is slightly more than that shown in Figure II-6 because it includes San Felipe and some other deliveries to users outside the Central Valley.

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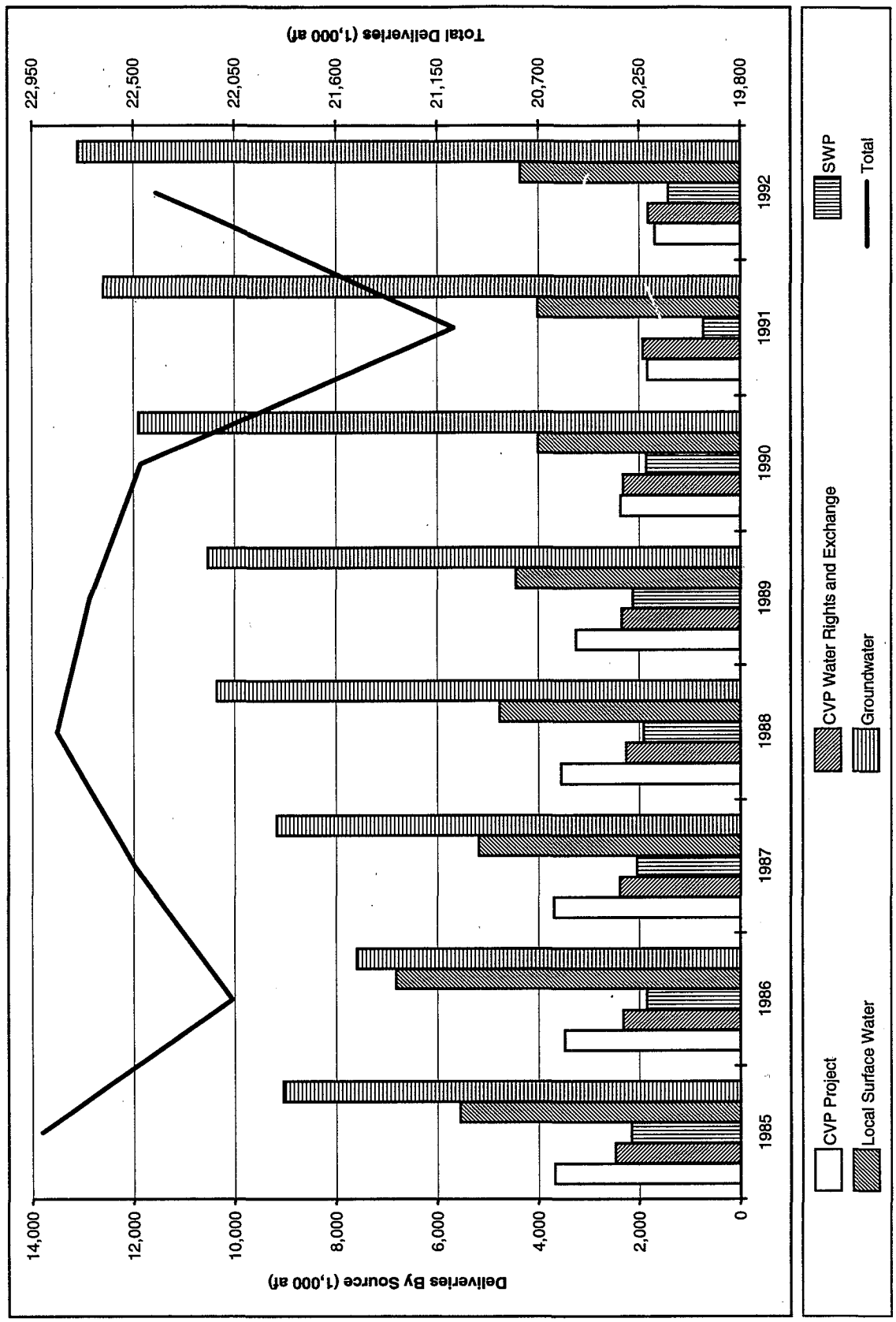

FIGURE II-6
CENTRAL VALLEY IRRIGATION WATER DELIVERIES BY SOURCE
1985-1992

TABLE II-11

1989 CVP ACREAGE AND IRRIGATION WATER SUPPLY

CVP Division and Type of Service	Irrigable Acres for Service	Irrigated Acres	Percent Irrigated	Net Supply Delivered to Farm (acre-feet)	Delivery Per Acre Irrigated (acre-feet)
Full Service					
Delta Division	45,648	41,299	90	131,907	3.19
Sacramento River Division	32,253	23,834	74	72,052	3.02
Trinity Division	4,729	3,009	64	5,772	1.92
Total Full Service	82,630	68,142	82	209,731	3.08
Supplemental Service					
American River Division	51,826	7,580	15	19,642	2.59
Delta Division	167,518	138,533	83	280,657	2.02
Friant Division	999,808	813,885	81	856,481	1.05
Sacramento River Division	98,411	74,679	76	208,801	2.80
San Felipe Division	37,430	23,730	63	19,827	0.84
Shasta and Trinity Divisions	471,730	358,524	76	612,631	1.71
West San Joaquin Division	618,972	550,227	89	1,261,062	2.29
Total Supplemental Service	2,445,695	1,967,158	80	3,833,093	1.95
Temporary Service					
Delta Division	140,174	130,793	93	577,668	4.42
Friant Division	33,227	29,542	89	13,690	0.46
Sacramento River Division	4,262	1,506	35	2,862	1.90
Shasta Division	10,711	10,283	96	18,309	1.78
Total Temporary Service	188,374	172,124	91	38,537	3.56
Total/Average	**2,716,699**	**2,207,751**	**81**	**4,081,361**	**1.85**

SOURCE:
Reclamation, 1989 Summary Statistics. Does not include water rights settlement and some exchange contract water. Does not include water from U.S. Army Corps of Engineers (COE) projects.

Most of the irrigated land served by the CVP receives supplemental supplies. In 1989 only 3 and 8 percent of project lands received full service and temporary supplies, respectively. At least 89 percent of land served also received water supplies from some source other than the CVP. A large share of the value of production attributable to CVP supplies occurs on supplemental lands.

Table II-11 shows that 19 percent of land served by the project in 1989 was not irrigated. This may have been because of normal land fallowing or because the land received no CVP water in that year. Full service lands received the largest amount of CVP water per acre (3.08 acre-feet in 1989), but supplemental service lands received a partial supply (1.95 acre-feet per acre).

Crop mix and value for 1988 and 1989, recent years with near-normal CVP delivery, are provided in Table II-12. In 1988, project-served lands produced about $3.3 billion worth of agricultural commodities valued at the farm. Relatively low-value crops such as cereals, forage, miscellaneous field crops, and seed accounted for 61 percent of acres served but only 28 percent of the value of production. Fruits, nuts, and vegetables, relatively high-value crops, accounted for 38 percent of acres served and 68 percent of the value of production. These figures changed little in 1989 when crops valued at $3.5 billion were produced. Acreages of vegetables, fruits, and nuts were up in 1989, reflecting a long-term trend.

Table II-13 shows how CVP water was allocated among the various contract categories during the recent drought. Settlement and exchange contracts were cut 25 percent during the latter part of the drought, which started in 1987. The accumulated effects of the drought became more severe in 1991 to 1992 with agricultural cuts reaching 75 percent in 1992. The winter of 1992-1993 was normal to above normal, so most water supplies were restored. Water year 1993-1994 was again below normal.

TABLE II-12

CROP MIX AND TOTAL VALUES OF CROPS PRODUCED ON LAND RECEIVING CVP WATER

Crops	1988 Acres	1989 Acres	1988 Value, $ Million	1989 Value, $ Million
Cereals	383,053	440,551	159	188
Forage	225,583	272,430	115	155
Misc. Field Crop	689,743	636,335	659	680
Vegetables	283,504	335,255	658	829
Seeds	46,984	35,735	34	31
Fruits	407,257	414,304	1,352	1,273
Nuts	148,417	157,569	253	254
Gardens & Nuts	7,448	7,340	111	130
Total	**2,191,989**	**2,299,519**	**3,341**	**3,540**

NOTES:
Total acreage includes multiple-cropped acres - 70,000 in 1988 and 115,000 in 1989.
Crop values shown are not consistent with CAC values reported elsewhere but are provided to indicate the general economic magnitude of CVP production.
SOURCES:
Reclamation, 1988, 1989, Summary Statistics.

TABLE II-13

CVP PROJECTED PERCENT SUPPLY REDUCTIONS RECENT YEARS

Category of Water Use	April 1990	May 1991	May 1992	May 1993	May 1994
Water Rights	25	25	25	0	0
Agricultural Contracts	50	50-75	75	0-50	65
M&I Contracts (% historical use)	25	25	25	0-25	25

NOTE:
These are forecasts as of the date given. Final deliveries may have changed. Does not include hardship deliveries or transfers. When a range is given, the lower value is N of delta, the higher value is S of delta.
SOURCES:
DWR, various years.

Through contracts with 29 water agencies, the SWP provides water within the Central Valley to Butte, Solano, Kings, and Kern counties and outside the Central Valley to several Southern California counties, to Alameda and Santa Clara counties in the South Bay Area, and to Napa and Solano counties in the North Bay Area. Average SWP water supplies to the Central Valley from 1985 until 1992 were about 1.7 million acre-feet per year. In addition, the SWP provides water rights deliveries to water rights holders along the Feather River. The SWP plans to

increase water deliveries by developing more storage and more efficient conveyance. Additional proposed sources have included Delta facilities, water purchases, conjunctive use of surface storage and groundwater in the Central Valley, and Los Banos Grandes, a reservoir that would be located in the San Joaquin Valley.

Local surface water supplies (those not delivered by either project) averaged about 6.3 million acre-feet per year between 1985 and 1992, about 30 percent of all water supplies in the Central Valley. More local surface water supplies are available on the east side of the valley because of the larger amount of precipitation in the Sierra. Locally owned water projects are especially important on the Yuba, Stanislaus, Tuolumne, Kings, and Merced rivers, but local sources on the west side, such as the federal Solano project, are also important.

Groundwater provides a significant supply in normal years and is often used to reduce or eliminate shortages of surface water supplies during drought. Declining groundwater tables, subsidence, and loss of aquifer storage continue to be costly problems, particularly in the western and southern parts of the San Joaquin River Region where less surface water is available. Declining groundwater tables increase pumping costs. The costs of subsidence include damage to structures, failure of well casings, and frequent surveying. Water from the CVP and SWP had replaced some of the groundwater pumping, and withdrawals were about equal to estimated recharge (Bertoldi et al., 1991). However, the recent drought reduced surface water supplies and renewed the past trend of groundwater depletion throughout the valley.

WATER PRICING

More than 50 districts within the Central Valley were surveyed to estimate current irrigation water prices charged by water districts. The districts were asked to describe their source(s) and amounts of water, their wholesale costs, and their markups. Weighted-average water prices were then calculated for each of the 22 regions used by the CVPM.

Table II-14 gives weighted-average water prices that approximate charges within the three basins of the Central Valley. Water costs vary substantially throughout the valley depending on the region and the source of water. Average retail water costs for the Central Valley range from $12 per acre-foot in the Sacramento River Region to $45 in the Tulare Lake Region. Average surface water prices are lowest in the Sacramento River Region at $11.35 per acre-foot and highest in the Tulare Lake Region at $42.50, reflecting higher SWP costs. Estimated groundwater pumping costs range from about $20 in parts of the San Joaquin River Region to more than $75 in parts of the Tulare Lake Region. Groundwater costs were calculated using average lifts and drawdowns based on CVGSM information.

The marketing and price of CVP water is now governed by several laws including the Reclamation Project Act of August 4, 1939 (53 Stat. 1187), the Reclamation Reform Act of 1982 (96 Stat. 1263), the Act of October 17, 1986 (PL 99 - 546), and the CVPIA.

The Reclamation Reform Act discouraged the irrigation of large landholdings with Reclamation water by establishing the concept of full-cost pricing for water delivered to irrigate land in excess of acreage limitations. The Act of 1986 codified several rate-setting policies such as automatic

adjustment of water rates in new or amended contracts, ability-to-pay calculations every five years, and mandatory repayment of annual operation and maintenance (O&M) costs and O&M cost deficits incurred after 1985. Ability to pay allows contractors to be excused from capital repayment if they are unable to pay for it. Under section 3407(d) of the CVPIA, contractors can be excused from restoration charges based on ability to pay. Ability to pay is estimated by Reclamation, upon request, using a payment capacity analysis based on farm budgets.

TABLE II-14

ESTIMATES OF 1992 PRICES CHARGED BY WATER DISTRICTS IN THE CENTRAL VALLEY

Location	Total Surface Water (1,000 acre-feet)	Estimated Surface Water Price ($/acre-foot)
Sacramento River Region	5,234	11.35
San Joaquin River Region	5,045	14.73
Tulare Lake Region	2,822	42.50
Total Central Valley	**13,101**	**19.36**

NOTE:
Surface water quantities are average 1985-1992 water supplies.

SOURCES:
Reclamation, 1993, 1994; DWR, 1994; telephone survey (1994) of Central Valley water districts.

Costs of the CVP allocated to flood control, navigation, and public health and safety, and part of the costs allocated to fish and wildlife and recreation are not reimbursable; they need not be repaid by water or power sales. The CVP first developed a cost allocation process in 1947 to assign costs to purposes based on project benefits and use of project components.

CROPPING PATTERNS AND IRRIGATED ACRES

A cropping pattern is the share of acres within a region planted to individual crops or categories of crops, including fallowed land. Agricultural land use can be partially described by its cropping pattern, and cropping patterns are important to agricultural and regional economics. If the CVPIA reduces the amount of irrigation water available, farmers can change their cropping patterns by fallowing a portion of the lands that receive CVP water, by planting crops that require less irrigation water, or by adopting water conservation measures. All three options would affect farm profits. The extent of the impact would depend on the change in the amount of water used, the cost of producing the new crops, the prices received for the new crops, and the costs of implementing water conservation measures, such as more efficient irrigation systems.

Cropping pattern data in this section are drawn from several different sources. Although the sources do not totally agree, the cropping patterns are generally consistent, and observations and conclusions drawn are valid.

Table II-15 shows 1990 normalized irrigated acres for the Central Valley in DWR's three hydrologic basins. Normalized acres represent DWR's estimate of what acreage would have been if 1990 had been a normal, or average, water year. Figure II-7 graphs the Central Valley and California data.

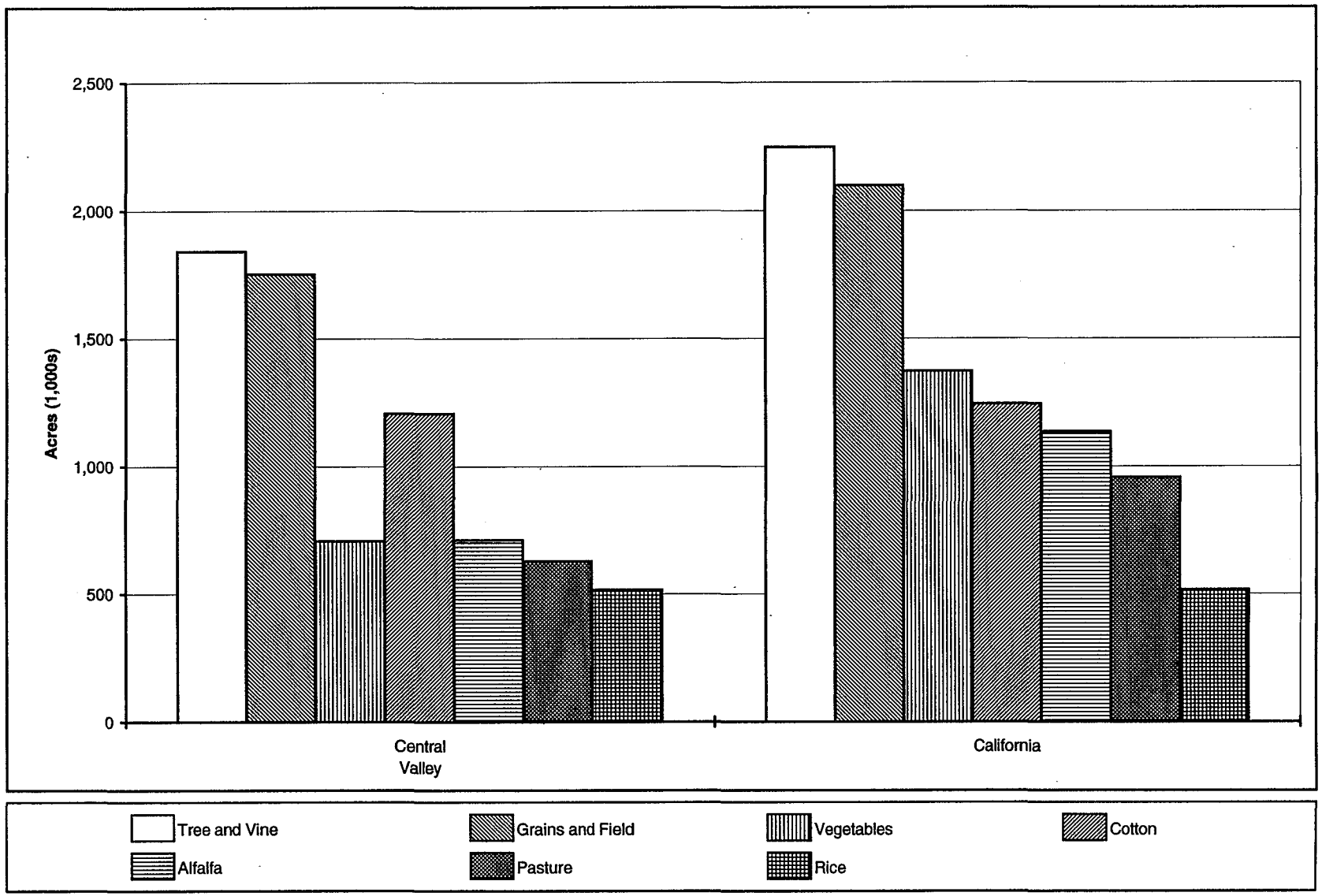

FIGURE II-7

1990 NORMALIZED IRRIGATED ACRES FOR THE CENTRAL VALLEY AND CALIFORNIA

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TABLE II-15

1990 NORMALIZED IRRIGATED ACRES BY DWR HYDROLOGIC REGION

Crop	Sacramento Hydrologic Region	San Joaquin Hydrologic Region	Tulare Hydrologic Region	Total Central Valley	Other Hydrologic Regions	Total State
Grain	303	182	297	782	206	988
Rice	494	21	1	516	1	517
Cotton	0	178	1,029	1,207	37	1,244
Sugar Beets	75	64	35	174	42	216
Corn	104	181	100	385	18	403
Other Field	155	121	135	411	80	491
Alfalfa	141	226	345	712	423	1,135
Pasture	357	228	44	629	327	956
Tomatoes	120	89	107	316	36	352
Other Truck	55	133	204	392	629	1,021
Almonds/Pistachios	101	245	164	510	0	510
Other Deciduous	205	147	177	529	41	570
Citrus/Olive	18	9	181	208	211	419
Grapes	17	184	393	594	154	748
Total Acres Irrigated	2,145	2,008	3,212	7,365	2,205	9,570
Acres Double Cropped	44	53	65	162	240	402
Total Acres	**2,101**	**1,955**	**3,147**	**7,203**	**1,965**	**9,168**
Percent of Total	**23**	**21**	**34**	**78**	**5**	**22**

NOTE:
All values in 1,000 acres.
SOURCE:
DWR, 1994.

Virtually all of California's rice and cotton acreage, almost half of its vegetable acreage, and 80 percent of its orchard land are in the Central Valley. The Central Valley also contains almost 60 percent of California's irrigated hay acreage. The Central Valley used more of its irrigated and harvested land for orchards, cotton, and vegetables than does the rest of the U.S. The U.S. uses more than three-fourths of its irrigated and harvested land for grains, field crops, and hay. This illustrates the comparative advantage of the Central Valley as a cotton, orchard, and vegetable-producing region.

Table II-16 shows 1984-1993 harvested acreage from the CAC data. Several adjustments are required to make these data comparable to the DWR data in Table II-15. First, the CAC data have excluded the Shasta Lake, Pit River, and Southeast Planning Subareas, which encompassed about 250,000 irrigated areas in 1990 (DWR, 1994). Second, the numbers in Table II-17 suggest that the CAC data include on average 350,000 acres of dryland crops. In 1987 there were only about 310,000 acres, but large farm program acreage reduction percentages (ARPs) in 1987 fallowed substantial shares of dryland acreage. Also, there was a large amount of dryland farming in 1992 because of the drought. Third, the CAC data probably do not include about 200,000 acres of irrigated nonbearing fruit trees, nuts, and grapes over the 1985 through 1992 period.

Table II-16 shows an average of 7 million harvested acres over the 1984 to 1993 period. Adjusting downward for 350,000 acres of dryland, upward for 200,000 acres of non-harvested irrigated acreage, and upward again for the 250,000 irrigated acres not included in the CAC data gives about 7.1 million irrigated acres, 100,000 acres less than DWR's normalized acreage estimate of 7.2 million acres.

TABLE II-16

HARVESTED ACRES IN THE CENTRAL VALLEY 1984 - 1993

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Sacramento River Region										
Cotton	0	0	0	0	0	0	0	0	0	0
All Hay & Pasture	430	431	419	423	419	405	403	413	387	392
Rice	473	409	370	375	429	424	398	350	401	450
Grains	372	403	338	281	263	347	315	269	309	278
Other Field Crops	424	409	373	370	342	350	357	311	344	434
Grapes	6	7	7	7	7	7	9	10	11	11
Almonds	85	90	92	93	93	91	92	88	89	89
Walnuts	61	62	65	66	66	67	69	70	71	76
Citrus	13	12	13	13	13	13	13	13	14	14
Other Fruits & Nuts	90	95	95	99	98	101	104	104	106	112
Tomatoes	104	94	90	89	97	111	126	140	109	130
Melons	7	8	9	6	7	7	9	9	8	10
Other Vegetables	33	34	32	30	27	28	31	32	33	12
Total	**2,097**	**2,054**	**1,902**	**1,853**	**1,861**	**1,951**	**1,927**	**1,810**	**1,883**	**2,008**
San Joaquin River Region										
Cotton	529	534	424	484	548	439	484	472	477	502
All Hay & Pasture	652	625	634	659	671	682	709	703	693	673
Rice	30	26	24	22	23	22	19	15	16	19
Grains	306	298	268	233	218	238	223	160	175	183
Other Field Crops	471	445	445	489	458	463	442	382	402	427
Grapes	375	377	374	372	368	366	365	363	360	370
Almonds	213	235	242	249	251	256	263	253	256	272
Walnuts	61	61	61	61	62	63	65	66	66	66
Citrus	43	44	45	44	43	46	46	46	46	45
Other Fruits & Nuts	91	91	93	98	100	97	101	103	104	111
Tomatoes	123	116	115	121	126	139	179	179	145	165
Melons	46	53	54	62	59	57	61	57	55	74
Other Vegetables	90	105	112	140	138	141	154	151	153	173
Total	**3,030**	**3,010**	**2,892**	**3,034**	**3,064**	**3,009**	**3,112**	**2,950**	**2,948**	**3,081**
Tulare Lake Region										
Cotton	792	698	578	688	777	655	701	604	671	684
All Hay & Pasture	358	361	389	372	352	380	376	378	315	282
Rice	1	1	1	1	1	1	1	0	0	0
Grains	235	268	252	247	207	230	248	163	188	197
Other Field Crops	144	131	157	131	187	227	213	236	227	283
Grapes	163	160	163	151	149	144	143	147	151	151
Almonds	101	109	111	107	108	107	112	110	112	115
Walnuts	31	31	31	32	30	29	30	33	33	32
Citrus	136	135	135	135	135	133	143	138	146	162
Other Fruits & Nuts	48	51	52	54	56	55	62	70	77	82
Tomatoes	8	9	6	6	6	8	10	13	9	17
Melons	7	8	8	10	8	11	12	10	10	8
Other Vegetables	86	79	70	80	83	100	98	108	107	108
Total	**2,110**	**2,040**	**1,952**	**2,015**	**2,097**	**2,078**	**2,147**	**2,010**	**2,045**	**2,122**
Central Valley										
Cotton	1,320	1,232	1,002	1,172	1,326	1,094	1,185	1,076	1,148	1,186
All Hay & Pasture	1,440	1,418	1,442	1,454	1,441	1,468	1,488	1,494	1,395	1,347
Rice	504	436	394	398	452	446	418	366	417	470
Grains	913	970	859	761	689	815	786	592	672	658
Other Field Crops	1,039	986	975	990	987	1,040	1,012	929	973	1,144
Grapes	544	544	544	531	523	517	517	520	523	532
Almonds	399	433	445	449	451	454	467	452	456	477
Walnuts	152	153	157	159	157	160	164	169	170	175
Citrus	191	190	193	192	190	192	202	197	206	221
Other Fruits & Nuts	228	237	240	251	254	252	267	276	287	306
Tomatoes	235	219	211	217	228	259	315	332	262	313
Melons	60	68	71	78	75	75	82	76	73	91
Other Vegetables	209	218	214	250	249	269	283	291	293	294
Total	**7,236**	**7,105**	**6,747**	**6,902**	**7,022**	**7,039**	**7,185**	**6,770**	**6,876**	**7,211**

NOTE:
All values are in 1,000 acres.
SOURCE:
CAC reports, various years.

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TABLE II-17

DRYLAND ACREAGE IN CENTRAL VALLEY COUNTIES 1987 AND 1992

Crop	1987 Entire Valley	1987 Sacramento River Region	1992 Entire Valley	1992 Sacramento River Region
Wheat	100,980	63,385	131,285	78,999
Dry Beans	1,644	1,644	4,793	3,023
All Hay	76,170	37,318	85,131	43,292
Barley (1)	40,406	22,424	47,623	26,251
Safflower (1)	29,796	25,113	58,714	45,961
Other	59,779	20,947	56,006	7,673
Total	**308,775**	**170,831**	**383,552**	**205,199**

NOTES:
(1) Data for barley and safflower are only for farms that also had some irrigated acreage.
Shasta, Placer, Yuba, and Contra Costa not included.
SOURCES:
Census, 1989, 1994.

Some of the small difference between the DWR normalized data and the adjusted CAC average can be attributed to farm programs. In the period of 1987 through 1989, farm programs idled large amounts of rice, cotton, and grains throughout the valley through ARPs. The Agricultural Stabilization and Conservation Service reported that about 900,000 dryland and irrigated acres were idled in California by ARP provisions in 1987, of which 437,000 acres were rice and cotton (U.S. Department of Agriculture [USDA], 1987). ARPs, as a percent of participating acreage, are shown in Table II-18. Farm programs are explained in more detail later in this technical appendix.

TABLE II-18

FARM PROGRAM ACREAGE REDUCTION PERCENTAGE 1985-1992

Year	Corn	Sorghum	Barley	Oats	Wheat	Rice	Upland Cotton
1985	10.0	10.0	10.0	10.0	20.0	20.0	20.0
1986	17.5	17.5	17.5	17.5	22.5	35.0	25.0
1987	20.0	20.0	20.0	20.0	27.5	35.0	25.0
1988	20.0	20.0	20.0	5.0	27.5	25.0	12.5
1989	10.0	10.0	10.0	5.0	10.0	25.0	25.0
1990	10.0	10.0	10.0	5.0	10.0	22.5	12.5
1991	7.5	7.5	7.5	0.0	15.0	5.0	5.0
1992	5.0	5.0	5.0	0.0	5.0	0.0	10.0

NOTE:
Percent of participating base that must be idled.

The CAC data show that cotton acreage valleywide fell to 1,002,000 and 1,172,000 acres in 1986 and 1987 (Table II-16), below DWR's estimate of 1.2 million acres. Rice acreage fell to less than 400,000 acres in these years as compared to DWR's estimate of 516,000 acres.

In 1991 acreage declined because of the drought. Based on econometric methods and with the low ARPs in effect in 1991 and 1992, an estimated 500,000 and 350,000 more acres, respectively, would have been cultivated valleywide if there had been no drought. These estimates and evidence from 1993 suggest that, with small ARPs and no drought, total valleywide irrigated acreage derived from the CAC data would be quite close to or even greater than DWR's estimate of 7.2 million acres.

Table II-16 also shows important acreage trends over the last 10 years. There appears to have been a downward trend in grain acreage. Some of this trend could be related to drought in 1991 and 1992, but grain acreage did not recover in 1993 as did acreage of other field crops. Acreage of fruits, nuts, and vegetables appears to be increasing; the only exception is grapes, with slightly less acreage in 1993 than in 1984. Acreage of high-value crops has grown over time with increasing demand, largely at the expense of low-valued crops. This trend is expected to continue for the foreseeable future, according to acreage projections by DWR (1994).

Reclamation has provided 1990 data on cropland for the San Benito County Water Conservation and Flood Control District and the Santa Clara Valley Water District, both in the SFD. Harvested cropland for both districts was a little more than 25,000 acres and yielded about $65 million in production (Table II-19). Vegetables were grown on about half of the acreage and fruits and nuts on about 30 percent of the acreage. Harvested acreage in San Benito and Santa Clara counties as a whole was 79,000 in 1987 and 72,300 in 1992 (Census, 1989 and 1994). Irrigated acres for the same two counties were reported as 55,000 acres in 1987 and 47,000 acres in 1992.

TABLE II-19

1990 IRRIGATED ACRES AND VALUE OF PRODUCTION FOR SAN FELIPE DIVISION

Crop	Irrigated Acres	Value of Production ($1,000)
Fruits and Nuts	7,498	13,952
Grains and Field Crops	3,400	1,699
Hay/Alfalfa and Pasture	1,850	713
Vegetables	12,445	48,622
Total	**25,193**	**64,986**

SOURCE:
Reclamation, 1995.

REGIONAL DESCRIPTIONS

Sacramento River Region conditions cause a wide variation in crop mix. The uplands are suitable for a variety of crops, but the fine-textured soils adjacent to the Sacramento River are most suited to rice production. Figure II-8 shows that grains and field crops; rice; and hay, pasture, and alfalfa are the major crops in the Sacramento River Region (72 percent of irrigated acres).

Irrigated acreage within the San Joaquin River Region is very diversified. Almost half of the 1992 acreage was planted with grains, hay, and pasture (Figure II-8). Orchards were planted on about 30 percent of the irrigated acres, and cotton and vegetables were each planted on about 10 percent. The region is the leading California area for production of grapes, almonds, walnuts, tomatoes, melons, and many other crops. Vegetables and cotton are grown on the west side, and grapes, fruits, nuts, and cotton are grown on the east side.

The warm climate of the Tulare Lake Region allows for great crop diversity. As Figure II-8 shows, cotton leads irrigated acres (32 percent), followed by fruits and nuts (28 percent), grains and field crops (17 percent), hay and pasture (12 percent), and vegetables (10 percent). The region has benefitted from supplemental water supply provided by the SWP for areas within Kern and Kings counties. Tulare County is the leading milk-producing county in the U.S.

The SFD has a moderate climate in comparison to the Central Valley. The relatively cool summers make the region ideal for production of cool-season vegetables and strawberries.

FARM PROFILES

Numbers and sizes of farms, together with ownership patterns, describe the general structure of agriculture within a region. A large number of farms can mean larger economic influences within the region in terms of employment, spending, and taxes. Ownership patterns can give an indication of the numbers of farm owners and managers who live within a region, and labor expenses are important to workers and the communities in which they live. Data on these factors are provided by the Census of Agriculture.

The 1992 census reported slightly more than 41,000 farms in the Central Valley, a little more than half of the total farms in California (Table II-20). There were no significant changes in number of farms, farm sizes, or general farmland use between 1987 and 1992. The number of farms and land in farms decreased slightly between 1987 and 1992, and average farm size remained fairly constant at a little more than 350 acres per farm. About 90 percent of the farms contained less than 500 acres, 5 percent covered between 500 and 999 acres, and 5 percent covered 1,000 acres or more in either census year. Table II-20 shows substantial differences between counties in average farm size.

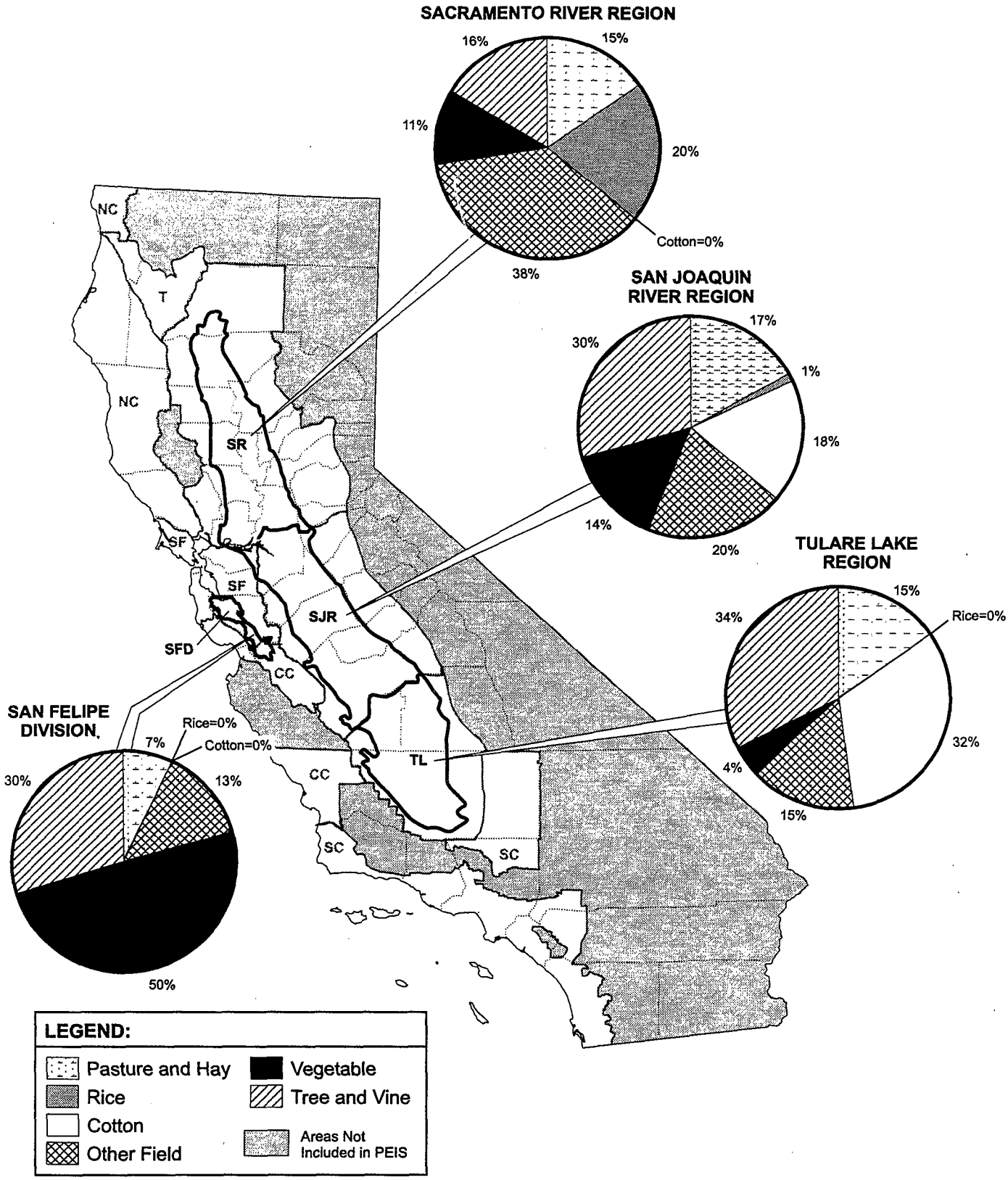

FIGURE II-8

1990 AGRICULTURAL LAND USE IN THE CENTRAL VALLEY AND SAN FELIPE DIVISION

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TABLE II-20

NUMBER OF CENTRAL VALLEY FARMS AND FARM SIZES 1987 AND 1992

	Number of Farms	Land in Farms (1,000 acres)	Average Farm Size (acres)	Farms Less Than 500 Acres	Farms of 500-999 Acres	Farms of 1,000 Acres or More	Total Cropland (1,000 acres)
1987							
California	**83,217**	**30,598**	**368**	**74,240**	**3,804**	**5,173**	**10,895**
Percent of Farms				**89**	**5**	**6**	
Sacramento River Region (1)	13,100	4,910	375	11,332	799	969	2,238
Percent of Farms				87	6	7	
San Joaquin River Basin (2)	21,380	5,325	249	19,620	811	949	2,984
Percent of Farms				92	4	4	
Tulare Lake Region (3)	9,370	5,149	550	8,117	562	691	2,302
Percent of Farms				87	6	7	
Total Central Valley	**43,850**	**15,384**	**351**	**39,069**	**2,172**	**2,609**	**7,524**
Percent of Farms				**89**	**5**	**6**	
1992							
California	**77,669**	**28,979**	**373**	**68,969**	**3,702**	**4,998**	**10,479**
Percent of Farms				**89**	**5**	**6**	
Sacramento River Region (1)	12,587	4,710	374	10,917	766	904	2,116
Percent of Farms				87	6	7	
San Joaquin River Basin (2)	20,060	5,047	252	18,198	888	974	2,992
Percent of Farms				91	4	5	
Tulare Lake Region (3)	8,556	4,970	581	7,339	530	687	2,177
Percent of Farms				86	6	8	
Total Central Valley	**41,203**	**14,727**	**357**	**36,454**	**2,184**	**2,565**	**7,285**
Percent of Farms				**88**	**5**	**6**	

NOTES:
(1) Sacramento River Region encompasses Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba counties.
(2) San Joaquin River Region encompasses Fresno, Madera, Merced, San Joaquin, and Stanislaus counties.
(3) Tulare Lake Region encompasses Kern, Kings, and Tulare counties.
SOURCES:
Census, 1989, 1994.

About half of the land in farms in the Central Valley in 1992 was dedicated to cropland, 80 percent to harvested crops and 20 percent to pasture and grazing. In 1987, these figures were 75 percent and 25 percent, respectively. The proportion of cropland that is irrigated rose slightly from 76 percent in 1987 to 78 percent in 1992.

In 1992, there were approximately 12,500 farms in the Sacramento River Region. Average farm size was approximately 375 acres. The average farm had 168 acres of cropland, of which 116 acres were irrigated and 122 acres were harvested. Pasture accounts for much of the difference between cropland and harvested cropland. Over the 5-year period from 1987 to 1992, the number of farms declined from 13,100 to 12,600, and total cropland fell from 2.2 to 2.1 million acres. The amount of irrigated cropland rose from 66 to 69 percent.

In 1992, there were about 20,000 farms in the San Joaquin River Region, down from more than 21,000 in 1987. Average farm size was about 250 acres. The average farm consisted of 149 acres of cropland, 125 irrigated and 123 harvested. Total cropland remained virtually unchanged (2,984,000 acres in 1987 to 2,992,000 acres in 1992) as did the amount of cropland irrigated (82 percent to 84 percent).

Farms in San Joaquin and Stanislaus counties are notably smaller than those in the other counties within the San Joaquin River Region. Average farm size on the east side of the San Joaquin Valley is generally smaller than on the west side, reflecting water and soil conditions and average crop mix in the two areas.

The Tulare Lake Region has farms larger in average size than the other two Central Valley regions. In 1992, there were approximately 8,600 farms in the Tulare Lake Region, down significantly from approximately 9,400 farms in 1987. Average farm size in 1992 was 581 acres, up from 550 acres in 1987. These two factors suggest some consolidation of farms. In 1992 the average farm consisted of 254 acres of cropland, 210 acres of harvested cropland, and 206 acres of irrigated cropland. Total cropland declined slightly from 2.3 to about 2.2 million acres in 1992, and the amount of cropland irrigated changed from 79 percent to 81 percent (Census, 1994).

TABLE II-21

OWNERSHIP CHARACTERISTICS OF CENTRAL VALLEY FARMS 1987 AND 1992

	Number of Farms	Farming Principal Occupation	Full Owners	Part Owners	Tenants	Number of Farms	Farming Principal Occupation	Full Owners	Part Owners	Tenants
	1987					1992				
California	**83,217**	**41,906**	**60,639**	**12,218**	**10,360**	**77,669**	**40,215**	**56,559**	**11,471**	**9,639**
Percent of Farms		**50**	**73**	**15**	**12**		**52**	**73**	**15**	**12**
Sacramento River Region (1)	13,100	6,932	8,966	2,380	1,750	12,587	6,855	8,491	2,295	1,801
Percent of Farms		53	68	18	14		54	68	18	14
San Joaquin River Region (2)	21,380	11,783	15,591	3,430	2,359	20,060	11,520	14,325	3,330	2,405
Percent of Farms		55	73	16	11		57	71	17	12
Tulare Lake Region (3)	9,370	5,215	6,795	1,508	1,607	8,556	4,872	6,195	1,391	970
Percent of Farms		56	73	16	11		57	73	16	11
Total Central Valley	**43,850**	**23,930**	**31,352**	**7,318**	**5,176**	**41,203**	**23,247**	**29,011**	**7,016**	**5,176**
Percent of Farms		**55**	**71**	**17**	**12**		**56**	**70**	**17**	**13**

NOTES:
(1) Sacramento River Region encompasses Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba counties.
(2) San Joaquin River Region encompasses Fresno, Madera, Merced, San Joaquin, and Stanislaus counties.
(3) Tulare Lake Region encompasses Kern, Kings, and Tulare counties.
SOURCES:
Census, 1989, 1994 (Table 11).

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Table II-21 shows farm ownership and operation patterns in 1987 and 1992. About 56 percent of Central Valley farms are operated by persons who claim farming as their principal occupation; 70 percent are operated by full owners, 17 percent by part owners, and 13 percent by tenants. These figures suggest that most farmers and land owners in the Central Valley live in the region.

Census county data are not necessarily representative of conditions in the SFD. Reclamation data for 1990 indicate a little less than 500 full- and part-time farms with about 25,000 acres of cropland in the SFD (Reclamation, 1995).

AGRICULTURAL PRODUCTION COSTS AND REVENUES

Agricultural net returns are revenues less costs. Higher costs reduce farm profits, but some part of costs also represent farm expenditures in the regional economy. Revenues are price times production. Central Valley farms accounted for more than $8.5 billion in agricultural sales in 1987 and $10 billion in 1992, as shown in Table II-22. About two-thirds of these sales were receipts for crops. The remainder of the sales were mostly livestock products. Revenues in 1992 were probably less than normal because of the influence of drought. Farmers received an additional $329 million in government payments and $171 million from direct sales, custom work, and other farm services for a total income of $10.5 billion in 1992. Production expenses were about $8.2 billion, leaving a net cash return of $2.4 billion. Net cash return includes the payment for family labor, management, returns to land and water, risk, and some other uncounted costs of farming.

The market value of Sacramento River Region crops sold reached $1.7 billion in 1993 (Table II-23); rice, tomatoes, almonds, and walnuts were the most valuable crops. In the San Joaquin River Region, fruits and nuts accounted for approximately half of the total value of crop production ($4.7 billion). Vegetables and cotton accounted for approximately 20 and 10 percent of the San Joaquin River Region's value of crop production, respectively. In the Tulare Lake Region, grapes were the highest value crop, followed by cotton and oranges. All fruits and nuts accounted for almost 60 percent of the total value of crop production (about $3.8 billion) in the Tulare Lake Region.

Estimates of agricultural costs, revenues, and net returns vary substantially among sources. These variations result primarily from differences in survey sample, timing of surveys, and assumptions regarding cost calculations. Data described here are from the Census of Agriculture (Census, 1989, 1994). They are presented because they allow a consistent comparison of Central Valley conditions to conditions in California and the U.S.

Table II-24 details some of the components of agricultural production expenses in 1987 and 1992. Hired and contract labor was the largest expense reported, accounting for one-fourth of total expenses. Other large categories (other than livestock-related expenses) were fertilizers and chemicals, petroleum products and electricity, and interest paid.

These census data are roughly comparable, but not identical, to the databases used for impact analysis. The analysis of alternatives used CAC reports for crop prices, yields, and acreages. Reclamation and Cooperative Extension crop production budgets were used to estimate

TABLE II-22

CENTRAL VALLEY FARM INCOMES AND EXPENSES 1987 AND 1992

	Market Value of All Agricultural Products Sold	Market Value of Crops Sold	Percent Market Value Crops	Other Revenue		Total Income	Production Expenses	Net Cash Return
				Government Payments & CCC Loans	Direct Sales & Other Private			
1987								
California	**13,922**	**9,269**	**67**	**307**	**158**	**14,387**	**10,918**	**3,469**
Sacramento River Region (1)	1,667	1,048	63	123	30	1,833	1,043	790
Percent of State	12	11		40	19	13	10	23
San Joaquin River Region (2)	4,240	2,500	59	70	47	4,393	3,321	1,072
Percent of State	30	27		23	30	31	30	31
Tulare Lake Region	2,617	1,945	74	84	24	2,746	2,020	726
Percent of State	19	21		27	15	19	19	21
Total Central Valley	**8,524**	**5,493**	**64**	**277**	**101**	**8,972**	**6,384**	**2,588**
Percent of State	**61**	**59**		**90**	**64**	**62**	**58**	**75**
1992								
California	**17,052**	**11,747**	**69**	**350**	**278**	**17,680**	**13,805**	**3,875**
Sacramento River Region (1)	1,569	1,280	82	147	43	1,759	1,273	486
Percent of State	9	11		42	15	10	9	13
San Joaquin River Region (2)	5,144	3,060	59	90	83	5,317	4,171	1,146
Percent of State	30	26		26	30	30	30	30
Tulare Lake Region (3)	3,306	2,355	71	92	45	3,443	2,706	737
Percent of State	19	20		26	16	19	20	19
Total Central Valley	**10,019**	**6,695**	**67**	**329**	**171**	**10,519**	**8,150**	**2,369**
Percent of State	**59**	**57**		**94**	**62**	**59**	**59**	**61**

NOTES:
All values in million dollars.
(1) Sacramento River Region encompasses Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba counties.
(2) San Joaquin River Region encompasses Fresno, Madera, Merced, San Joaquin, and Stanislaus counties.
(3) Tulare Lake Region encompasses Kern, Kings, and Tulare counties.
SOURCES:
Census, 1989, 1994 (Tables 2, 3, and 4).

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TABLE II-23

1993 VALUE OF CROPS IN CENTRAL VALLEY

	Cotton	All Hay	Rice	Other	Total Field Crops	Grapes	Almonds	Oranges	Walnuts	Peaches	Other	Total Orchard	All Lettuce	All Tomatoes	All Melons	Other	Total Vege-tables	Total All Crops
California	**1,170.7**	**806.6**	**393.5**	**1,530.9**	**3,901.7**	**2,313.4**	**1,063.7**	**806.8**	**421.3**	**306.6**	**2,192.6**	**7,104.4**	**1,095.8**	**718.0**	**267.9**	**2,861.6**	**4,943.3**	**15,949.4**
Sacramento River Region																		
Butte	0.0	1.9	71.6	16.3	89.8	0.0	78.6	0.1	37.4	8.9	43.6	168.6	0.0	0.0	0.0	0.9	0.9	259.3
Colusa	0.0	7.3	98.7	64.1	170.1	0.0	35.6	0.0	6.7	0.0	14.8	57.1	0.0	31.4	0.0	4.3	35.7	262.9
Glenn	0.0	13.6	71.3	41.7	126.6	0.0	33.9	0.0	10.8	0.0	29.1	73.8	0.0	0.0	0.0	0.0	0.0	200.4
Placer	0.0	0.9	12.5	5.4	18.8	0.1	0.0	0.0	3.2	0.2	2.3	5.8	0.0	0.0	0.0	0.0	0.0	24.6
Sacramento	0.0	5.2	7.6	46.7	59.5	18.4	0.0	0.0	0.5	0.0	35.5	54.4	0.1	13.4	0.0	5.0	18.5	132.4
Shasta	0.0	9.4	0.0	8.8	18.2	0.0	0.0	0.0	1.9	0.0	1.4	3.3	0.0	0.0	0.0	0.0	0.0	21.5
Solano	0.0	11.7	0.0	62.3	74.0	4.4	1.6	0.0	5.1	0.5	12.7	24.3	0.0	31.8	0.0	4.1	35.9	134.2
Sutter	0.0	3.4	70.0	36.7	110.1	0.0	8.1	0.0	40.8	31.9	39.1	119.9	0.0	27.2	9.6	2.7	39.5	269.5
Tehama	0.0	3.8	1.1	12.0	16.9	0.0	13.0	0.0	23.4	0.0	25.2	61.6	0.0	0.0	0.0	0.1	0.1	78.6
Yolo	0.0	19.6	16.3	59.5	95.4	4.0	11.2	0.0	12.1	0.4	6.1	33.8	0.0	83.1	5.2	4.6	92.9	222.1
Yuba	0.0	0.7	31.2	4.8	36.7	0.0	3.0	0.0	14.9	16.2	29.7	63.8	0.0	0.0	0.0	0.0	0.0	100.5
Total	**0.0**	**77.5**	**380.3**	**358.3**	**816.1**	**26.9**	**185.0**	**0.1**	**156.8**	**58.1**	**239.5**	**666.4**	**0.1**	**186.9**	**14.8**	**21.7**	**223.5**	**1,706.0**
Percent of State	**0%**	**10%**	**97%**	**23%**	**21%**	**1%**	**17%**	**0%**	**37%**	**19%**	**11%**	**9%**	**0%**	**26%**	**6%**	**1%**	**5%**	**11%**
San Joaquin River Region																		
Fresno	397.0	69.7	4.8	170.2	641.7	528.6	91.0	79.7	8.4	69.2	233.6	1,010.5	112.0	222.3	80.1	195.5	609.9	2,262.1
Madera	45.5	29.8	0.0	31.3	106.6	172.2	108.4	21.5	1.8	5.0	84.4	393.3	0.0	0.0	0.0	15.7	15.7	515.6
Merced	76.3	58.3	3.0	88.5	226.1	30.1	175.3	0.0	14.9	21.2	51.9	293.4	0.0	53.4	26.2	50.4	130.0	649.5
San Joaquin	0.0	56.3	3.5	124.0	183.8	128.2	90.0	0.0	67.8	10.8	88.4	385.2	0.0	69.6	4.2	105.9	179.7	748.7
Stanislaus	0.0	41.6	1.7	72.3	115.6	32.5	190.8	0.0	66.4	46.1	42.2	378.0	0.0	25.9	8.2	29.4	63.5	557.1
Total	**518.8**	**255.7**	**13.0**	**486.3**	**1,273.8**	**891.6**	**655.5**	**101.2**	**159.3**	**152.3**	**500.5**	**2,460.4**	**112.0**	**371.2**	**118.7**	**396.9**	**998.8**	**4,733.0**
Percent of State	**44%**	**32%**	**3%**	**32%**	**33%**	**39%**	**62%**	**13%**	**38%**	**50%**	**23%**	**35%**	**10%**	**52%**	**44%**	**14%**	**20%**	**30%**
Tulare Lake Region																		
Kern	261.5	62.6	0.0	100.0	424.1	366.8	190.6	166.1	5.6	11.1	217.3	957.5	25.7	11.1	23.6	259.8	320.2	1,701.8
Kings	238.6	21.5	0.0	111.7	371.8	15.9	4.5	0.0	17.5	19.0	55.6	112.5	0.0	25.3	2.8	16.1	44.2	528.5
Tulare	137.2	62.4	0.0	116.1	315.7	377.7	27.4	356.1	65.5	53.1	306.2	1,186.0	0.0	0.7	0.0	45.1	45.8	1,547.5
Total	637.3	146.5	0.0	327.8	1,111.6	760.4	222.5	522.2	88.6	83.2	579.1	2,256.0	25.7	37.1	26.4	321.0	410.2	3,777.8
Percent of State	54%	18%	0%	21%	28%	33%	21%	65%	21%	27%	26%	32%	2%	5%	10%	11%	8%	24%
Total Central Valley	**1,156.1**	**479.7**	**393.3**	**1,172.4**	**3,201.5**	**1,678.9**	**1,063.0**	**623.5**	**404.7**	**293.6**	**1,319.1**	**5,382.8**	**137.8**	**595.2**	**159.9**	**739.6**	**1,632.5**	**10,216.8**
Percent of State	**99%**	**59%**	**100%**	**77%**	**82%**	**73%**	**100%**	**77%**	**96%**	**96%**	**60%**	**76%**	**13%**	**83%**	**60%**	**26%**	**33%**	**64%**

NOTE:
All dollar values are in million dollars per year.
SOURCE:
CAC, 1993 Annual Report.

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TABLE II-24

CENTRAL VALLEY FARM PRODUCTION EXPENSES

	Livestock Related	Seeds, Bulbs, Plants, & Trees	Fertilizers & Chemicals	Petroleum Products & Electricity	Hired & Contract Labor	Custom Work (1)	Repair & Maintenance	Interest Paid	Cash Rent	Taxes	Property & Other	Total Expenses
1987												
California	**2485**	**216**	**973**	**663**	**2998**	**335**	**503**	**697**	**382**	**246**	**1420**	**10918**
Percent of Total Expenses	**23%**	**2%**	**9%**	**6%**	**27%**	**3%**	**5%**	**6%**	**3%**	**2%**	**13%**	
Sacramento River Region	126	22	140	85	252	48	68	86	53	35	128	1,043
Percent of Total Expenses	12%	2%	13%	8%	24%	5%	7%	8%	5%	3%	12%	
San Joaquin River Region	937	36	300	183	783	129	146	237	102	71	397	3,321
Percent of Total Expenses	28%	1%	9%	6%	24%	4%	4%	7%	3%	2%	12%	
Tulare Lake Region	339	27	231	154	554	78	106	152	66	38	275	2,020
Percent of Total Expenses	17%	1%	11%	8%	27%	4%	5%	8%	3%	2%	14%	
Total Central Valley	**1402**	**85**	**671**	**422**	**1589**	**255**	**320**	**475**	**221**	**144**	**800**	**6384**
Percent of Total Expenses	**22%**	**1%**	**11%**	**7%**	**25%**	**4%**	**5%**	**7%**	**3%**	**2%**	**13%**	
1992												
California	**3044**	**274**	**1264**	**915**	**3889**	**449**	**631**	**739**	**493**	**291**	**1816**	**13805**
Percent of Total Expenses	**22%**	**2%**	**9%**	**7%**	**28%**	**3%**	**5%**	**5%**	**4%**	**2%**	**13%**	
Sacramento River Region	147	34	180	110	316	66	83	82	57	37	161	1,273
Percent of Total Expenses	12%	3%	14%	9%	25%	5%	7%	6%	4%	3%	13%	
San Joaquin River Region	1266	47	369	276	944	165	183	244	127	81	469	4,171
Percent of Total Expenses	30%	1%	9%	7%	23%	4%	4%	6%	3%	2%	11%	
Tulare Lake Region	514	33	301	218	747	96	139	173	86	48	351	2,706
Percent of Total Expenses	19%	1%	11%	8%	28%	4%	5%	6%	3%	2%	13%	
Total Central Valley	**1927**	**114**	**850**	**604**	**2007**	**327**	**405**	**499**	**270**	**166**	**981**	**8150**
Percent of Total Expenses	**24%**	**1%**	**10%**	**7%**	**25%**	**4%**	**5%**	**6%**	**3%**	**2%**	**12%**	

NOTES:
(1) Includes customwork, machine hire, and rental of machinery and equipment.
All dollar values are in million dollars per year.

SOURCE:
Census, 1994, Table 3.

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production costs. These data are described in the CVPM Methodology/Modeling Technical Appendix.

Many farm expenses have important regional economic significance. Dollars earned and spent by agriculture within a region stimulate additional employment and production in other industries. The direct and indirect output caused by agricultural sales is estimated to add close to $51 billion to the Central Valley economy (Carter and Goldman, 1992). These effects are discussed in more detail in the Regional Economics Technical Appendix.

Crop revenues in the CVPM are crop yield in units of production per acre, times acres, times price. Yield and price data are from the CAC with corrections for dryland acreage previously discussed. Price and yield data used in the CVPM are displayed in Table II-25.

AGRICULTURAL WATER CONSERVATION

Agricultural water conservation refers to water delivery and irrigation practices that increase the efficiency of water use. Water use efficiency is commonly measured at the farm, district, project, or basin level as the consumptive use or irrecoverable loss of water within the defined geographic area divided by water delivered into the area. For example, on-farm application efficiency is measured as on-farm crop consumptive use of irrigation water divided by the amount of water applied. Other definitions of water use efficiency are sometimes used, especially those employing the concept of beneficial use. Beneficial use is often defined to include consumptive use plus water applied for non-consumptive reasons: leaching of salts, frost control, etc.

On-farm application efficiency depends on many factors including crop type, terrain, climate, irrigation system, and management of the system. Application efficiencies in the Central Valley range from below 50 to above 80 percent. Lowest efficiencies tend to occur in the Sacramento Valley where water is more abundant and less expensive. Rice cultivation here generates much more irrigation tailwater than other crops, but this tailwater normally returns to the hydrologic system. Higher efficiencies are found in the San Joaquin River and Tulare Lake regions for the opposite reasons.

District and project efficiencies incorporate the efficiency of the district conveyance systems as well as the on-farm application. Districts with improved conveyance, especially lined canals and laterals, tend to have higher district conveyance efficiencies. Again, the southern Central Valley tends to be more efficient at the district and project level because of greater use of lining and piping. Some Sacramento Valley districts, most notably those in the Tehama-Colusa area, have entirely piped or lined conveyance systems.

Water considered part of the inefficient use (loss) at the field level may be recovered and reused at another time or location. Generally, as the area of water use measurement broadens (from field to farm to district to basin), efficiency increases because more of the site-specific losses get reused. Reduction of losses at the field level may not translate into equivalent savings at a district or basin level if these losses are already being reused. Sometimes field-level losses are encouraged as a means of recharging groundwater in wet years or providing tailwater for wildlife habitat.

TABLE II-25

CROP ACREAGE, YIELDS, PRODUCTION, AND VALUE 1985-1992 AVERAGE

Crop	Harvested Irrigated (1,000 Acres)	Average Yield (Tons/Acre) (1)	Product (1,000 Tons)	Average Price Per Unit	Average Revenue Per Acre	Value of Production ($ millions)
Wheat	371.8	3.03	1,127	107	325	121
Misc. Grain	151.9	2.30	350	106	244	37
Rice	415.9	3.85	1,600	151	581	242
Cotton (Bales)	1167.3	2.47	2,885	409	1,010	1,179
Sugar Beets	147.3	25.12	3,699	36	909	134
Corn	364.9	4.45	1,625	105	468	171
Misc. Hay	211.1	3.33	704	63	211	45
Dry Beans	167.9	1.11	186	555	616	103
Oil Seed	66.1	1.57	103	265	415	27
Alfalfa Seed	192.2	0.27	52	2,351	642	123
Alfalfa	579.7	7.60	4,480	88	671	389
Pasture (AUMs)	481.9	13.60	6,555	12	163	79
Process Tomatoes	232.1	31.41	7,291	51	1,609	374
Fresh Tomatoes	24.1	13.73	330	416	5,719	138
Melons	74.0	9.04	669	208	1,884	139
Onions	41.9	19.09	799	117	2,227	93
Potatoes	23.9	18.59	445	179	3,319	79
Misc. Vegetables	199.0	26.60	5,295	170	4,519	899
Almonds	459.0	0.68	310	2,357	1,592	731
Walnuts	160.0	1.37	219	1,022	1,401	224
Prunes	128.6	2.63	338	787	2,071	266
Peaches	134.0	12.69	1,701	368	4,676	627
Citrus	150.6	11.33	1,707	329	3,724	561
Olives	60.3	3.47	209	545	1,893	114
Raisin Grapes	347.9	7.97	2,773	345	2,753	958
Wine Grapes	189.8	8.50	1,614	193	1,644	312
Total	**6543.2**					**8,165**

NOTE:
(1) Tons per acre unless otherwise noted next to crop name. Cotton price includes value of cottonseed.
SOURCES:
CAC, 1985-1992.

Because of these issues, the value of irrigation water conservation for saving water is widely debated. The only potential for increased efficiency at the basin level comes from reduced evaporation, transpiration, or flows to irretrievable water bodies such as saline groundwater or the ocean. However, other benefits can follow from irrigation water conservation. Farmers improve their irrigation practices to obtain higher crop yields and, to the extent that a price is charged for water, to reduce water costs. Districts can also reduce water costs or stretch supplies by conserving. Irrigation conservation sometimes improves water quality downstream, and overall management of supplies can be improved.

AGRICULTURAL WATER MEASUREMENT

Practically all agricultural districts in the Central Valley currently have some type of measurement capability at the district level, and most can measure water delivered to individual users. In some cases, control structures that are already in place could facilitate water measurement. These control

structures are usually gates or weirs that, when lowered or opened, allow water to flow to the users. In some other cases, water is physically pumped out of a canal or ditch by the user.

More than 80 agricultural CVP contractors have been asked to submit water conservation plans, but less than 75 percent had done so as of December 1995, and only half of those were approved and accepted by DWR and Reclamation. Of this half, approximately 30 stated that the district was already 100 percent measured. This leaves more than 50 agricultural CVP contractors who may be somewhat short of full measurement to all end users. In some cases, programs are in place but not funded; in others the majority of the users are measured. However, some of the districts have no field-level measurement whatsoever. These cases occur predominantly in the Sacramento Valley where many districts receive only a small portion of their surface water supplies through CVP water service contracts.

LAND VALUES

The value of irrigated land is largely determined by the profit expected from farming it, and this profit depends on the quantity and reliability of irrigation water supply. In practice, land prices are also affected by the potential for urban and other development uses of the land, and increasingly by the value of its water for other uses.

Average farm land values for the Central Valley and Central Coast Region are provided in Table II-26. These land values do not include any improvements on the land. Irrigated land value for field crops, rice, cotton, and pasture ranged from $1,800 to $3,000 per acre in all locations. Average values of irrigated land used for the same purpose are typically highest in the Central Coast Region, lower in the San Joaquin River Region, and lowest in the Sacramento River Region. Land values in the Sacramento River Region generally declined during the five-year period from 1985 to 1990, but prices generally increased in the San Joaquin River and Central Coast regions.

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TABLE II-26

CENTRAL VALLEY FARM LAND VALUES
1985 AND 1990

Land Use	Year	Region		
		Sacramento River	San Joaquin River	Central Coast
Irrigated Truck	1985	$2,800	$3,500	$5,900
	1990	2,600	3,600	8,100
Cotton	1985		2,900	
	1990		2,750	
Rice	1985	1,800	1,950	
	1990	1,800	2,100	
Irrigated Field Crops	1985	2,400	3,000	2,750
	1990	2,000	3,000	2,800
Irrigated Pasture	1985	1,800	2,300	2,400
	1990	1,800	2,500	2,800
Non-irrigated Cropland	1985	1,100	1,300	1,500
	1990	950	1,300	1,650
Unimproved Rangeland	1985	650	700	800
	1990	550	650	950

NOTE:
All land values in dollars per acre.
SOURCE:
DFA, 1990.

There is normally a large range in average land values reflecting local variations in climate, soils, and water supply reliability and costs. High-end values can be twice the size of those given in Table II-26, while low-end values may be half that size or smaller. Land values tend to be lower in areas with high soil salinity, drainage problems, and unreliable water supply.

Land values have held generally steady since 1990 with some notable movements in both directions. High-end rice acreage in the Sacramento River Region has recently sold for as much as $5,000 per acre. Throughout the region, reliable water supplies and suitability for permanent crops are two factors that enhance land value (Thompson, 1996).

ENERGY USE

Agricultural energy is expended through use of water, through fossil fuel consumption, and indirectly through use of energy-intensive materials such as nitrogen fertilizer.

The amount of energy used to supply water depends on the source of the water, where it is used, the amount used, and how it is applied. Groundwater requires energy for pumping, and surface water deliveries often require energy for pumping to the elevation of the irrigated land. All water deliveries south of the Delta require energy for pumping at the Delta export facilities. Sprinkler and drip irrigation systems use additional energy for pressurization.

The amount of energy used to pump groundwater or to pressurize irrigation systems depends on the hydraulic head required and on the efficiency of the well and pumping plant. The energy, measured in kilowatt-hours (kWh), needed to pump an acre-feet of water is related to the required feet of head, H, and the overall pumping efficiency, Eff, as:

$$kWh = 1.02 \times H / Eff$$

Raising an acre-feet of water 300 feet using an overall well and pump efficiency of 70 percent requires about 437 kWh. Pressurizing an acre-feet of water to 60 pounds per square inch (psi) for some sprinkler and drip irrigation systems requires just over 200 kWh (psi x 2.31 = feet of head).

Modern agriculture has become increasingly energy intensive. Modern tractors, combines and harvesters can require 4 to 8 gallons of fuel per hour of use, and an acre of cropland often requires two or more hours of tractor time per acre. One study of dryland grain production in Glenn County estimated a need for 13 gallons of fuel per acre (CES, 1981). Indirect energy needs arise in the production and transportation of farm chemicals and in the transportation and processing of farm products.

CROP ROTATIONS

Crop rotation is the practice of changing the crop grown on a piece of land to increase crop yields and reduce costs of crop production. Legumes are frequently used in a crop rotation to increase nitrogen levels in soil, and other crops can improve the organic content of soils. Crops are often rotated to reduce pest problems because pest populations tend to build over time if the land is kept in the same crop. Crop rotations are limited where soils are suitable for a limited number of crops. For example, some bottomlands in the Sacramento River Region are suitable only for rice. In this situation, land fallow may be used to rest the land and allow pest populations to decline.

Common crop rotations in the Central Valley involve wheat and tomatoes in parts of the Sacramento River Region and tomatoes and cotton in the San Joaquin River Region. Alfalfa is a legume commonly used to build soil nitrogen and organic matter. It is grown for three to five years and then replaced with an annual crop.

In general, crop rotations are not an absolute constraint on crop mix. Considerable flexibility in crop rotations is observed as growers attempt to respond to changing market conditions. Some rotations can be avoided by the use of more fertilizers or pesticides.

CENTRAL VALLEY AGRICULTURE IN NATIONAL AND INTERNATIONAL MARKETS

California leads all other states in value of agricultural production, and the Central Valley provides most of this production. The Central Valley accounts for almost 10 percent of the total U.S. market value of agricultural crops sold. More than half of this value comes from fruits and nuts. The Central Valley accounts for almost 40 percent of U.S. production.

California's 20 percent share of the U.S. cotton market value is produced on less than 10 percent of total U.S.-harvested cotton acres (including non-irrigated acres) because of the Central Valley's higher yields (Table II-27) and the higher quality of its cotton. Central Valley hay and vegetables also account for large shares of the national market. In general, the Central Valley's larger proportion of irrigated acreage allows yields and the proportion of high-value crops grown to exceed national averages.

Table II-28 further illustrates the Central Valley's dominance in the production of fruits and nuts and its importance as a vegetable-growing region. It provides about two-thirds of the U.S. production of apricots, grapes, garlic, and tomatoes; about 90 percent of U.S. production of figs, nectarines, plums and prunes, pistachios, and walnuts; and almost all the almonds. In 1992, the Central Valley produced 18 percent of all U.S. rice, but more than half the U.S. output of medium-grain rice (DFA, 1994; USDA, 1993).

In addition to its importance in national markets, Central Valley agriculture plays an important role in international markets. California produces about 10 percent of total U.S. agricultural exports. These exports represent almost 25 percent of the gross farm income of the state (Carter and Goldman, 1992). Leading California export commodities and the percent of each grown in the Central Valley include cotton (99 percent), almonds (100 percent), grapes (73 percent), oranges (77 percent), walnuts (96 percent), tomatoes (83 percent), and rice (100 percent).

The high quality and uniqueness of several Central Valley commodities give them an advantage in export markets. Central Valley cotton commands a premium price because of the fineness, length, and strength of its cotton fibers; more than 80 percent of the cotton grown in the Central Valley in 1990 was exported. The Central Valley is the only U.S. producer of high-quality japonica rice, the variety demanded by Japanese and several other Asian markets. Historically, Japan's trade restrictions have allowed only small amounts of processed and packaged U.S. rice to be imported and have allowed no bulk imports. The 1993 drought conditions in Japan created a demand for rice imports that resulted in the first bulk shipment of Central Valley rice to Japan in 1994. These exports are expected to increase due to the recent General Agreement on Tariffs and Trade (GATT).

FARM PROGRAMS

The federal government has taken an active role in agricultural production since the 1930s through farm programs. Although national economic conditions and political philosophies have changed, three essential goals of agricultural policies have remained: provide for prosperity in the agricultural sector, ensure a reliable food supply, and promote conservation of land and water resources. Farm programs were developed from a national perspective without particular emphasis on regional or state production.

Commodity programs are designed to increase incomes of growers of certain commodities. Rice, cotton, wheat and corn are important commodities in California. In California, almost 4 million acres of cropland were eligible to participate in commodity programs in 1991 and 1992, and an

TABLE II-27

COMPARISON OF CENTRAL VALLEY YIELDS TO NATIONAL YIELDS

Crop		U.S.	California
Rice			
Acres	(1,000 acres)	3,118	401
Quantity	(1,000 bushels)	175,942	31,865
Yield	(bushels per acre)	56.4	79.4
Cotton			
Acres	(1,000 acres)	10,962	1,066
Quantity	(1,000 bales)	15,370	2,792
Yield	(bales per acre)	1.4	2.6
Hay			
Acres	(1,000 acres)	56,596	1,531
Quantity	(1,000 dry tons)	126,981	7,567
Yield	(tons per acre)	2.2	4.9
Grapes			
Acres	(1,000 acres)	867	735
Quantity	(1,000 tons)	5,512	4,923
Yield	(tons per acre)	6.4	6.7
Apricots			
Acres	(1,000 acres)	27	24
Quantity	(1,000 tons)	118	111
Yield	(tons per acre)	4.4	4.6
Nectarines			
Acres	(1,000 acres)	41	36
Quantity	(1,000 tons)	253	234
Yield	(tons per acre)	6.2	6.5

SOURCE:
Census, 1994, Tables 26, 27, 28, and 31.

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TABLE II-28

CENTRAL VALLEY'S NATION-LEADING CROPS IN 1992

Vegetables (Harvested Acres)							
	Green & Lima Beans	Carrots	Garlic	Melons	Tomatoes	Other	All Vegetables Harvested
U.S.	**43,056**	**106,938**	**21,179**	**362,187**	**397,368**	**2,851,630**	**3,782,358**
California	**10,523**	**51,531**	**18,609**	**93,980**	**254,155**	**587,946**	**1,016,744**
Percent of U.S.	**24**	**48**	**88**	**26**	**64**	**21**	**27**
Sacramento River Region (1)	0	(2)	7	13,737	100,014	10,287	124,043
Percent of U.S.	0	0	0	4	25	0	3
San Joaquin River Region (2)	7,373	469	11,505	44,157	123,750	83,212	270,466
Percent of U.S.	17	0	54	12	31	3	7
Tulare Lake Region (3)	0	39,499	2,689	6,851	8,896	25,412	83,347
Percent of U.S.	0	37	13	2	2	1	2
Total Central Valley	**7,373**	**39,966**	**14,201**	**64,745**	**232,660**	**118,911**	**477,856**
Percent of U.S.	**17**	**37**	**67**	**18**	**59**	**4**	**13**

Fruits and Nuts (Acres)										
	Apricots	Figs	Grapes	Nectarines	Plums & Prunes	Almonds	Pistachios	English Walnuts	Other	Total Land in Orchards
U.S.	**26,984**	**20,131**	**867,151**	**40,971**	**142,118**	**441,700**	**69,344**	**214,159**	**2,948,220**	**4,770,778**
California	**24,070**	**20,011**	**735,251**	**35,995**	**130,723**	**441,668**	**66847**	**211,541**	**579,675**	**2,245,781**
Percent of U.S.	**89**	**99**	**85**	**88**	**92**	**100**	**96**	**99**	**20**	**47**
Sacramento River Region (1)	1,493	35	12,895	199	72,429	86,352	2,151	82,968	58,496	317,018
Percent of U.S.	6	0	1	0	51	20	3	39	2	7
San Joaquin River Region (2)	13,993	18,804	375,873	16,993	24,096	269,357	29,020	72,040	108,603	928,779
Percent of U.S.	52	93	43	41	17	61	42	34	4	19
Tulare Lake Region (3)	2,358	129	151,319	18,241	31,727	81,598	33,617	33,985	189,042	542,016
Percent of U.S.	9	1	17	45	22	18	48	16	6	11
Total Central Valley	**17,844**	**18,968**	**540,087**	**35,433**	**128,252**	**437,307**	**64,788**	**188,993**	**356,141**	**1,787,813**
Percent of U.S.	**66**	**94**	**62**	**86**	**90**	**99**	**93**	**88**	**12**	**37**

NOTES:
(1) Sacramento River Region encompasses Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba counties.
(2) San Joaquin River Region encompasses Fresno, Madera, Merced, San Joaquin, and Stanislaus counties.
(3) Tulare Lake Region encompasses Kern, Kings, and Tulare counties.
SOURCES:
Census, 1989, 1994.

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average of 2.6 million acres were in compliance with the programs (USDA, 1990-1992). The income provided by government payments is not an important share of all Central Valley agricultural income (roughly 3 percent), but farm programs have important effects on commodity crop economics, especially rice and cotton. A large share of eligible rice and cotton acreage participates and, in most years, a substantial share of net income is attributable to farm programs.

Until 1996, ARPs were set for each program crop based on stocks-to-use ratios. A farmer participating in the commodity program agreed to reduce acres for the program crop by the ARP percentage. In exchange, the farmer received nonrecourse price-support loans and income support through deficiency payments. The nonrecourse loan provisions allowed the farmer to default on his nonrecourse loan if market price fell below the loan rate. The government then took title to the crop and held it off the market, so the loan rate acted as a support price on the market. Deficiency payments provided income support for participating farmers. The deficiency payment rate was the difference between the target price and the market price or loan rate, whichever was higher. The minimum target price was typically established by law.

Until 1996, the 50/92 (cotton and rice only) and 0/92 (all other grains) provisions allowed farmers who planted at least 50 or 0 percent, respectively, of their permitted acreage to the program crop to receive 92 percent of their deficiency payments. These provisions were very important to farmers during the recent drought. Flex acres allowed farmers to plant a specified percentage of their base acres to certain other crops without incurring a reduction in their base acres for payment purposes.

In the last 10 years, as much as 400,000 acres of California rice and cotton cropland has been idled by acreage reduction requirements, and voluntary fallow provisions (0/92 and 50/92) were used during the height of the 1987-1992 drought to idle a similar amount of cropland while allowing farmers to keep most of their deficiency payments. In 1991, nearly one-third of the complying acreage base in California was idled under the mandatory or voluntary acreage reduction provisions. By 1992, only one-fifth of the complying base was idled as surface water supplies increased that year. In 1991 and 1992, 21 and 14 percent, respectively, of complying cotton acreage was idled, and 31 and 14 percent of complying rice acreage was idled in each year.

The Federal Agriculture Improvement and Reform Act of 1996 makes several substantial changes to past farm programs. Participating commodity base acreage now receives fixed payments per acre regardless of what crop is grown on the base acreage. Any crop except for fruits or vegetables may be grown, while payments are received, and acreage reduction requirements are no longer authorized. Nonrecourse loan provisions are retained.

The new farm legislation continues a trend toward decoupling of income support from planting decisions. All other factors being equal, greater crop diversity on land formerly planted to rice and cotton may be expected. In the short term, relatively high market prices for most commodities may slow this trend. The high prices and elimination of ARPs should result in larger-than-average crop acreage and water demand.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

Chapter III

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

The analysis in this chapter is based primarily on results and implications of the CVPM. This model was revised specifically for use in this analysis, and provides estimates of impacts to agricultural land use and crop mix, value and net income from irrigated production, surface water and groundwater use, on-farm irrigation efficiency, and water costs. This information is also used in other analyses to estimate changes in regional income and employment; financial impacts on agriculture, the CVP, and the Restoration Fund; and vegetation and wildlife impacts associated with land use changes. Additional assessment is provided of agricultural water conservation and measurement, farmland values, agricultural energy use, and potential impacts of changes in the reliability of water delivery.

The SFD is not a part of the CVPM, and changes are assessed in a separate analysis. In contrast to the CVPM analysis for the Central Valley, only lands directly served by CVP water are included in the San Felipe analysis. Also, quantities of other water supplies, including groundwater, are not estimated. For purposes of impact analysis, other supplies are assumed unchanged by the alternatives.

The five alternatives (the No-Action Alternative plus the four action alternatives) are evaluated and compared at the projected year 2020 level of development. For agricultural analysis, this means that acreage and crop mix are based on the 2020 projections and assumptions in DWR Bulletin 160-93. These assumptions create a baseline on which the conditions of the No-Action and action alternatives are imposed. Supplemental analyses that attempt to isolate the potential impacts of a single implementation option are presented with Alternatives 1 and 2.

The main text of this appendix presents results aggregated into the SFD and three Central Valley regions: the Sacramento River Region, the San Joaquin River Region, and the Tulare Lake Region. The Central Valley regions are defined according to county lines: Sacramento River Region includes Sacramento, Yolo, and Solano counties at its southern reach; San Joaquin River Region extends from San Joaquin County in the north through Fresno County at its southern reach; Tulare Lake Region includes Kings, Tulare, and Kern counties. Additional discussion is provided on selected smaller regions, corresponding to CVPM subregions, when impacts are particularly focused in those smaller areas. Results for the 22 Central Valley subregions are summarized in Attachment A.

ANALYTICAL APPROACH AND ASSUMPTIONS

For each alternative, CVPM is used to estimate 2020 conditions on crop acreage and production, income, water use, and irrigation efficiency in the Central Valley. Additional analysis, some of it

qualitative, is used for issues not captured adequately in the modeling. SFD impacts are assessed using a simpler spreadsheet analysis of crop acreage, value, and water use changes.

CVPM is described in detail in the CVPM Modeling Technical Appendix. However, some key implementation assumptions are summarized here. The calibration database in CVPM includes land use, water supply, prices, costs, and yields for the years 1985 to 1992. Average conditions for the years 1987 through 1990 are used as the baseline for crop yields, prices, costs and government programs. These years avoid the 1986 flood and the worst years of the drought (1991 and 1992). From this historical baseline, crop acreage is scaled up to match DWR's projected (or interpolated) land use for 2020, holding relative prices and costs the same. Essentially, the supply and demand functions for the crops are shifted by equal amounts so that the projected land use and production occur but at the same relative prices and costs.

The scaled land use, along with the historical baseline for other economic data, forms the projected baseline condition upon which policy assumptions or changes are imposed for impact analysis. For example, the baseline data are scaled up to 2020 land use prior to imposing the No-Action Alternative assumptions. These assumptions (including the effect of Bay-Delta Accord and cost-of-service CVP water pricing) are then imposed and model results reported.

The key assessment variables used to describe conditions in and compare alternatives are briefly described in the following paragraphs.

Irrigated Land Use measures the total agricultural land under irrigation in the study area, on average, for a particular hydrologic condition. It also estimates the mix of crops irrigated. It does not include lands that are fallowed even though they are developed for irrigation, nor does it include non-irrigated production.

Value of Production, or Gross Income, from irrigated production is measured two ways in the analysis: assuming crop prices remain constant, and allowing crop prices to adjust according to market demand elasticities. The constant-price estimate is used for generating regional economic impacts associated with crop production, because the regional economic model assumes fixed prices. Gross margins from the regional economic model are also used with the constant-price estimates to calculate net income losses from fallowing or retiring land. The variable-price estimate is the better estimate for directly comparing alternatives.

As discussed in Chapter II, **Net Income** is more difficult to estimate than gross revenue, because it depends on many cost components that are not readily observed. As a result, different agencies and different databases produce widely varying estimates of net income to agriculture. For purposes of comparison, we estimate net income associated with irrigated production using gross margins (net return as a percentage of gross return) from the regional economic impact model. Changes in net income attributed to an alternative include changes from reduced acreage plus changes in other costs such as groundwater pumping, irrigation systems, and water cost.

Water use changes in irrigated agriculture are measured in two ways: changes in **Applied Water** and changes in **Irrigation Efficiency**, calculated as ET of AW divided by AW. The applied water numbers represent delivery of water to the field; the reader should distinguish this from water

delivered to contractors or water diverted from streams, which are reported in other technical appendices.

For each of the action alternatives, additional discussion is provided on **Impacts on Consumers**; **Federal Commodity Payments**; **Variability, Risk, and Uncertainty**; **Land Values**; and **Finance and Credit**.

NO-ACTION ALTERNATIVE

The No-Action Alternative provides a base for comparison with each of the action alternatives. The following are the key features and assumptions of the No-Action Alternative:

2020 level of demand for crop production: The crop mix and total acreage projected by DWR for 2020 is used as a basis for the No-Action Alternative. Table III-1 summarizes the DWR's projected, normalized acres for the year 2020. Note that this crop mix is significantly different from that described in "Recent Conditions" in Chapter II. Vegetables and orchards form a much higher proportion of 2020 baseline acreage, while field and forage crops are projected to be lower.

CVP water priced at cost-of-service rates: Reclamation's water rates policy prior to CVPIA was that, upon renewal of water service contracts, users would pay the cost-of-service rate as calculated by Reclamation (unless ability-to-pay relief was granted). This rate is set to recover current costs of O&M, accumulated O&M deficit, and principal only on allocated capital costs. In most cases this rate is higher than rates set in existing contracts, and so higher than rates used in the analysis of existing conditions. Because all contracts will have been renewed by 2020, the No-Action Alternative analysis uses cost-of-service rates shown in Reclamation's 1992 water rate manual (Reclamation, 1993).

Ability to Pay: Current Reclamation policy allows irrigation water contractors to request a study of their capacity to pay for project water. If Reclamation determines that payment capacity is insufficient to recover the cost-of-service rate, all or a portion of the capital repayment portion of the rate may be forgiven. This analysis assumes that this policy remains in effect, and estimates appropriate water rates using payment capacities from a 1992 planning-level study prepared by Reclamation (1992).

1994 Bay-Delta Accord: DWR's Bulletin 160-93 was prepared prior to the 1994 Bay-Delta Accord, but the analysis presented here incorporates the Delta operations of the Accord. Although DWR's land use projections are used as a basis, or starting point, for this assessment, the assumptions underlying its projections are not consistent with this document's No-Action Alternative assumptions regarding water supply or cost. The No-Action Alternative agricultural analysis estimated how acreage, production, and water use might change from DWR's baseline in response to these water supply conditions. Results of this analysis are used as a basis of comparison for all of the action alternatives.

TABLE III-1

PROJECTED IRRIGATED ACRES

Crop	1995 (Interpolated from 1990 values)	2020
Sacramento River Region		
Pasture	206	166
Alfalfa	127	116
Sugar Beets	89	80
Other Field Crops	251	265
Rice	491	473
Truck Crops	71	105
Tomatoes	134	145
Deciduous Orchard	316	349
Small Grain	323	272
Grapes	30	38
Subtropical Orchard	14	14
Subtotal	2,052	2,023
San Joaquin River Region		
Pasture	209	148
Alfalfa	281	193
Sugar Beets	57	43
Other Field Crops	271	274
Rice	20	14
Truck Crops	189	312
Tomatoes	168	151
Deciduous Orchard	448	472
Small Grain	189	164
Grapes	301	279
Cotton	497	470
Subtropical Orchard	46	49
Subtotal	2,676	2,569
Tulare Lake Region		
Pasture	21	9
Alfalfa	267	181
Sugar Beets	27	19
Other Field Crops	173	176
Rice	1	0
Truck Crops	92	205
Tomatoes	8	6
Deciduous Orchard	254	264
Small Grain	141	108
Grapes	248	244
Cotton	675	645
Subtropical Orchard	147	150
Subtotal	2,054	2,007
San Felipe Division		
Pasture and Hay	2	2
Other Field Crops	3	3
Vegetable	12	12
Tree and Vine	8	8
Subtotal	25	25
Total	**6,807**	**6,624**

NOTE:
All values in thousand acres.
SOURCE:
DWR (1994).

IRRIGATED LAND USE

Starting from DWR's 2020 baseline land use, the water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and SFD in Table III-2.

Dominant crops in the Sacramento River Region include rice, deciduous orchards, grains, and other field crops. The San Joaquin River Region includes a broad mix of crops, with cotton, deciduous orchards, and grapes having the largest acreage. The largest acreages in the Tulare Lake Region include cotton, deciduous orchards, and grapes. Alfalfa hay and grains show significant acreage in all three regions. Irrigated acreage shown for the SFD only includes lands directly served by CVP water. San Felipe acreage is dominated by vegetables, orchards and vineyards. A relatively low percentage is used for field crops, pasture, and hay.

GROSS REVENUE FROM IRRIGATED LANDS

Table III-3 summarizes the gross revenue, or value of production, by region and crop. Sacramento River Region accounts for just under 20 percent of the gross revenue in the Central Valley, with Tulare Lake Region at about 38 percent and San Joaquin River Region at about 43 percent.

Gross revenue shows the large influence of fruit and vegetable crops: truck crops, tomatoes, orchards, and vineyards especially. These crops account for over two-thirds of the value of irrigated production valley-wide. In the SFD, they account for over 95 percent of the gross revenue. Cotton and rice also produce significant revenue in the Central Valley. Although the direct value of other crops such as hay and grains is relatively low, they support linked sectors such as dairies, other livestock, and food processing. These linkages are discussed further in the Regional Economics Technical Appendix.

NET INCOME FROM IRRIGATED LANDS

Table III-4 shows the estimated net income associated with the irrigated crops in each region. Sacramento River Region with about 30 percent of acreage produces less than 20 percent of Central Valley net income due to the crop mix, yields, and prices received. San Joaquin River and Tulare Lake Regions each produce about 40 percent of net income in the Central Valley.

AGRICULTURAL WATER USE

Under the No-Action Alternative average condition, approximately 11.7 million acre-feet of surface water and 9.3 million acre-feet of groundwater is applied to irrigated lands in the Central Valley, for a total of about 21 million acre-feet. Surface water application declines in a dry condition, but groundwater pumping increases. Total application increases in a dry condition because less rainfall is available for crop demand - more consumptive demand must be met through irrigation. The opposite occurs in a wet condition. As a result of these factors, total water use during an average dry condition can remain fairly steady or even rise, as indicated in Table III-5. In dry years, irrigated acreage and farm revenue tends to decline by a smaller percentage than surface water supply.

TABLE III-2

IRRIGATED ACREAGE IN THE NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	165	160	165
Alfalfa	115	113	116
Sugar Beets	80	79	80
Other Field Crops	264	261	265
Rice	473	467	475
Truck Crops	105	105	105
Tomatoes	145	145	145
Deciduous Orchard	349	349	349
Small Grain	272	265	272
Grapes	37	37	37
Subtropical Orchard	14	14	14
Subtotal	2,019	1,995	2,023
San Joaquin River Region			
Pasture	147	145	146
Alfalfa	191	188	191
Sugar Beets	43	42	43
Other Field Crops	273	270	273
Rice	14	14	14
Truck Crops	311	311	311
Tomatoes	151	150	151
Deciduous Orchard	472	472	472
Small Grain	163	159	164
Grapes	279	279	279
Cotton	465	452	465
Subtropical Orchard	49	49	49
Subtotal	2,558	2,531	2,558
Tulare Lake Region			
Pasture	10	8	10
Alfalfa	181	172	183
Sugar Beets	19	19	19
Other Field Crops	177	170	177
Rice	0	0	0
Truck Crops	205	205	205
Tomatoes	6	6	6
Deciduous Orchard	264	264	264
Small Grain	108	102	109
Grapes	244	244	244
Cotton	646	620	649
Subtropical Orchard	150	150	150
Subtotal	2,010	1,960	2,016
San Felipe Division			
Pasture and Hay	2	2	2
Other Field Crops	3	2	3
Vegetable	12	9	12
Tree and Vine	8	8	8
Subtotal	25	20	25
Total	**6,612**	**6,506**	**6,622**

NOTE:
All values in thousand acres.

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TABLE III-3

GROSS REVENUE IN THE NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	24	23	24
Alfalfa	65	65	65
Sugar Beets	60	60	60
Other Field Crops	125	123	125
Rice	401	396	402
Truck Crops	397	397	397
Tomatoes	218	218	218
Deciduous Orchard	370	370	370
Small Grain	84	82	84
Grapes	65	65	65
Subtropical Orchard	20	20	20
Subtotal	1,829	1,819	1,830
San Joaquin River Region			
Pasture	32	32	32
Alfalfa	113	112	113
Sugar Beets	35	35	35
Other Field Crops	164	162	164
Rice	12	11	12
Truck Crops	1,869	1,868	1,869
Tomatoes	226	224	226
Deciduous Orchard	671	671	671
Small Grain	77	75	77
Grapes	553	553	553
Cotton	503	490	503
Subtropical Orchard	182	182	182
Subtotal	4,437	4,415	4,437
Tulare Lake Region			
Pasture	2	2	2
Alfalfa	111	107	112
Sugar Beets	16	16	16
Other Field Crops	107	103	108
Rice	0	0	0
Truck Crops	1,256	1,255	1,256
Tomatoes	9	9	9
Deciduous Orchard	411	411	411
Small Grain	62	58	63
Grapes	621	621	621
Cotton	713	685	716
Subtropical Orchard	584	584	584
Subtotal	3,892	3,851	3,898
San Felipe Division			
Pasture and Hay	0.8	0.3	0.8
Other Field Crops	2	1	2
Vegetable	75	52	75
Tree and Vine	11	11	11
Subtotal	89	64	89
Total	**10,247**	**10,149**	**10,254**

NOTE:
All values in million dollars/year.
San Felipe Division reported to greater precision due to magnitude of area.

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TABLE III-4

NET REVENUE IN THE NO-ACTION ALTERNATIVE

Region	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River	268	267	268
San Joaquin River	558	558	558
Tulare Lake	522	518	522
San Felipe Division	8	6	8
Total	**1,356**	**1,349**	**1,356**

NOTE:
All values in million dollars/year.

TABLE III-5

IRRIGATION WATER APPLIED IN THE NO-ACTION ALTERNATIVE

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	4,524	4,200	4,705
Groundwater	2,603	3,196	2,445
Total Applied	7,127	7,396	7,150
San Joaquin River			
Surface Water	4,453	3,879	4,852
Groundwater	3,427	4,446	2,856
Total Applied	7,880	8,325	7,708
Tulare Lake			
Surface Water	2,761	1,840	3,327
Groundwater	3,297	4,456	2,607
Total Applied	6,058	6,296	5,934
San Felipe Division (1)			
CVP Water	71	43	88
Total			
Surface Water	11,809	9,962	12,972
Groundwater	9,327	12,098	7,908
Total Applied	21,136	22,060	20,880

NOTES:
(1) Non-CVP supplies are not estimated for the San Felipe Division.

All values in thousand acre-feet/year.

The non-CVP water supplies in the SFD were not estimated, so only CVP supplies are shown in Table III-5.

Central Valley irrigation efficiency averages 70.4 percent, ranging from 66 percent in the Sacramento Valley to 73.8 percent in the Tulare Lake Region. (See Table III-6).

TABLE III-6

IRRIGATION WATER USE AND EFFICIENCY IN THE NO-ACTION ALTERNATIVE

Region	Applied Water (1,000 af)	ET of Applied Water (1,000 af)	Irrigation Efficiency (percentage)
Sacramento River	7,127	4,703	66.0
San Joaquin River	7,880	5,658	71.8
Tulare Lake	6,058	4,469	73.8
Total	**21,065**	**14,830**	**70.4**

NOTE:
Non-CVP supplies are not estimated for the San Felipe Division.

NO-ACTION ALTERNATIVE WITH NON-CVPIA WATER TRANSFERS

Water transfer impacts are assessed as a supplemental analysis to each PEIS alternative. To provide a basis for comparison, transfers are also assessed here under No-Action Alternative conditions. This transfer scenario uses results of the No-Action Alternative hydrologic analysis and uses transfer demands and potential supplies derived from the No-Action Alternative M&I and agricultural economics analyses.

The M&I demand functions used to estimate the demand for water transfer to M&I users were developed in the M&I economic analysis, as explained in the M&I Water Costs Methodology/Modeling Technical Appendix. These demand functions are incorporated into the Central Valley Production and Transfer Model (CVPTM). CVPTM is an extension of the CVPM, created to allow simulation of water transfers among agricultural users and from agricultural uses to M&I or fish and wildlife uses. CVPM and CVPTM are described in detail in the Agricultural Economics Methodology/Modeling Technical Appendix and the CVPTM Methodology/Modeling Technical Appendix, respectively.

The objectives of water transfer analysis are to:

- identify opportunities for water transfers and show how these opportunities change alternative implementation of CVPIA;
- indicate likely buying and selling regions and estimate relative price ranges for water sales in different regions;
- estimate the change in water use and the amount of land fallowing and crop revenue loss caused by the transfers; and
- estimate the cost of water acquisition for fish and wildlife (applies to CVPIA alternatives only).

Analysis is presented for average year conditions (using average 1922-1990 hydrology and M&I demands) and dry year conditions (using average 1928-1934 hydrology and M&I demands). The buying regions and relative price ranges for water sales are discussed in the M&I Water Use and Cost Methodology/Modeling Technical Appendix. The analysis presented here focuses on impacts to the agricultural sector, including:

- the amount of water transferred to or from agricultural use within broad regions
- the amount of land fallowed as a result of water transfers
- net revenue losses resulting from land fallowing
- receipts and gains from water transfers

Results shown here should be viewed as an example of the relative magnitude of these impacts. Actual water transfers occurring in the future will be determined by a number of specific conditions that cannot be predicted in a programmatic analysis.

The No-Action Alternative transfer scenario used 11 agricultural regions that are either potential buyers or sellers and 10 M&I regions that are potential buyers (aggregated to 4 for presenting results). Detailed assumptions for the No-Action Alternative transfer scenario are described in the Water Transfer Opportunities Technical Appendix and the CVPTM Methodology/Modeling Technical Appendix.

The results of the No-Action Alternative transfer scenario are presented in Table III-7. Under conditions assumed for the No-Action Alternative, total water transfers are estimated at 154,000 acre-feet in an average year and 1,021,000 acre-feet in a dry year. Most average year transfers are expected to be from the San Joaquin River and Tulare Lake regions to urban uses in the Central and South Coast regions. Transfers during dry years are much higher because of the generally higher M&I demand in the Central and South Coast, Bay Area, and Sacramento Valley regions.

Land fallowing as a result of water transfers in an average year is estimated to be 43,000 acres, or less than 1 percent of irrigated acreage in the Central Valley. Higher demands for transferred water in dry years increase the land fallowing to about 293,000 acres, or 5 percent of irrigated land. In general, major crops idled by transfers are pasture, hay, grain, field crops, rice, and cotton.

Anticipated change in net revenues to agricultural water users has been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. As expected for transactions between willing buyers and sellers, in all cases sellers would benefit from water transfers. Gains range from $11.5 million ($75 per acre-foot sold) in an average year to $143 million ($140 per acre-foot sold) in a dry year, when urban users bid up water prices to make up for shortfalls in supplies from their normal water sources. The estimates of gains to sellers do not include any cost of tilling, weed control, etc. that may be needed for temporarily fallowed land. If these activities cost $25 to $30 per acre, this would reduce the net gain per acre-foot by about $10. Significant variation in selling price and gains from sales can be expected within a region and between regions.

TABLE III-7

WATER TRANSFER ESTIMATES IN THE NO-ACTION ALTERNATIVE

Region	Agricultural Water Transfer (1) (1,000 acre-feet)		Land Fallowed as a Result of Transfer (2) (1,000 acre)		Receipts from Transfers (3) ($1,000)		Net Revenue Change (4) ($1,000)	
	Average	Dry	Average	Dry	Average	Dry	Average	Dry
Sacramento River	0	-561	0	-150	0	83,725	0	71,986
San Joaquin River	-6	-276	-2	-71	265	54,476	105	48,808
Tulare Lake	-148	-184	-42	-72	17,557	31,666	11,414	22,783
Total	**-154**	**-1,021**	**-44**	**-293**	**17,822**	**169,867**	**11,519**	**143,577**

NOTES:

(1) Negative number indicates water transferred out of the region; positive number indicates water transferred into the region.

(2) Negative number indicates decreased crop acreage due to water transferred out; positive number indicates increased crop acreage due to water transferred in.

(3) Positive number indicates revenue received for water transferred out; negative number indicates payment for water transferred in.

(4) Net revenue change represents the gains from trade in a region. For selling regions, this equals receipts from water sold (net of its cost) minus the net revenue lost from lower crop acreage. For buying regions, net revenue change equals net revenue from added crop acres plus the avoided cost of groundwater pumping minus payment for water purchased.

The San Felipe Division was not explicitly considered in the quantitative analysis of water transfer opportunities. It is not expected to be a seller of water but might participate as a buyer.

ALTERNATIVE 1

The following are the key features and assumptions of Alternative 1 that distinguish it from the No-Action Alternative.

Dedication of water for fish and wildlife purposes: Alternative 1 implements the CVPIA provisions for dedicating water for fish and wildlife restoration. This reallocation of project yield reduces supplies available for delivery to agricultural users.

CVP tiered water pricing: Section 3405(d) of the CVPIA requires that water rates charged to contractors be based on a tiered structure. The first 80 percent of contract total is charged at not less than the cost-of-service rate, the next 10 percent at not less than the average of cost-of-service and full cost (as defined in the Reclamation Reform Act), and water delivered above 90 percent of contract total at not less than the full-cost rate. Alternative 1 assumes that water rates are set using the minimum levels defined: cost-of-service and full cost.

Restoration Charges: A $6 per acre-foot restoration charge (1992 dollars) is imposed on all CVP agricultural water service contracts. In addition, CVPIA imposes a surcharge on deliveries to the Friant Division that increases over time to a maximum of $7 per acre-foot. For the year 2020 evaluation, the $7 per acre-foot surcharge is used for a total CVPIA charge of $13 ($1992) per acre-foot to Friant Division water users.

Ability to Pay: This analysis assumes that the policy remains in effect, and estimates appropriate water rates using payment capacities from a 1992 planning-level study prepared by Reclamation (1992b). This study estimated payment capacity (before district costs) at about $11 per acre-foot north of Delta and $70 per acre-foot for deliveries south of Delta. CVPIA also directs Reclamation to reduce some or all of the $6 per acre-foot restoration charge if payment capacity is exceeded. The implementation of tiered pricing under payment capacity limits assumes that only the restoration charge and principal on capital can be forgiven. The price increases in the higher price tiers are due to interest on capital, and are not forgiven under current policy. The result is that the ability to pay policy may reduce water price up to the restoration charge plus principal on capital, and the amount of the reduction is the same in each price tier.

Land Retirement Program: Alternative 1 assumes that 30,000 acres of irrigated land are retired in order to implement the San Joaquin Valley Drainage Program recommendations. This is in addition to the lands that DWR Bulletin 160-93 already assumed had been retired. These lands are on the west side and southern portion of the San Joaquin Valley, with about 14,400 acres in the San Joaquin River Region and 15,600 acres in the Tulare Lake Region.

IRRIGATED LAND USE

Starting from DWR's 2020 baseline land use, the water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the SFD and the three Central Valley regions and compared to the No-Action Alternative results in Table III-8 and Figure III-1.

Changes from the No-Action Alternative are largely determined by the assumed location of land targeted for the retirement program and by the location of water contractors most affected by the reallocation of project water. The San Joaquin River Region shows the largest decline in acreage, about 31,000 acres (1.2 percent), followed by Tulare Lake Region, which declines 15,600 acres (0.8 percent). Sacramento River Region shows a small decline of about 1,500 acres. Total reduction in the Central Valley is about 48,000 acres, less than 1 percent of irrigated acreage. However, the reductions are focused in areas receiving CVP water supply.

Tulare Lake Region's decline is due to the Land Retirement Program. San Joaquin River Region's decline results from a combination of the Land Retirement Program and additional fallowing due to reduced CVP delivery. The predominance of cotton as the crop most affected is largely a result of the areas targeted for retirement and those losing CVP delivery: both of these occur in areas where cotton is the predominant field crop. A decline of 28,400 acres represents about 2.5 percent of the No-Action Alternative cotton acreage in the Central Valley. In the Sacramento River Region, about 1,200 acres of rice account for most of the estimated acreage decline, but this is much less than 1 percent of rice acreage.

In the SFD, acreage declines by about 9,000 acres on average due to reduced CVP deliveries. This assumes that groundwater is not used to replace surface water on a long-term basis. Most of the decline is in vegetables and permanent crops because these dominate the irrigated acreage. This region does not have the flexibility to focus water supply reductions on field and forage crops.

Similar patterns of change are estimated under dry and wet conditions.

GROSS REVENUE FROM IRRIGATED LANDS

The Central Valley reduction in gross revenue is estimated to be $46 million per year. This estimate accounts for crop price increases expected to occur because production has declined. (Without this price increase, the gross revenue would decline another $3.9 million per year.)

Most of the decline is in cotton, consistent with the change in acreage. The total decline in value represents less than one half of one percent of the No-Action Alternative value. Table III-9 and Figure III-2 summarize the change from the No-Action Alternative in the gross revenue by region and crop.

Gross revenue in the SFD declines by more than 30 percent relative to land served by CVP water. Measured relative to all irrigated land in San Felipe, Santa Clara, and Santa Cruz counties, $31 million in lost production represents about a 7.5 percent loss (Census, 1994). The loss per acre is high because of the predominance of vegetables, orchards, and vineyards in the region.

TABLE III-8

IRRIGATED ACREAGE IN ALTERNATIVE 1 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	-0.3	-0.5	-0.2
Alfalfa	0.1	0.0	0.1
Sugar Beets	0.0	0.0	0.0
Other Field Crops	0.0	-0.1	-0.1
Rice	-1.2	-1.6	-1.3
Truck Crops	0.0	0.0	0.0
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	0.0	0.0	0.0
Small Grain	-0.1	0.1	-0.1
Grapes	0.0	0.0	0.0
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-1.5	-2.1	-1.6
San Joaquin River Region			
Pasture	-1.2	-0.9	-0.5
Alfalfa	-2.7	-2.8	-2.4
Sugar Beets	-0.2	-0.2	-0.2
Other Field Crops	-3.4	-3.1	-3.0
Rice	-0.1	0.0	-0.1
Truck Crops	-0.6	-0.6	-0.6
Tomatoes	-1.8	-1.7	-1.7
Deciduous Orchard	-0.1	0.1	-0.1
Small Grain	-1.9	-1.8	-1.8
Grapes	-0.1	-0.1	-0.1
Cotton	-18.7	-17.6	-18.0
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-30.8	-28.9	-28.5
Tulare Lake Region			
Pasture	-0.2	-0.2	-0.2
Alfalfa	-2.5	-2.7	-2.6
Sugar Beets	-0.2	-0.2	-0.2
Other Field Crops	-1.7	-1.7	-1.7
Rice	0.0	0.0	0.0
Truck Crops	-0.3	-0.2	-0.3
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	-0.1	-0.1	-0.1
Small Grain	-0.8	-0.9	-0.9
Grapes	-0.1	-0.1	-0.1
Cotton	-9.7	-10.0	-10.4
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-15.6	-16.1	-16.5
San Felipe Division			
Pasture and Hay	-0.7	-0.6	-0.4
Other Field Crops	-1.2	-1.1	-0.8
Vegetable	-4.4	-4.0	-2.8
Tree and Vine	-2.7	-2.7	-2.7
Subtotal	-9.0	-8.4	-6.7
Total	**-56.9**	**-45.9**	**-53.3**

NOTE:
All values in thousand acres.

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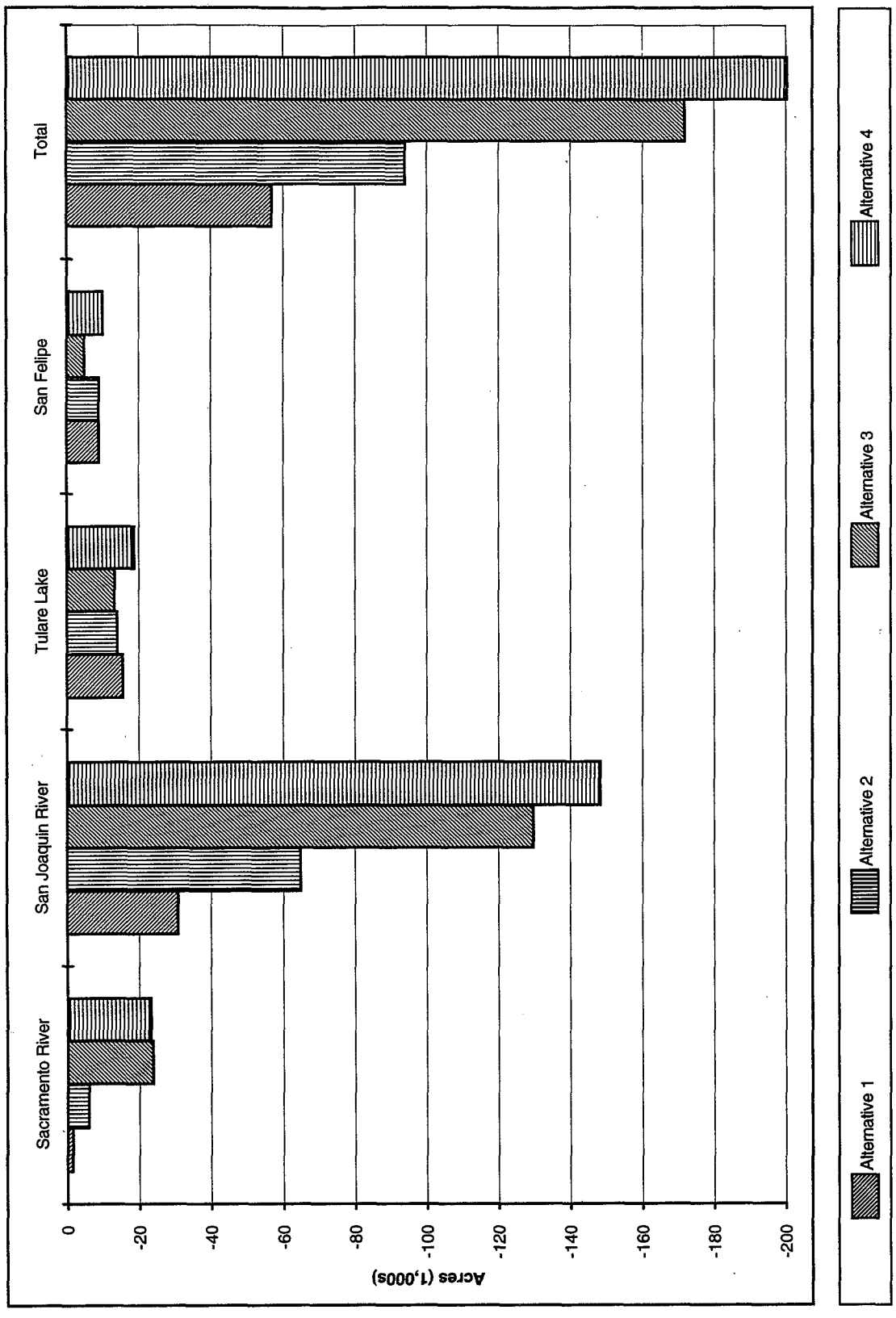

FIGURE III-1
IRRIGATED ACRES - ALTERNATIVES 1 THROUGH 4 AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990 AVERAGE CONDITION

TABLE III-9

GROSS REVENUE IN ALTERNATIVE 1 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.00	-0.05	0.00
Alfalfa	0.26	0.18	0.25
Sugar Beets	0.01	0.00	0.01
Other Field Crops	-0.02	-0.07	-0.03
Rice	-0.99	-1.36	-1.04
Truck Crops	0.03	0.02	0.03
Tomatoes	0.38	0.32	0.36
Deciduous Orchard	0.04	0.04	0.04
Small Grain	-0.02	0.02	-0.01
Grapes	0.01	0.01	0.01
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-0.30	-0.89	-0.38
San Joaquin River Region			
Pasture	-0.20	-0.17	-0.07
Alfalfa	-1.29	-1.43	-1.09
Sugar Beets	-0.15	-0.13	-0.15
Other Field Crops	-2.09	-1.89	-1.81
Rice	-0.07	-0.03	-0.07
Truck Crops	-3.44	-3.21	-3.38
Tomatoes	-2.33	-2.22	-2.26
Deciduous Orchard	-0.12	-0.12	-0.12
Small Grain	-0.98	-0.90	-0.90
Grapes	-0.04	-0.04	-0.04
Cotton	-20.54	-19.42	-19.72
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-31.25	-29.56	-29.61
Tulare Lake Region			
Pasture	-0.04	-0.05	-0.04
Alfalfa	-1.16	-1.38	-1.21
Sugar Beets	-0.13	-0.13	-0.14
Other Field Crops	-1.13	-1.11	-1.11
Rice	0.00	0.00	0.00
Truck Crops	-1.74	-1.35	-1.89
Tomatoes	-0.02	-0.02	-0.03
Deciduous Orchard	-0.11	-0.11	-0.11
Small Grain	-0.41	-0.51	-0.43
Grapes	-0.16	-0.16	-0.16
Cotton	-9.60	-10.04	-10.34
Subtropical Orchard	-0.03	-0.03	-0.03
Subtotal	-14.53	-14.89	-15.49
San Felipe Division			
Pasture and Hay	-0.14	-0.13	-0.09
Other Field Crops	-0.73	-0.66	-0.46
Vegetable	-26.58	-24.28	-16.88
Tree and Vine	-3.79	-3.79	-3.79
Subtotal	-31.24	-28.86	-21.22
Total	**-77.32**	**-74.20**	**-66.70**

NOTE:
All values million dollars/year.

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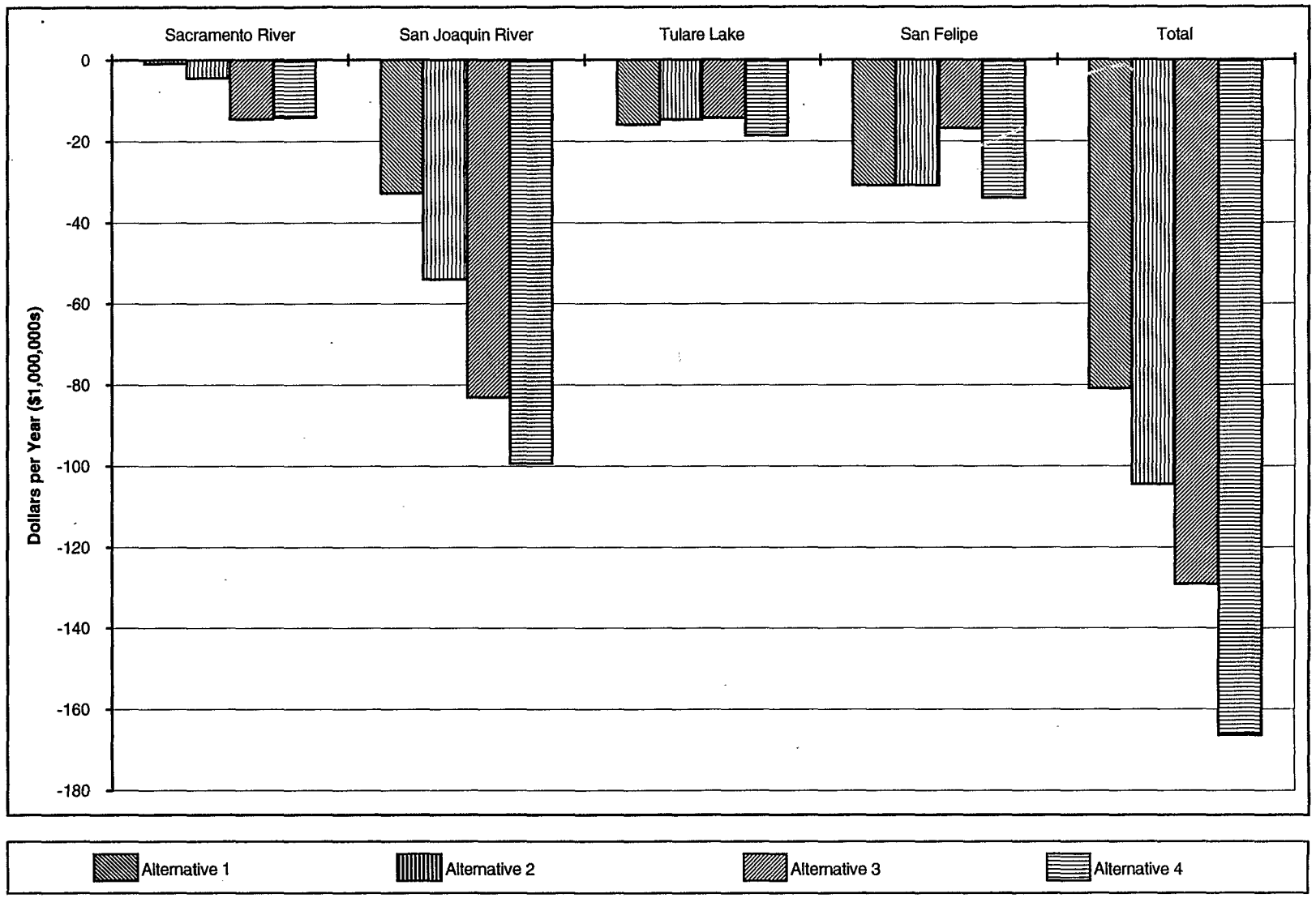

FIGURE III-2
GROSS REVENUE - ALTERNATIVES 1 THROUGH 4 AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990 AVERAGE CONDITION

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NET INCOME FROM IRRIGATED LANDS

Table III-10 shows the estimated change in net farm income associated with the irrigated crops in each region. The table includes estimates of several components:

- Net income from a change in acreage irrigated. This includes net income directly attributed to an increase or decrease in acreage, plus the effect of crop price changes on all lands in production. These two effects may move in the same or in opposite directions.
- Change in the cost of groundwater pumping.
- Change in the cost of irrigation systems and management.
- Change in the cost of CVP water, including tiered prices, restoration charge, and Friant-Kern surcharge.

TABLE III-10

CHANGE IN NET REVENUE IN ALTERNATIVE 1 AS COMPARED TO NO-ACTION ALTERNATIVE (1922-1990)

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Felipe Division	Total
Fallowed Land	0.6	-1.9	-0.4	-3.0	-4.8
Groundwater Pumping	-1.4	-18.0	2.1	0.0	-17.4
Irrigation Cost	-0.3	-3.8	-0.8	0.0	-4.8
CVP Water Cost	-0.3	-11.9	-16.5	-0.3	-29.0
Total Reduction	-1.4	-35.6	-15.6	-3.3	-56.0
Increase from Higher Crop Prices	1.1	1.6	1.2	0.0	3.9
Increase from Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase from Water Sales	0.0	0.0	0.0	0.0	0.0
Combined Net Revenue Change	-0.3	-33.1	-13.4	-3.3	-50.1

NOTE:
All values in million dollars/year.

Approximately 50 percent of the total reduction in net income is attributable to increased cost of CVP water. Another 30 percent is due to the cost of groundwater pumping. Increases in irrigation system costs and loss of net revenue account for about equal shares of the remaining loss.

Reductions in net income are partly offset by a $3.9 million increase for remaining lands due to higher crop prices, and by approximately $2 million in annual payment from the Land Retirement Program. The net income estimates are not detailed by crop because the analysis treats the farm

as an entire operation. Different water sources are not designated to specific crops, so an increase in water cost cannot be apportioned to individual crops.

AGRICULTURAL WATER USE

Water use reported here represents an estimate of the change in water actually applied to the field for crop growth, rather than diversions or deliveries to contractors. The numbers in Table III-11 represent the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region, and changes in groundwater use. Results for average conditions are also shown graphically in Figure III-3.

TABLE III-11

IRRIGATION WATER APPLIED IN ALTERNATIVE 1 AS COMPARED TO NO-ACTION ALTERNATIVE

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River			
Surface Water	-39	-95	-11
Groundwater	25	75	-3
Total Applied	-14	-20	-14
San Joaquin River			
Surface Water	-302	-282	-246
Groundwater	134	110	90
Total Applied	-168	-172	-156
Tulare Lake			
Surface Water	-22	1	-49
Groundwater	-44	-75	-19
Total Applied	-66	-74	-68
San Felipe Division (1)			
CVP Water	-18	-17	-13
Total			
Surface Water	-381	-393	-319
Groundwater	115	110	68
Total Applied	-266	-283	-251

NOTES:
(1) Non-CVP supplies are not estimated for the San Felipe Division.

All values in 1,000 acre-feet/year.

The net reduction in surface water delivered to the field of 363,000 acre-feet includes an overall decline in CVP water application of about 385,000 acre-feet and an increase of about 21,000 acre-feet in SWP agricultural delivery in Tulare Lake Region. The large majority of CVP water reduction occurs in the San Joaquin River Region, primarily in the San Luis and Delta-Mendota service areas on the west side of the region.

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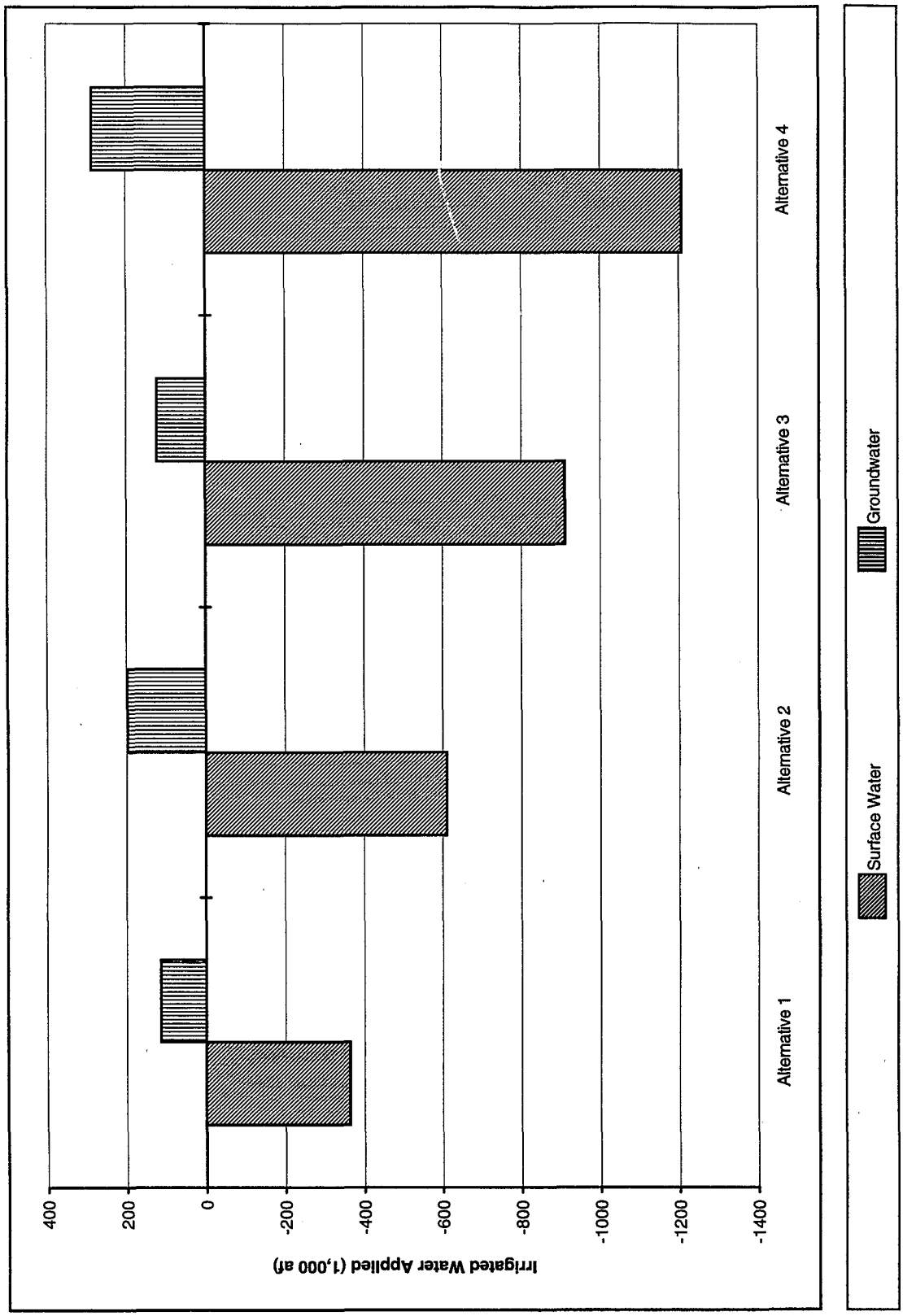

FIGURE III-3
IRRIGATION WATER APPLIED - ALTERNATIVES 1 THROUGH 4 AS COMPARED TO THE NO-ACTION ALTERNATIVE 1922-1990 AVERAGE CONDITION

Of the net 363,000 acre-feet loss of surface water in the Central Valley, about 155,000 acre-feet come from 48,000 acres of fallowed or retired lands, about 115,000 acre-feet are replaced from new groundwater pumping, and the remainder (about 93,000 acre-feet) comes from reduced irrigation losses including tailwater and deep percolation.

SFD loses about 18,000 acre-feet of CVP supply in the average condition, all of which, by assumption, comes from reduced application to crops.

Table III-12 shows average irrigation efficiency by region in the Central Valley. Average irrigation efficiency would remain about the same in the Sacramento River Region as in the No-Action Alternative, 66 percent. Only the San Joaquin River Region shows a change in irrigation efficiency, rising from 71.8 percent in the No-Action Alternative to 72.4 percent in Alternative 1. Valley-wide, the irrigation efficiency would rise only about 0.3 percent. Note that this also accounts for a reduction of over 28,000 acres of cotton, which is irrigated at 78 percent efficiency on average. In some subregions, efficiency actually declines because of the disproportionate reduction in cotton acreage relative to less efficiently irrigated crops.

TABLE III-12

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 1

Region	Applied Water (1,000 acre-feet)	ET of Applied Water (1,000 acre-feet)	Irrigation Efficiency (percentage)
Sacramento River	7,112	4,697	66.0
San Joaquin River	7,712	5,583	72.4
Tulare Lake	5,991	4,429	73.9
Total	20,815	14,709	70.7

NOTE:
Non-CVP supplies are not estimated for the San Felipe Division.

IMPACTS ON CONSUMERS OF IRRIGATED CROPS

Besides the direct impact on agricultural income, impacts on consumers of farm commodities are considered. Reduced production of farm goods, and the increase in their prices, result in a loss to consumers because more of their income must be spent on the goods and they may not be able to purchase as much as they would in the No-Action Alternative condition. This may occur both for final consumers of irrigated commodities and for businesses creating products that depend on irrigated agriculture for inputs, such as dairies and textile manufacturers.

For example, a reduction in Central Valley production of forage for dairy cattle means that California dairies will reduce production, substitute other feed, or import forage from other regions or states, at higher cost. Any of these responses will have some impact on price and supply of dairy products. A recent study of the impacts of the water supply reductions on the

supply of dairy products. A recent study of the impacts of the water supply reductions on the dairy industry estimated that importing hay from Nevada or Imperial County would raise the cost of hay by about 40 percent. The reduction in hay and pasture in Alternative 1 represents less than 1 percent of Central Valley production. If all the reduction is replaced by imported forage, forage cost would increase 0.4 percent (40 percent of 1 percent). Feed cost represents about 50 percent of total cost of milk production, so the impact on the cost of producing milk would be insignificant (much less than 1 percent). Localized impacts could be larger.

Another way of assessing effects on consumers is to estimate changes in consumer surplus, roughly defined as the net benefit to all consumers of a commodity. Consumers of farm commodities span a much wider area than the production regions used for other comparisons, so consumer surplus estimates are calculated for valley-wide changes in production only. These estimates do not attempt to account for production and surplus adjustments in other parts of the U.S. economy. Therefore, they represent only the most direct impacts on consumer surplus. Losses to consumers resulting from the reduced Central Valley agricultural production of Alternative 1 are estimated to be about $3.9 million per year. Additional losses would occur from reduced production in the SFD, although these losses have not been quantified.

FEDERAL COMMODITY PAYMENTS

Alternative 1 would decrease agricultural revenues from USDA farm programs because retired land would lose eligibility for farm program payments. These payments are counted as part of the gross and net revenue impacts to farmers, but also can be viewed as an expense to the federal government. Reductions in program payments are therefore savings to the federal treasury. Table III-13 shows Central Valley agricultural commodity acreage idled by Alternative 1 and the direct reduction of about $3.8 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. Most of the cost savings is associated with the retirement or permanent fallowing of cotton acreage. Some additional savings may also result indirectly from higher crop prices. SFD acreage eligible for farm program payments is quite small, and changes in payments resulting from Alternative 1 are negligible.

TABLE III-13

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 1

Region	Commodity Acreage Retired (1,000 acres)	Farm Program Cost Savings (million dollars/year)
Sacramento River	1.3	0.4
San Joaquin River	24.2	2.2
Tulare Lake	12.3	1.2
San Felipe Division	0.0	0.0
Total	**37.8**	**3.8**

The 1996 Farm Bill recently signed into law revises the way commodity payments are determined, and decouples the size of the payment from the actual production level. There remains, however, some uncertainty about how USDA will handle lands that are part of a grower's base acreage yet are retired or fallowed as CVPIA is implemented. For purposes of analysis, we assume that USDA will remove such lands from the grower's base acreage and reduce the deficiency payment accordingly.

VARIABILITY, RISK, AND UNCERTAINTY

The CVPIA may affect economic costs to water users through effects on the reliability of water supplies. Reliability involves variability, risk, and uncertainty.

Variability simply means that water supplies are not the same in every year. In the Sacramento Basin, during the 71 year period from 1922 to 1992, 16 years were classified as dry and another 11 years were classified as critical. Actual delivery depends on the pattern of hydrology and delivery over several years. The Surface Water Technical Appendix presents detailed estimates of the frequency of deliveries to agricultural users.

Risk means that not only do supplies vary, but that they cannot be predicted with certainty. Risk refers to future variable events (in this case water supply) that have a probability distribution that can be estimated. Typically, as in this analysis, the probability of different water supplies being available is based on a historical record of supplies.

Uncertainty describes a situation in which future water supplies are unknown and cannot be well predicted. This usually occurs either when no reliable historical record exists or when the conditions have changed so much that the historical record is no longer useful to predict future supplies. The uncertainty created by new laws, changing technology, or climatic change are examples.

Variable surface water supplies can be a substantial economic problem in irrigated agriculture. Farmers often must make important investment, planting, and marketing decisions before knowing their water supply. Water supply variability adds to other risks imposed by crop price, yield, and production cost variability. This section identifies some ways in which the CVPIA might affect variability, risk and uncertainty. Costs needed to eliminate increased variability in agricultural water supplies under Alternative 1 are estimated.

Variability and Risk

The cost of additional groundwater pumping capacity provides a measure of the cost of less reliable surface water supply. The analysis was done for all subregions, using surface water delivery information from the hydrologic analysis. Minimum surface water supplies were determined for the year of smallest delivery, and for the 2-year and 3-year running average. Table III-14 summarizes the results by region of the 2-year and 3-year periods in which minimum average surface water delivery was most different between Alternative 1 and the No-Action Alternative. The 2-year running average exhibits the largest difference between the No-Action Alternative and Alternative 1 for the San Joaquin River and Tulare Lake regions, but the 3-year difference is largest for Sacramento River Region. Results are not very different between the two

measures. Three subregions dominate the aggregate results, accounting for over 90 percent of the estimated cost. Two of these, the Westlands and Tehama-Colusa subregions, are described in detail in a section below. The other is the Delta-Mendota Service Area.

TABLE III-14

MINIMUM WATER DELIVERIES AND COST OF GROUNDWATER CAPACITY NEEDED TO ELIMINATE SHORTAGE IN ALTERNATIVE 1 AS COMPARED TO NO-ACTION ALTERNATIVE

Region/Item	Deliveries (1,000 acre-feet)			Cost of Capacity ($ Million/yr)
	No-Action Alternative	Alternative 1	Difference	
Sacramento River				
Minimum 2-Year Average	2140	2059	81	0.63
Minimum 3-Year Average	2215	2122	93	0.71
San Joaquin River				
Minimum 2-Year Average	1588	1205	389	4.50
Minimum 3-Year Average	1711	1379	58	4.03
Tulare Lake				
Minimum 2-Year Average	395	109	286	0.42
Minimum 3-Year Average	413	149	264	0.34
Total				
Minimum 2-Year Average	4220	3726	494	5.76
Minimum 3-Year Average	4538	4089	449	5.28

The last column of Table III-14 shows the estimated annualized capital cost needed to eliminate these shortages. Sacramento River Region costs would be $0.6 million to 0.7 million per year. San Joaquin River Region has by far the largest cost, $4 million to 4.5 million annually. Tulare Lake Region is less than $0.5 million per year. Note that these costs would occur every year to finance the investment, even though the additional capacity would only be used occasionally. This does not include the power and other variable costs of pumping the water.

Example assumptions used to arrive at these estimates are shown in Table III-15. Total drilling depth was assumed to range between 200 to 500 feet, depending on the region. This depth was estimated deeper than the current estimates of depth to groundwater to account for drawdown and depletion in a severe drought condition, the need to draw water from more than one aquifer layer, and the long-term decline in groundwater levels estimated for some regions in Alternative 1. Drilling plus pump cost was estimated to be $132 per foot drilled. Wells were assumed to produce 2,000 gallons per minute and run 1,500 hours during the season, producing about 550 acre-feet per well. The total cost of a well, pump and testing in the example calculation is $41,600. Well development costs were amortized assuming an 8 percent interest rate, and wells and pumps have an assumed life of 30 and 10 years, respectively.

TABLE III-15

ASSUMPTIONS USED TO ESTIMATE COST OF ADDITIONAL WELL CAPACITY TO ELIMINATE DOWNSIDE RISK

Variable	Assumptions
Well cost per foot ($/ft)	80
Depth of well (feet)	300
Well cost ($)	24,000
Well test cost ($)	2,000
Pump cost per foot ($)	52
Pump cost ($)	15,600
Total cost per well ($)	41,600
Annualized cost per well ($)	4,634
Water produced per well (acre-feet)	550

Long-Term Uncertainty

The CVPIA created a temporary increase in long-term uncertainty associated with water allocations because new allocation rules were not defined. This problem will be resolved once an alternative is selected for implementation. The CVPIA will shorten the duration of water supply contracts from 40 years to 25 years. This provision may increase long-term uncertainty associated with water allocation rules. However, there is currently no basis to determine if allocations will change in long-term contracts in a way that could increase costs of uncertainty.

Short-Term Uncertainty

Monthly and seasonal water allocation rules may change due the CVPIA in a way that could increase short-term uncertainty. For example, delays in the announcement of water deliveries can interfere in growers' planting and purchasing decisions. It is unclear whether CVPIA implementation will affect such uncertainty.

LAND VALUES

Value of irrigated land depends significantly upon the quantity and variability of the water supply available, and on the profitability of farming. The San Joaquin River Region has the largest potential reduction in land value. Its reduction in annual net income is estimated at $33.1 million per year spread over about 2.6 million acres, for a reduction in net income per acre of about $12.7 per year. A simple estimate of land value is to calculate the present value of the stream of profit earned on the land. Therefore, capitalizing this region's stream of lost income using 4 percent real interest rate, the average reduction in land value is about $320 per acre. The actual reduction would be greater in local areas most affected by higher water cost and reduced delivery, but some of this loss may be mitigated by payments for the Land Retirement Program. Land values could potentially increase in regions unaffected by reduced delivery or higher costs, a result of higher crop prices.

FINANCE AND CREDIT

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. Therefore, changes in conditions that reduce profit, increase risk, or reduce the value of land can be expected to reduce lenders' willingness to lend money or to increase the interest rate they charge. Archibald and Kuhnle (1992) reported that growers were finding it more difficult to get affordable credit because of reduced supply and increased cost and variability of water. That study also found evidence of increased scrutiny of water supplies by potential lenders. Although quantitative estimates are not available, it is probable that similar impacts will occur due to CVPIA implementation.

COSTS OF WATER CONSERVATION AND MEASUREMENT

Conservation and measurement costs may occur both at the farm and the district level. On-farm conservation costs are reflected in the irrigation cost estimates discussed above. District costs may result from either mandatory conservation requirements or discretionary conservation guidelines.

Attachment B summarizes the draft conservation guidelines issued by Reclamation to implement CVPIA, assesses the possible qualitative impacts on agriculture, and estimates potential costs associated with water measurement requirements. In summary, net costs of conservation provisions will probably not be significant for districts that already measure water to customers. With the exception of measurement, most mandatory provisions are either inexpensive or would be required even without the CVPIA. Discretionary provisions may be avoided if their costs are burdensome or far exceed the benefits.

For districts that do not currently measure delivery to each customer, the cost of achieving an acceptable accuracy of measurement could be significant. The estimated annual cost of the measurement hardware, based on the assumptions described in Attachment B, is $123 per turnout. The entire measurement program cost per turnout would be $470 to $670 per year. Depending on the acres served per turnout (typical areas are 20 to 200 acres), the cost per acre could range from $4 to $33 per year.

Typical production costs per acre range from $300 to $800 for row crops to over $2,000 for permanent crops. Therefore, new water measurement costs could be as high as 10 percent of production costs per acre in locations where low production costs coincide with unmeasured water deliveries to small fields. The cost of measurement is not expected to be significant on a regional basis, but costs could be important for some districts in the Sacramento Valley.

From a strict water balance perspective, the hydrologic benefits of the additional water conservation will not be significant at the regional level. Water quality benefits and crop yield benefits may occur.

CASE STUDY: WESTLANDS SUBREGION

Westlands Water District is the largest single water service contractor served by the CVP. It is in the San Luis Unit, served by CVP water exported from the Delta. Impacts from reductions in

water delivery and increased water cost fall most heavily on water service contractors. The purpose of this case study is to describe these impacts for one of the most affected contractors. Other water service contractors receiving CVP water from Delta export facilities would show similar kinds of impacts. Total impacts for the aggregated regions are documented in the regional summary discussed above.

The Westlands Subregion receives about 187,000 acre-feet less on average in Alternative 1 compared to the No-Action Alternative. In the dry condition, the difference in delivery is 189,000 acre-feet, and in the wet condition 123,000 acre-feet. A combination of acreage reduction, groundwater pumping, and modest irrigation efficiency increases accounts for the loss of surface delivery. Land fallowed (or retired as part of the Land Retirement Program) is about 25,000 acres, or about 5 percent of average No-Action Alternative irrigated acres. Groundwater pumping increases by 105,000 acre-feet on average, fallowed and retired land reduces water application by about 75,000 acre-feet, and irrigation adjustments save another 7,000 acre-feet. The additional groundwater pumping would contribute to the overdraft condition and is not sustainable over the very long term. Increased average condition pumping also reduces the availability of groundwater to supplement surface supply during drought. Impacts on groundwater levels and subsidence are discussed in the Groundwater Technical Appendix.

Gross revenue is estimated to decline about $28 million per year on average, with similar declines in dry and wet years. This represents about a 2 percent reduction compared to the No-Action Alternative. Net revenue declines about $25.5 million, or about 22 percent of the No-Action Alternative estimate. Increased groundwater cost represents the largest part of the loss, $15.6 million, which includes the cost of pumping an additional 105,000 acre-feet plus the incremental cost increase on all pumping because of greater lifts. CVP water cost accounts for about $6.5 million on average, and loss of net revenue on fallowed and retired land is about $2.4 million in an average year. Irrigation improvements cost another $1 million per year to achieve.

In addition to the average year costs, increased variability of CVP water supply imposes a cost. Using the approach described above for the Central Valley as a whole, the cost of installing additional groundwater capacity to account for the lowest CVP water supply was estimated. Minimum CVP water supplies were determined for the year of smallest delivery, and for the 2-year and 3-year running average. Depending on which of these three values is used as a target, the annual cost of building capacity ranges from $3 million to 4 million per year, as shown in Table III-16. This cost occurs every year, not just in years where the extra capacity actually gets used, and does not include the variable cost of pumping.

CASE STUDY: TEHAMA-COLUSA SUBREGION

The Tehama-Colusa Canal (TCC) Service Area serves CVP water from the Sacramento River to water service contractors along the west side of the Sacramento Valley. Impacts from reductions in water delivery and increased water cost fall most heavily on water service contractors. The purpose of this case study is to describe these impacts for one of the most affected areas north of the Delta. The Tehama-Colusa Subregion encompasses most, though not 100 percent, of the TCC Service Area. Other water service contractors receiving CVP water north of Delta would show similar kinds of impacts. Total impacts for the aggregated regions are documented in the regional summary discussed above.

TABLE III-16

COST OF GROUNDWATER NEEDED TO ELIMINATE SHORTAGE, WESTLANDS SUBREGION

Item	Deliveries (1,000 acre-feet)			Cost of Capacity (Million $/yr)
	No-Action Alternative	Alternative 1	Difference	
Minimum Annual	250	39	211	2.92
Minimum 2-Year Average	395	109	286	3.96
Minimum 3-Year Average	413	149	264	3.65

The Tehama-Colusa Subregion receives about 21,000 acre-feet less on average in Alternative 1 compared to the No-Action Alternative. In the dry condition, the difference between Alternative 1 and No-Action Alternative delivery is 54,000 acre-feet, and in the wet condition about 1,000 acre-feet. A combination of groundwater pumping and modest amounts of land fallowing and irrigation efficiency increases accounts for the loss of surface delivery. Less than 300 acres are fallowed according to the estimate, accounting for less than 1,000 acre-feet. Groundwater pumping increases by about 17,000 acre-feet on average, and irrigation adjustments save another 3,000 acre-feet. Variations in CVP supply in dry and wet conditions are estimated to be made up by groundwater pumping.

Gross revenue is estimated to decline about $63,000 per year on average, much less than 1 percent of the No-Action Alternative value. Net revenue declines about $0.8 million, or about 7 percent of the No-Action Alternative estimate. Increased groundwater cost accounts for almost the entire loss, $0.7 million, which includes the cost of pumping an additional 17,000 acre-feet plus the incremental cost increase on all pumping because of greater lifts. CVP water cost is virtually unchanged, because the assumed ability-to-pay policy provides relief from both capital repayment and the restoration charge. Irrigation improvements cost another $0.1 million per year to achieve.

In addition to the average year costs, increased variability of CVP water supply imposes a cost. Using the approach described above for the Central Valley as a whole, the cost of installing additional groundwater capacity to account for the lowest CVP water supply was estimated. Minimum CVP water supplies were determined for the year of smallest delivery, and for the 2-year and 3-year running average. Depending on which of these three values is used as a target, the annual cost of building capacity ranges from $0.3 million to 0.5 million per year, as seen in Table III-17. This cost occurs every year, not just in years where the extra capacity actually gets used, and does not include the variable cost of pumping.

TABLE III-17

COST OF GROUNDWATER NEEDED TO ELIMINATE SHORTAGE, TEHAMA-COLUSA CANAL SUBREGION

Item	Deliveries (1,000 acre-feet)			Cost of Capacity (Million $/yr)
	No-Action Alternative	Alternative 1	Difference	
Minimum Annual	41	4	37	0.31
Minimum 2-Year Average	78	25	52	0.44
Minimum 3-Year Average	90	32	58	0.49

SUPPLEMENTAL ANALYSIS 1a : DEDICATED WATER WITH DELTA COMPONENT

Assumptions

Under the main Alternative 1, the CVP's share of incremental water costs to meet the 1994 Bay-Delta Accord is considered to be part of the 800,000 acre-feet of CVPIA dedicated water. Alternative 1 also provides that the remaining dedicated water can be used, as needed, to meet instream flow requirements for CVP-controlled streams. This supplemental analysis examines the incremental effects of prescribing a portion of the dedicated water for Delta purposes. This reduces the volume of dedicated water released for instream flow north of Delta that can be pumped for agricultural delivery south of the Delta.

Incremental agricultural impacts are assessed for surface water use, groundwater pumping, irrigated acres, the cost of CVP water and groundwater, gross revenue, and net revenue.

Results

The results of the dedicated water with Delta component analysis are presented for average year conditions in Table III-18. The table shows a direct comparison of the supplemental analysis results with the main Alternative 1.

The principal impact on water delivery would occur in the Delta-Mendota and San Luis service areas, which fall in the San Joaquin River Region. Of the 84,000 acre-feet total reduction in water deliveries, 74,000 acre-feet would occur in this region. The remaining 6,000 acre-feet reduction would be in the Tulare Lake Region, from reductions in Cross Valley Canal delivery.

It is estimated that project water deliveries would be replaced by increased groundwater pumping. The increased reliance on groundwater would result in increased pumping costs of 3 percent in the San Joaquin River Region and 0.6 percent in the Tulare Lake Region. This would lead to net revenue losses of about 0.4 and 0.2 percent in the San Joaquin River and Tulare Lake regions, respectively. Total increase in cost of groundwater is about $7 million on average, partly offset by a $4 million reduction in payments for CVP water that is no longer delivered.

TABLE III-18

SUPPLEMENTAL ANALYSIS 1a RESULTS AS COMPARED TO ALTERNATIVE 1

Item/Region	Change	Percent Change
CVP Water Use (1,000 acre-feet)		
Sacramento River	0	0.0
San Joaquin River	-74	-7.9
Tulare Lake	-6	-0.6
San Felipe Division	-4	-8.3
Total	-84	-3.2
Groundwater Use (1,000 acre-feet)		
Sacramento River	0	0.0
San Joaquin River	74	2.0
Tulare Lake	6	0.2
San Felipe Division	0	0
Total	80	0.8
Irrigated Acreage (1,000 acres)		
Sacramento River	0	0.0
San Joaquin River	0	0.0
Tulare Lake	0	0.0
San Felipe Division	-2	-12.5
Total	-2	0.0
CVP Water Cost ($ Million)		
Sacramento River	0	0.0
San Joaquin River	-4	-8.5
Tulare Lake	0	-0.0
San Felipe Division	-0.2	-8.3
Total	-4	-4.7
Groundwater Cost ($ Million)		
Sacramento River	0	0.0
San Joaquin River	6	3.0
Tulare Lake	1	0.6
San Felipe Division	0	0.0
Total	7	1.4
Gross Revenue ($ Million)		
Sacramento River	0	0.0
San Joaquin River	-1	0.0
Tulare Lake	0	0.0
San Felipe Division	-8	-14.0
Total	-9	0.0
Net Revenue ($ Million)		
Sacramento River	0	0.0
San Joaquin River	-2	-0.4
Tulare Lake	-1	-0.2
San Felipe Division	-1	-20.0
Total	-4	-0.2

NOTE:
San Felipe Division reported to greater precision due to magnitude of area.

SUPPLEMENTAL ANALYSIS 1c : FULL-COST-PLUS TIERED PRICING

Assumptions

The main analysis of Alternative 1 implements tiered water pricing as set forth in Section 3405(d) of the CVPIA. The first 80 percent of contract total is charged the Cost-of-Service rate, tiering up to the Full Cost rate. This supplemental analysis evaluates the additional impact of charging Full Cost rate for the first 80 percent of contract total, with the next 10 percent of contract total priced at 10 percent higher than Full Cost, and the final 10 percent of contract priced at 20 percent higher than Full Cost. Terms are defined as follows:

- **Cost of Service** includes O&M, accumulated O&M deficit (if any), and repayment of principal on capital (plus interest payment for M&I contracts).
- **Full Cost** includes all components of cost of service plus interest on capital, as defined in the Reclamation Reform Act.
- **Contract Total** is the maximum water delivery provided by the contract.

Incremental agricultural impacts are assessed for surface water use, groundwater pumping, irrigated acres, the cost of CVP water and groundwater, gross revenue, and net revenue.

Results

The results of the full-cost-plus tiered pricing analysis are presented for average year conditions in Table III-19. The table shows a direct comparison of the supplemental analysis results to the main Alternative 1.

The imposition of full-cost-plus pricing is estimated to reduce total CVP water purchases by about 570,000 acre-feet on average. Reductions are mostly in the Sacramento River and San Joaquin River Regions. Some CVP water service contractors that receive water from the Tehama-Colusa, Delta-Mendota, and Friant-Kern Canals and the New Melones Reservoir are unable to afford some or all of their CVP water. Sacramento River Region reductions would be mainly met through land fallowing, while those in the San Joaquin River Region would be mostly from a shift to groundwater.

Net revenues to agriculture in the Sacramento River and Tulare Lake regions are estimated to drop by about 2 percent with the imposition of full cost tiered water pricing. San Joaquin River Region agriculture would experience a net revenue reduction on the order of 10 percent. The higher San Joaquin losses are attributed to the higher groundwater pumping costs.

TABLE III-19

SUPPLEMENTAL ANALYSIS 1c RESULTS AS COMPARED TO ALTERNATIVE 1

Item/Region	Change	Percent Change
CVP Water Use (1,000 acre-feet)		
Sacramento River	-199	-33.6
San Joaquin River	-354	-37.8
Tulare Lake	-17	-1.8
San Felipe Division	0	0.0
Total	-570	-23.1
Groundwater Use (1,000 acre-feet)		
Sacramento River	0	0.0
San Joaquin River	320	8.9
Tulare Lake	17	0.5
San Felipe Division	0	0.0
Total	337	3.6
Irrigated Acreage (1,000 acres)		
Sacramento River	-56	-2.8
San Joaquin River	-6	-0.2
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	-62	-0.9
CVP Water Cost ($ Million)		
Sacramento River	-2	-19.2
San Joaquin River	3	5.6
Tulare Lake	9	23.2
San Felipe Division	4.6	163.1
Total	15	10.7
Groundwater Cost ($ Million)		
Sacramento River	0	0.0
San Joaquin River	21	10.9
Tulare Lake	1	0.6
San Felipe Division	0	0.0
Total	22	4.6
Gross Revenue ($ Million)		
Sacramento River	-28	-1.5
San Joaquin River	-2	-0.1
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	-30	-0.3
Net Revenue ($ Million)		
Sacramento River	-3	-1.0
San Joaquin River	-25	-4.0
Tulare Lake	-10	-2.0
San Felipe Division	-4.6	86.0
Total	-43	-3.0

NOTE:
San Felipe Division reported greater precision due to magnitude of area.

SUPPLEMENTAL ANALYSIS 1d : NO SHORTAGES ON LEVEL 2 REFUGE DELIVERY

Assumptions

The main Alternative 1 assumed that CVP Level 2 deliveries to wildlife refuges were subject to shortages up to 25 percent. This supplemental analysis estimates the incremental impacts on agriculture if refuges receive no shortages in Level 2 delivery.

Incremental agricultural impacts are assessed for surface water use, groundwater pumping, irrigated acres, the cost of CVP water and groundwater, gross revenue, and net revenue.

Results

Results of the analysis are presented in Table III-20. The table shows a direct comparison of the supplemental analysis results with the main Alternative 1.

The San Joaquin River Region would bear most of the impacts of this action. Deliveries from the Delta-Mendota and San Luis canals would be reduced by about 25,000 acre-feet. Impact on deliveries in the Sacramento River and Tulare Lake regions would be less than 5,000 acre-feet each.

Most delivery reductions in the three regions are expected to be replaced by pumping groundwater. Net revenue declines about $1 million per year in San Joaquin River Region. Impacts to net revenues are minor in the other two regions.

SUPPLEMENTAL ANALYSIS 1e : WATER TRANSFER OPPORTUNITIES

Assumptions

The supplemental analysis of water transfers without fees is based upon most of the same assumptions as in the No-Action Alternative transfers scenario. The major differences are the use of Alternative 1 hydrology and water pricing and the assumption that all CVP water is now transferable, but with specific costs imposed. These costs and assumptions are detailed in the Municipal Water Costs and Water Transfer Opportunities Technical Appendices.

Results shown here should be viewed as an example of the relative magnitude of the impacts of CVPIA on water transfers. Actual water transfers occurring in the future will be determined by a number of specific conditions that cannot be predicted in a programmatic analysis.

Results

The results of Supplemental Analysis 1e are presented in Table III-21. The total average year transfer is estimated to be 159,000 acre-feet, which is slightly higher than in the No-Action Alternative. This increase is primarily the result of additional transfer demand by CVP contractors. Estimated dry year transfers, however, are about 100,000 acre-feet lower than those

TABLE III-20

SUPPLEMENTAL ANALYSIS 1d RESULTS AS COMPARED TO ALTERNATIVE 1

Item/Region	Change	Percent Change
CVP Water Use (1,000 acre-feet)		
Sacramento River	-4	-0.7
San Joaquin River	-25	-2.7
Tulare Lake	-2	-0.2
San Felipe Division	0	0.0
Total	-31	-1.3
Groundwater Use (1,000 acre-feet)		
Sacramento River	4	0.2
San Joaquin River	25	0.7
Tulare Lake	2	0.0
San Felipe Division	0	0.0
Total	31	0.3
Irrigated Acreage (1,000 acres)		
Sacramento River	0	0.0
San Joaquin River	0	0.0
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	0	0.0
CVP Water Cost ($ Million)		
Sacramento River	0	0.0
San Joaquin River	-1	-0.8
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	-1	-0.5
Groundwater Cost ($ Million)		
Sacramento River	0	0.0
San Joaquin River	2	0.7
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	2	0.3
Gross Revenue ($ Million)		
Sacramento River	0	0.0
San Joaquin River	0	0.0
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	0	0.0
Net Revenue ($ Million)		
Sacramento River	0	0.0
San Joaquin River	-1	-0.2
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	-1	-0.1

TABLE III-21

SUPPLEMENTAL ANALYSIS 1e RESULTS AS COMPARED TO ALTERNATIVE 1

Region	Agricultural Water Transfer (1) (1,000 acre-feet)		Land Fallowed as a Result of Transfer (2) (1,000 acres)		Receipts from Transfers (3) ($1,000)		Net Revenue Change (4) ($1,000)	
	Average	Dry	Average	Dry	Average	Dry	Average	Dry
Sacramento River	-5	-268	-1	-62	269	19,587	228	15,091
San Joaquin River	-14	-303	-4	-82	980	38,067	380	30,599
Tulare Lake	-140	-343	-39	-112	15,535	59,525	10,059	45,069
Total	-159	-914	-44	-256	16,784	117,179	10,667	90,759

NOTES:

(1) Negative number indicates water transferred out of the region; positive number indicates water transferred into the region.

(2) Negative number indicates decreased crop acreage due to water transferred out; positive number indicates increased crop acreage due to water transferred in.

(3) Positive number indicates revenue received for water transferred out; negative number indicates payment for water transferred in.

(4) Net revenue change represents the gains from trade in a region. For selling regions, this equals receipts from water sold (net of its cost) minus the net revenue lost from lower crop acreage. For buying regions, net revenue change equals net revenue from added crop acres plus the avoided cost of groundwater pumping minus payment for water purchased.

The San Felipe Division was not explicitly considered in the quantitative analysis of water transfer opportunities. It is not expected to be a seller of water but might participate as a buyer.

for the Base Transfer Scenario. This is a result of the availability of CVP water closer to the point of M&I demand, which reduces conveyance losses and water contributed to Delta outflow. In other words, the water received by purchasers is about the same in both water transfer analyses, but under 1e, buyers can buy CVP water closer to home and therefore avoid some of the transport losses.

Land fallowed as a result of water transfers in an average year is estimated to be 43,000 acres, or less than 1 percent of irrigated acreage in the Central Valley. In general, crop lands idled by transfers are estimated to be pasture, hay, grain, field crops, rice, and cotton. Higher demands for transferred water in dry years would increase the land fallowing to about 255,000 acres, or about 4 percent.

Anticipated change in net revenues to agricultural water users has been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. As expected for transactions among willing buyers and sellers, in all cases sellers would benefit from water transfers. Gains would range from $10.7 million ($40 to $70 per acre-foot sold) in an average year to $90.7 million ($45 to $130 per acre-foot sold) in a dry year, when urban users would bid up water prices to make up for shortfalls in supplies from their normal water sources. These estimates are lower than those reported in the Base Transfer Scenario because with the provision for CVP water transfer more water is available for transfer, so there is more price competition among sellers. The estimates of gains to sellers do not include any cost of tilling, weed control, etc. that may be needed for temporarily fallowed land. If these activities cost $25 to $30 per acre, this would reduce the net gain per acre-foot by about $10. Significant variation in selling price and gains from sales can be expected within a region and between regions.

The estimates above focus on interregional transfers. Local transfers within a region are not included in these estimates, but would not have the system-wide implications and impacts that interregional transfers are likely to have. The ability to transfer water to other regions may reduce local transfers by increasing the competition for water.

SUPPLEMENTAL ANALYSIS 1f : WATER TRANSFER OPPORTUNITIES WITH $50-PER-ACRE-FOOT FEE

The CVPIA requires the Secretary of the Interior to evaluate the level of collections to the Restoration Fund and, if total collections do not equal $50 million on an average annual basis, to impose in 1998, and every year thereafter, such changes, subject to subsection 3407(d), as may be required to bring total fund revenues up to the $50 million level on a 3-year rolling average basis. The imposition of a $50 per acre-foot fee on all CVP water transfers was identified during alternatives development as one possible way of increasing contributions to the Restoration Fund, if needed.

The $50 fee on CVP transfers would result in fewer opportunities for CVP contractors to sell water. The fee would eliminate most or all of the locational advantage some CVP water might offer to potential buyers, who would then be more likely to buy non-CVP water. The impact of the fee on interregional transfers to agricultural buyers is minor as estimated by the water transfer analysis, because few interregional agricultural trades are estimated to occur. However, many of the transfers between CVP buyers and sellers are likely to occur within a region, where transport

and transactions costs are small. A $50-per-acre-foot fee on these kinds of transactions would virtually eliminate them, because additional groundwater pumping or non-CVP surface water would be much cheaper options for the potential buyer.

SUPPLEMENTAL ANALYSIS 1g : NO ABILITY-TO-PAY LIMITS

Assumptions

Ability-to-pay is a long-standing Reclamation policy that provides relief of all or part of capital repayment responsibility for CVP irrigation water users in cases where estimated farm income is insufficient to cover normal CVP irrigation water costs after allowance for returns to farm investment, production costs, and management. The estimate is based on conditions facing a representative commercial farming operation. CVPIA also provides for reduction of restoration charges if water users are unable to pay it based on an analysis by Reclamation.

This supplemental analysis assesses the impacts of eliminating ability-to-pay relief for capital repayment. Ability-to-pay guidelines are still applied to CVPIA restoration fund charges, as provided in Section 3407(d)(2)(A). All other assumptions of Alternative 1 are maintained. The analysis estimates the effects of removing the ability-to-pay policy on: CVP water use, groundwater pumping, irrigated acres, surface water and groundwater cost, and gross and net crop revenues.

Results

Results for average water year conditions are presented in Table III-22. The table shows a direct comparison of the supplemental analysis results with the main Alternative 1.

Reductions in total demand for CVP water resulting from removal of the ability-to-pay policy are estimated to be about 25,000 acre-feet per year. These reductions would occur primarily in areas served by the Tehama-Colusa, Delta-Mendota, and Madera canals and the New Melones Reservoir. Demand reductions in the Sacramento River Region would result in increased groundwater pumping and land fallowing, while those in the San Joaquin River Region would result primarily in increased groundwater pumping. Pumping costs would increase about $0.8 million per year. Groundwater pumping cost increases would be minor in the other two regions.

Water costs to some agricultural water users, especially in the Sacramento River Region, would be substantially increased. Based on the regional estimates of payment capacity available, the Tulare Lake Region would not receive price relief from the ability-to-pay policy, and therefore its removal in this scenario has no impact. Impact in the San Joaquin River Region is primarily in the New Melones Service Area, plus reductions in purchases of water from the higher priced tiers in the Madera Canal Service Area.

The large increase in CVP water cost in the Sacramento River Region results in a $6 million per year decline in net revenue. Another $1 million reduction is estimated in the San Joaquin River Region, from a combination of higher CVP and groundwater cost.

TABLE III-22

SUPPLEMENTAL ANALYSIS 1g RESULTS AS COMPARED TO ALTERNATIVE 1

Item/Region	Change	Percent Change
CVP Water Use (1,000 acre-feet)		
Sacramento River	-11.1	-1.9
San Joaquin River	-13.3	-1.4
Tulare Lake	0.0	0.0
San Felipe Division	0.0	0.0
Total	-24.4	-1.0
Groundwater Use (1,000 acre-feet)		
Sacramento River	1.2	0.0
San Joaquin River	12.8	0.4
Tulare Lake	0.0	0.0
San Felipe Division	0.0	0.0
Total	14.0	0.1
Irrigated Acreage (1,000 acres)		
Sacramento River	-1.8	-0.1
San Joaquin River	0.0	0.0
Tulare Lake	0.0	0.0
San Felipe Division	0.0	0.0
Total	-1.8	0.0
CVP Water Cost ($ Million)		
Sacramento River	5.9	75.6
San Joaquin River	0.1	0.2
Tulare Lake	0.0	0.0
San Felipe Division	0.0	0.0
Total	6.0	6.4
Groundwater Cost ($ Million)		
Sacramento River	0.0	0.0
San Joaquin River	0.8	0.4
Tulare Lake	0.0	0.0
San Felipe Division	0.0	0.0
Total	0.8	0.2
Gross Revenue ($ Million)		
Sacramento River	-0.2	0.0
San Joaquin River	0.0	0.0
Tulare Lake	0.0	0.0
San Felipe Division	0.0	0.0
Total	-0.2	0.0
Net Revenue ($ Million)		
Sacramento River	-6.0	-2.2
San Joaquin River	-1.0	-0.1
Tulare Lake	0.0	0.0
San Felipe Division	0.0	0.0
Total	-7.0	-0.4

ALTERNATIVE 2

Provisions of CVPIA implemented in Alternative 2 include all features of Alternative 1 plus the acquisition of water for in-stream flow and wildlife refuges. By assumption, b(3) water is acquired from willing agricultural sellers who would reduce acreage to provide water for sale, and acquisition is limited to an amount achievable within the limits of the Restoration Fund. In order to prevent groundwater replacement of acquired surface water, the analysis attempted to hold groundwater pumping to no more than the Alternative 1 level in subregions where water is acquired.

IRRIGATED LAND USE

Starting from DWR's 2020 baseline land use, the water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and the SFD and compared to the No-Action Alternative in Table III-23 and in Figure III-1.

Changes from the No-Action Alternative are determined by land targeted for the retirement program and by the dedicated water, as in Alternative 1, plus lands fallowed due to water acquisition. The San Joaquin River Region shows the largest decline in acreage, about 65,000 acres (2.5 percent), followed by Tulare Lake Region, which declines 14,000 acres (0.7 percent). Sacramento River Region shows a decline of about 6,000 acres (0.3 percent). Total reduction in the Central Valley is about 85,000 acres, or about 1.3 percent of the irrigated acreage in the No-Action Alternative.

San Joaquin River Region's decline results from a combination of the Land Retirement Program, additional fallowing due to reduced CVP delivery, and fallowing due to water acquisition. The predominance of cotton as the crop most affected is largely a result of the areas targeted for retirement and those losing CVP delivery: both of these occur in areas where cotton is the predominant field crop. A decline of 34,800 acres represents about 3 percent of No-Action Alternative cotton acreage in the Central Valley. Pasture, alfalfa hay, and field crops decline primarily as part of east side water acquisition. In the Sacramento River Region, about 4,300 acres of rice (less than 1 percent) account for most of the estimated acreage decline.

Tulare Lake Region's decline is due to the Land Retirement Program. Acreage actually declines less in Alternative 2 than in Alternative 1. This estimate occurs because the additional land fallowed for water acquisition creates an economic incentive for the fallowed crops to shift to other regions. In other words, even though land has been fallowed for water acquisition, the demand for the crops grown on that land still exists, and some of that demand gets met by lands in other regions. Similar patterns of change are estimated under dry and wet conditions.

SFD changes are similar to Alternative 1.

GROSS REVENUE FROM IRRIGATED LANDS

Central Valley reduction in gross revenue is estimated to be $66.5 million per year. This estimate accounts for crop price increases expected to occur because production has declined.

TABLE III-23

IRRIGATED ACREAGE IN ALTERNATIVE 2 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.4	-0.2	0.3
Alfalfa	0.0	-0.2	0.0
Sugar Beets	-0.1	-0.1	-0.1
Other Field Crops	-1.0	-1.3	-1.0
Rice	-4.3	-5.0	-4.8
Truck Crops	0.0	0.0	0.0
Tomatoes	-0.1	-0.2	-0.1
Deciduous Orchard	0.0	0.0	0.0
Small Grain	-0.7	-0.9	-0.7
Grapes	0.0	0.0	0.0
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-5.8	-7.9	-6.1
San Joaquin River Region			
Pasture	-12.4	-12.3	-11.4
Alfalfa	-9.8	-10.0	-9.2
Sugar Beets	-0.4	-0.4	-0.4
Other Field Crops	-8.9	-8.9	-8.4
Rice	-0.9	-0.9	-0.8
Truck Crops	-0.7	-0.7	-0.7
Tomatoes	-2.3	-2.2	-2.2
Deciduous Orchard	-0.7	-0.7	-0.7
Small Grain	-2.9	-3.3	-2.6
Grapes	-0.3	-0.3	-0.3
Cotton	-25.5	-24.6	-24.3
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-64.8	-64.3	-61.0
Tulare Lake Region			
Pasture	-0.1	-0.2	-0.1
Alfalfa	-2.2	-3.1	-3.0
Sugar Beets	-0.2	-0.2	-0.2
Other Field Crops	-1.3	-1.8	-1.6
Rice	0.0	0.0	0.0
Truck Crops	-0.3	-0.2	-0.3
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	-0.1	-0.1	-0.1
Small Grain	-0.4	-1.0	-0.6
Grapes	-0.1	-0.1	-0.1
Cotton	-9.3	-11.4	-11.3
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-14.0	-18.1	-17.3
San Felipe Division			
Pasture and Hay	-0.7	-0.6	-0.4
Other Field Crops	-1.2	-1.1	-0.8
Vegetable	-4.4	-4.1	-2.8
Tree and Vine	-2.7	-2.7	-2.7
Subtotal	-9.0	-8.5	-6.7
Total	**-93.6**	**-98.8**	**-91.1**

NOTE:
All values in 1,000 acres.

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(Without this price increase, the gross revenue would decline another $7.2 million per year.) Most of the decline is in cotton and other field crop categories, consistent with the change in acreage. The total decline in Central Valley gross revenue represents less than one percent of the No-Action Alternative value. Table III-24 and Figure III-2 summarize the changes from the No-Action Alternative in the gross revenue by region and crop.

SFD changes are similar to Alternative 1.

NET INCOME FROM IRRIGATED LANDS

The estimated change in net farm income associated with the irrigated crops in each region includes several components:

- Net income from a change in acreage irrigated. This includes net income directly attributed to an increase or decrease in acreage, plus the effect of crop price changes on all lands in production. These two effects may move in the same or in opposite directions.
- Change in the cost of groundwater pumping.
- Change in the cost of irrigation systems and management.
- Change in the cost of CVP water, including tiered prices, restoration charge, and Friant-Kern surcharge.

In addition to these components, Alternative 2 also includes water acquired for restoration purposes, and the revenue from this water becomes another component of income to the agricultural sector. Table III-25 summarizes these components for the average 1922-1990 condition. Dry and wet conditions would show similar relationships to average as in Alternative 1.

Approximately $65 million in lost net income is offset by about $7 million increase from higher crop prices plus another $17.5 million in revenue from selling water for restoration purposes. The net result is a decline in net income of about $40 million per year. Most of this ($25.6 million) is in the San Joaquin River region, with $13 million in the Tulare Lake Region and about $0.1 million in the Sacramento River Region. This net change masks significant winners and losers, with winners being growers able to sell water at a high price, and losers being primarily CVP contract water users. Their losses are similar to the estimates shown in Alternative 1.

The net income estimates are not detailed by crop because the analysis treats the farm as an entire operation. Different water sources are not designated to specific crops, so an increase in water cost cannot be apportioned to individual crops.

AGRICULTURAL WATER USE

Water use reported here represents an estimate of the change in water actually applied to the field for crop growth, rather than diversions or deliveries to contractors. The numbers in Table III-26 represent the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake

TABLE III-24

GROSS REVENUE IN ALTERNATIVE 2 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.44	0.35	0.40
Alfalfa	0.47	0.39	0.48
Sugar Beets	-0.05	-0.07	-0.05
Other Field Crops	-0.43	-0.60	-0.44
Rice	-3.55	-4.12	-3.71
Truck Crops	-0.03	-0.06	-0.03
Tomatoes	0.24	0.17	0.22
Deciduous Orchard	0.11	0.11	0.11
Small Grain	-0.21	-0.26	-0.20
Grapes	0.03	0.03	0.03
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-2.98	-4.06	2.05
San Joaquin River Region			
Pasture	-2.42	-2.42	-2.23
Alfalfa	-5.00	-5.12	-4.59
Sugar Beets	-0.36	-0.35	-0.34
Other Field Crops	-5.60	-5.58	-5.30
Rice	-0.73	-0.68	-0.68
Truck Crops	-4.20	-4.11	-4.19
Tomatoes	-2.98	-2.91	-2.88
Deciduous Orchard	-0.69	-0.69	-0.69
Small Grain	-1.49	-1.67	-1.36
Grapes	-0.35	-0.35	-0.35
Cotton	-27.21	-26.32	-25.90
Subtropical Orchard	-0.03	-0.03	-0.03
Subtotal	-51.06	-50.23	-48.54
Tulare Lake Region			
Pasture	0.01	-0.02	0.00
Alfalfa	-0.55	-1.14	-1.01
Sugar Beets	-0.13	-0.15	-0.15
Other Field Crops	-0.86	-1.18	-1.06
Rice	0.00	0.00	0.00
Truck Crops	-1.61	-1.32	-1.85
Tomatoes	-0.03	-0.02	-0.03
Deciduous Orchard	-0.01	-0.01	-0.01
Small Grain	-0.22	-0.53	-0.32
Grapes	-0.01	-0.01	-0.01
Cotton	-8.99	-11.33	-11.10
Subtropical Orchard	-0.01	-0.01	-0.01
Subtotal	-12.41	-15.72	-15.55
San Felipe Division			
Pasture and Hay	-0.14	-0.13	-0.09
Other Field Crops	-0.73	-0.66	-0.46
Vegetable	-26.58	-24.28	-16.88
Tree and Vine	-3.79	-3.79	-3.79
Subtotal	-31.24	-28.86	-21.22
Total	**-97.69**	**-98.87**	**-83.26**

NOTE:
All values in million dollars/year.

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TABLE III-25

CHANGE IN NET REVENUE IN ALTERNATIVE 2 AS COMPARED TO NO-ACTION ALTERNATIVE

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Felipe Division	Total
Fallowed Land	-0.7	-7.2	-1.8	-3.0	-12.7
Groundwater Pumping	-1.8	-20.0	0.5	0.0	-21.3
Irrigation Cost	-0.3	-3.7	-0.8	0.0	-4.7
CVP Water Cost	-0.3	-12.5	-16.5	-0.3	-29.6
Total Reduction	-3.1	-43.4	-18.6	-3.3	-68.4
Increase From Higher Crop Prices	1.7	3.1	2.4	0.0	7.2
Increase From Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase From Water Sales	1.2	13.7	2.6	0.0	17.5
Combined Net Revenue Change	-0.2	-25.7	-12.5	-3.3	-41.7

NOTE:
All values in million dollars/year.

TABLE III-26

IRRIGATION WATER APPLIED IN ALTERNATIVE 2 AS COMPARED TO NO-ACTION ALTERNATIVE

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Surface Water	-72	-127	-43
Groundwater	38	82	7
Total Applied	-34	-45	-36
San Joaquin River Region			
Surface Water	-480	-479	-421
Groundwater	182	165	142
Total Applied	-298	-314	-279
Tulare Lake Region			
Surface Water	-39	-11	-71
Groundwater	-23	-70	-1
Total Applied	-62	-81	-72
San Felipe Division (1)			
CVP Water	-18	-17	-13
Total			
Surface Water	-609	-634	-548
Groundwater	197	177	148
Total Applied	-412	-457	-400

NOTES:
(1) Non-CVP supplies are not estimated for the San Felipe Division.
All values in 1,000 acre-feet/year.

Region (see Surface Water Technical Appendix for discussion), reductions due to water acquisition, and changes in groundwater use. These results are also shown in Figure III-3.

The most important difference from Alternative 1 is the acquisition of water for restoration. Some water is acquired in all three regions for Level 2 refuge water supply, and additional water is purchased for instream flow in the San Joaquin River Region. The net effect of water acquisition on surface water delivered to the field is the difference between Alternative 1 and Alternative 2 levels of delivery. As shown in Table III-26, delivery fell by an additional 33,000 acre-feet in the Sacramento River Region (72,000 vs. 39,000 acre-feet), 178,000 acre-feet in San Joaquin River Region, and 17,000 acre-feet in the Tulare Lake Region.

Groundwater use increases more in Alternative 2 than in Alternative 1 (197,000 acre-feet vs. 115,000 acre-feet). This occurs because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping.

Table III-27 shows average irrigation efficiency by region. Average irrigation efficiency rises very slightly in the Sacramento River Region compared to the No-Action Alternative, from 66 to 66.1 percent. The San Joaquin River Region increases more noticeably in irrigation efficiency, rising from 71.8 percent in the No-Action Alternative to 72.4 percent in Alternative 2. Valley-wide, the irrigation efficiency rises about 0.3 percent, similar to Alternative 1.

TABLE III-27
IRRIGATION WATER USE AND EFFICIENCY
IN ALTERNATIVE 2

Region	Applied Water (1,000 acre-feet)	ET of Applied Water (1,000 acre-feet)	Irrigation Efficiency (percentage)
Sacramento River	7,092	4,685	66.1
San Joaquin River	7,582	5,493	72.4
Tulare Lake	5,996	4,433	73.9
Total	**20,670**	**14,611**	**70.7**

NOTE:
Non-CVP supplies are not estimated for the San Felipe Division.

IMPACTS ON CONSUMERS

Using surplus to consumers of Central Valley produce as a measure of losses caused by lower supply and higher prices of farm goods, losses are estimated to be about $7.2 million per year.

The reduction in hay and pasture in Alternative 2 represents about 3 percent of Central Valley production. If all the reduction is replaced by forage from outside the Central Valley, which

costs about 40 percent more, forage cost would increase 1.2 percent (40 percent of 3 percent). Feed cost represents about 50 percent of the total cost of milk production, so the impact on the cost of producing milk would be less than 1 percent. Localized impacts could be larger.

FEDERAL COMMODITY PAYMENTS

Alternative 2 would decrease agricultural revenues from USDA farm programs because retired land would lose eligibility for farm program payments. These revenues are an expense for the federal government. Table III-28 shows agricultural commodity acreage idled by Alternative 2 and the direct reduction of about $6.0 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. Most of the cost savings is associated with the retirement or permanent fallowing of cotton acreage. Some additional savings may also result indirectly from higher crop prices.

TABLE III-28
ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 2

Region	Commodity Acreage Retired (1,000 acres)	Farm Program Cost Savings (million $ per year)
Sacramento River	6.1	1.5
San Joaquin River	38.2	3.4
Tulare Lake	11.1	1.1
San Felipe Division	0.0	0.0
Total	**55.3**	**6.0**

The 1996 Farm Bill recently signed into law revises the way commodity payments are determined, and decouples the size of the payment from the actual production level. There remains, however, some uncertainty about how USDA will handle lands that are part of a grower's base acreage yet are retired or fallowed as CVPIA is implemented. For purposes of analysis, we assume that USDA will remove such lands from the grower's base acreage and reduce the deficiency payment accordingly.

VARIABILITY, RISK, AND UNCERTAINTY

Most of the impacts from risk and uncertainty in Alternative 2 are the same as in Alternative 1. Additional risk or uncertainty might occur due to water acquisition. Land fallowing or retirement, if concentrated in a small area, could threaten the infrastructure of suppliers, farm labor, and processors available to the remaining producers. Some additional uncertainty is placed on those who divert downstream from areas selling water for restoration. Changes in the timing of streamflows and availability of irrigation return flows could also affect some growers' pattern or costs of diversion.

Growers who sell water may be able to reduce financial risk. A steady income from water sales can combine with more variable crop revenues to provide a less risky income stream. Water sold can also be used to finance other production costs that otherwise would be funded through borrowing.

LAND VALUES

Land values in areas of higher water costs or losses of supply would be affected as in Alternative 1. Average reduction in land values in the most affected region, San Joaquin River Region, could be $320 per acre based on the regional change in net income.

Areas selling water would either be unaffected or increase in land value, as long as the water remained attached, or allocated, to the land. In other words, if the right to sell water depends on ownership or control of the land, then profit from selling the water would be capitalized into the price of the land. For example, if water is sold for $10 more per acre-foot than its net value in producing crops, then at 3 acre-feet per acre, profit would increase by $30 per acre and land value might increase by $750 per acre (capitalizing the annual profit at a 4 percent real rate). But if the right to sell water is separated from ownership of land, then the price of that land could fall (though the decline would be more than compensated by the stream of profits on water sales).

FINANCE AND CREDIT

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. Therefore, changes in conditions that reduce profit, increase risk, or reduce the value of land can be expected to reduce lenders' willingness to lend money or to increase the interest rate they charge, and vice versa. The same potential increases in risk and reduction in profit discussed in Alternative 1 also apply in Alternative 2.

Growers able to sell water for restoration can potentially increase net income and reduce risk, which would increase credit worthiness.

COSTS OF WATER CONSERVATION AND MEASUREMENT

Conservation and measurement costs for Alternative 2 would be similar to Alternative 1. In summary, net costs of conservation provisions will probably not be significant for districts that already measure water to customers. For districts that do not currently measure delivery to each customer, the cost per acre could be $4 to $33 per year. With the exception of measurement, most mandatory provisions are either inexpensive or would be required even without the CVPIA. Discretionary provisions may be avoided if their costs are burdensome or far exceed the benefits.

CASE STUDY: EASTSIDE SAN JOAQUIN RIVER REGION

Alternative 2 includes the acquisition of water from willing sellers for Level 4 refuge supply and for instream flow needs in the San Joaquin River tributaries, the Stanislaus, Tuolumne, and Merced rivers. In Alternative 2, about 160,000 acre-feet are purchased on average from this region, of which about 120,000 acre-feet represents reduced on-farm application. Table III-29

shows the estimated acres of different crops that growers in this subregion might choose to fallow to generate the water for sale. Under this estimate, over 90 percent of the water would come from irrigated pasture, alfalfa hay, other field crops, and cotton.

TABLE III-29

CROPS FALLOWED FOR WATER ACQUISITION PROGRAM EASTSIDE SAN JOAQUIN RIVER REGION IN ALTERNATIVE 2 AS COMPARED TO NO-ACTION ALTERNATIVE

	Ave	Dry	Wet
Pasture	-10.4	-10.2	-9.4
Alfalfa	-4.4	-4.2	-3.8
Sugar Beets	-0.1	-0.1	-0.1
Other Field Crops	-4.1	-3.9	-3.6
Rice	-0.6	-0.6	-0.6
Truck Crops	0.0	0.0	0.0
Tomatoes	-0.1	-0.1	-0.1
Deciduous Orchard	-0.5	-0.5	-0.5
Small Grain	-0.9	-0.8	-0.6
Grapes	-0.3	-0.3	-0.3
Cotton	-2.6	-2.4	-1.9
Subtropical Orchard	0.0	0.0	0.0

NOTE:
All values in 1,000 acres.

Because the water acquisition program relies on willing sellers, the net revenue received from water sales is at least as large as the direct loss in net revenue from crop production. Based on the estimated value of water for crop production, growers would receive, on average, about $8.6 million per year in net revenue from sales (after accounting for district water charges). Water sales would also cause impacts to farm workers, suppliers, and others who rely on crop production for their livelihood. These kinds of third-party impacts are assessed in the Regional Economics Technical Appendix.

SUPPLEMENTAL ANALYSIS 2b : WATER TRANSFER OPPORTUNITIES

Assumptions

The supplemental analysis of water transfers without fees is based upon most of the same assumptions as in the No-Action Alternative transfers scenario. The major differences are the use of Alternative 2 hydrology, water pricing, and water acquisition, and the assumption that all CVP water is transferable with specific costs imposed. These costs and assumptions are detailed in the Municipal Water Costs and Water Transfer Opportunities Technical Appendices.

Results shown here should be viewed as an example of the relative magnitude of the impacts of CVPIA on water transfers. Actual water transfers occurring in the future will be determined by a number of specific conditions that cannot be predicted in a programmatic analysis.

Results

The results of Supplemental Analysis 2b are presented in Table III-30. Under conditions assumed, total water transfers are estimated to be 157,000 acre-feet in an average year and 921,000 acre-feet in a dry year. Most average year transfers are estimated to be from the San Joaquin River and Tulare Lake Regions to urban uses in the Central and South Coast Regions. Transfers during dry years are much higher because of the higher M&I demand.

TABLE III-30

SUPPLEMENTAL ANALYSIS 2b RESULTS AS COMPARED TO ALTERNATIVE 2

	Agricultural Water Transfer (1) (1,000 acre-feet)		Land Fallowed as a Result of Transfer (2) (1,000 acres)		Receipts from Transfers (3) (1,000 $)		Net Revenue Change (4) (1,000 $)	
Region	Average	Dry	Average	Dry	Average	Dry	Average	Dry
Sacramento River	-7	-301	-1	-61	333	22,770	264	17,731
San Joaquin River	26	-264	0	-70	-2,064	35,517	296	28,508
Tulare Lake	-177	-357	-49	-121	21,245	64,250	14,199	48,670
Total	**-158**	**-922**	**-50**	**-252**	**19,514**	**122,537**	**14,759**	**94,909**

NOTES:

(1) Negative number indicates water transferred out of the region; positive number indicates water transferred into the region.

(2) Negative number indicates decreased crop acreage due to water transferred out; positive number indicates increased crop acreage due to water transferred in.

(3) Positive number indicates revenue received for water transferred out; negative number indicates payment for water transferred in.

(4) Net revenue change represents the gains from trade in a region. For selling regions, this equals receipts from water sold (net of its cost) minus the net revenue lost from lower crop acreage. For buying regions, net revenue change equals net revenue from added crop acres plus the avoided cost of groundwater pumping minus payment for water purchased.

The San Felipe Division was not explicitly considered in the quantitative analysis of water transfer opportunities. It is not expected to be a seller of water but might participate as a buyer.

Land fallowing as a result of water transfers in an average year is estimated to be 50,000 acres, or less than 1 percent of the total irrigated acreage in the three regions. Higher demands for transferred water in dry years increases the land fallowing to about 252,000 acres, or 4 percent. In general, crop lands idled by transfers are pasture, hay, grain, field crops, rice, and cotton.

Anticipated change in net revenues to agricultural water users has been estimated by combining net revenue loss due to crop reductions, the cost of any water purchased, and the income from water sales. In all cases sellers are expected to benefit from water transfers. Gains range from $14.7 million ($35 to $80 per acre-foot sold) in an average year to $94.9 million ($60 to $135 per acre-foot sold) in a dry year, when urban users bid up water prices to make up for shortfalls in supplies from their normal water sources. The average gains in 2b are slightly higher than those reported in Supplemental Analysis 1e because water acquisition for fish and wildlife has reduced the supply of water for sale and raised the price. The estimates of gains to sellers do not include any cost of tilling, weed control, etc. that may be needed for temporarily fallowed land. If these activities cost $25 to $30 per acre, this would reduce the net gain per acre-foot by about $10. Significant variation in selling price and gains from sales can be expected within a region and between regions.

The estimates above focus on interregional transfers. Local transfers within a region are not included in these estimates, but would not have the system-wide implications and impacts that interregional transfers are likely to have. The ability to transfer water to other regions may reduce local transfers by increasing the competition for water.

SUPPLEMENTAL ANALYSIS 2c : WATER TRANSFER OPPORTUNITIES WITH $50-PER-ACRE-FOOT FEE

The impact of imposing a $50-per-acre-foot fee on CVP water transfers would be similar to that described under Supplemental Analysis 1f.

SUPPLEMENTAL ANALYSIS 2d : FULL-COST-PLUS TIERED PRICING

Assumptions

The main analysis of Alternative 2 assumes that the first 80 percent of contract total is charged the Cost of Service rate, tiering up to the Full Cost rate. This supplemental analysis evaluates the additional impact of charging Full Cost rate for the first 80 percent of contract total, tiering up in 10 percent increments. This analysis is similar to Supplemental Analysis 1c discussed under Alternative 1, except using the assumptions of Alternative 2.

Results

The results of the full-cost-plus tiered pricing analysis are presented in Table III-31. The table compares the supplemental analysis results with the main Alternative 2.

Implementation of full-cost-plus tiered water pricing under Alternative 2 is estimated to reduce CVP water purchases by about 541,000 acre-feet in an average year. This reduction is about 30,000 acre-feet less than was predicted for Alternative 1 because acquisition of water for fish and wildlife in Alternative 2 has already fallowed some of the less productive land.

Reductions are mostly in the Sacramento River and San Joaquin River regions, and would occur primarily in areas served by the Tehama-Colusa, Delta-Mendota, and Madera canals and New Melones Reservoir. Sacramento River Region reductions would be mainly met through land

TABLE III-31

SUPPLEMENTAL ANALYSIS 2d RESULTS AS COMPARED TO ALTERNATIVE 2

Item/Region	Change	Percent Change
CVP Water Use (1,000 acre-feet)		
Sacramento River	-189	-32.5
San Joaquin River	-334	-36.6
Tulare Lake	-18	-1.9
San Felipe Division	0	0.0
Total	-541	-22.3
Groundwater Use (1,000 acre-feet)		
Sacramento River	0	0.0
San Joaquin River	334	9.3
Tulare Lake	18	0.5
San Felipe Division	0	0.0
Total	352	3.7
Irrigated Acreage (1,000 acres)		
Sacramento River	-53	-2.6
San Joaquin River	0	0.0
Tulare Lake	0	0.0
San Felipe Division	0	0
Total	-53	-0.8
CVP Water Cost ($ Million)		
Sacramento River	-2	-19.2
San Joaquin River	3	6.1
Tulare Lake	9	23.1
San Felipe Division	4.6	163.1
Total	15	10.9
Groundwater Cost ($ Million)		
Sacramento River	0	0.0
San Joaquin River	24	12.0
Tulare Lake	2	0.7
San Felipe Division	0	0.0
Total	26	5.1
Gross Revenue ($ Million)		
Sacramento River	-28	-1.5
San Joaquin River	0	0.0
Tulare Lake	0	0.0
San Felipe Division	0	0.0
Total	-28	-0.2
Net Revenue ($ Million)		
Sacramento River	-3	-1.0
San Joaquin River	-26	-4.0
Tulare Lake	-10	-2.0
San Felipe Division	-4.6	-86.0
Total	-43	-3.3

NOTE:
San Felipe Division reported to greater precision due to magnitude of area.

fallowing, while those in the San Joaquin River Region would be mostly from a shift to groundwater.

Net revenues to agriculture in the three regions are estimated to drop by up to 5 percent with the imposition of full cost tiered water pricing. San Joaquin River Region agriculture would experience the largest net revenue reduction, 4 percent. The higher losses in this region are attributed to the higher groundwater pumping costs.

ALTERNATIVE 3

Alternative 3 includes the same assumptions for the agricultural production analysis as Alternative 2, with additional water acquisition for instream flow needs on the eastside Sacramento and San Joaquin River tributaries. Under Alternative 3, water acquired and released for instream flow can be diverted from the Delta for export to San Joaquin Valley and coastal regions, if consistent with other existing water quality and environmental restrictions. In order to prevent groundwater replacement of acquired surface water, the analysis attempted to hold groundwater pumping to no more than the Alternative 1 level in subregions where water is acquired.

IRRIGATED LAND USE

Starting from DWR's 2020 baseline land use, the water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and the SFD and compared to the No-Action Alternative results in Table III-32 and Figure III-1.

Changes from the No-Action Alternative are determined by land targeted for the retirement program and by the dedicated water, as in Alternative 1, plus lands fallowed due to water acquisition. The San Joaquin River Region shows the largest decline in acreage, about 130,000 acres (5 percent), followed by Sacramento River Region, which declines about 24,000 acres (1.2 percent), and Tulare Lake Region, which declines 13,400 acres (0.7 percent). SFD would decline by about 5,000 acres. Total reduction is about 172,000 acres, or about 2.6 percent of the No-Action Alternative irrigated acreage.

San Joaquin River Region's decline results from the combination of the Land Retirement Program, additional fallowing due to reduced CVP delivery, and substantial fallowing due to water acquisition. Pasture, alfalfa hay, cotton, and other field crops show the largest reduction. Cotton reduction occurs mostly on the west side of the region, while pasture, alfalfa hay, and field crops decline primarily as part of east-side water acquisition.

Tulare Lake Region's decline is due largely to the Land Retirement program. Acreage actually declines less in Alternative 3 than in Alternative 1. This estimate occurs because the additional land fallowed for water acquisition creates an economic incentive for the fallowed crops to shift to other regions. In other words, even though land has been fallowed for water acquisition, the demand for the crops grown on that land still exists, and some of that demand gets met by lands in other regions.

TABLE III-32

IRRIGATED ACREAGE IN ALTERNATIVE 3 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	-5.4	-5.3	-5.6
Alfalfa	0.8	0.1	-0.5
Sugar Beets	-0.2	-0.1	-0.2
Other Field Crops	-2.7	-2.4	-2.7
Rice	-12.7	-11.6	-12.9
Truck Crops	0.0	-0.1	0.0
Tomatoes	-0.2	-0.2	-0.2
Deciduous Orchard	-0.3	-0.3	-0.3
Small Grain	-1.7	-1.7	-1.7
Grapes	-0.1	-0.1	-0.1
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-11.3	-13.0	-24.2
San Joaquin River Region			
Pasture	-47.2	-46.0	-47.1
Alfalfa	-19.8	-17.7	-20.3
Sugar Beets	-0.5	-0.4	-0.6
Other Field Crops	20.0	-20.2	-20.2
Rice	-3.0	-2.7	-3.0
Truck Crops	-0.7	-0.7	-0.8
Tomatoes	-2.1	-1.1	-2.3
Deciduous Orchard	-2.2	-2.2	-2.2
Small Grain	-5.3	-6.6	-5.3
Grapes	-1.1	-1.1	-1.1
Cotton	-27.7	-17.6	-28.7
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-129.7	-116.3	-131.6
Tulare Lake Region			
Pasture	0.0	0.0	0.0
Alfalfa	-1.3	-0.9	-1.5
Sugar Beets	-0.1	-0.1	-0.2
Other Field Crops Crops	-1.5	-1.7	-1.5
Rice	0.0	0.0	0.0
Truck Crops	-0.3	-0.2	-0.4
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	-0.1	-0.1	-0.1
Small Grain	-0.8	-1.1	-0.8
Grapes	-0.1	-0.1	-0.1
Cotton	-9.2	-6.7	-10.2
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-13.4	-10.8	-14.6
San Felipe Division			
Pasture and Hay	-0.4	-0.3	-0.3
Other Field Crops	-0.7	-0.2	-0.6
Vegetable	-2.4	-0.9	-2.1
Tree and Vine	-1.5	-1.5	-1.5
Subtotal	-5.0	-2.9	-4.5
Total	**-171.9**	**-151.6**	**-174.8**

NOTE:
All values in 1,000 acres.

In the Sacramento River Region, about 12,700 acres of rice (2.7 percent) is fallowed. Irrigated pasture and other field crops are the other crop categories showing the largest estimated decline. Similar patterns of change are estimated under dry and wet conditions.

GROSS REVENUE FROM IRRIGATED LANDS

The Central Valley reduction in gross revenue is estimated to be $99 million per year. This estimate accounts for crop price increases expected to occur because production has declined. (Without this price increase, the gross revenue would decline another $13.2 million per year.) Most of the decline is in the field crop categories, consistent with the change in acreage. The reduction in value produced from fruit and vegetable crops in the San Joaquin River Region is also notable even though the acreage decline is fairly small. The Central Valley's total decline in gross revenue represents about 1 percent of the No-Action Alternative value. SFD gross revenue would decline about $17 million on average, reflecting the high gross revenues of vegetables and fruits.

Table III-33 and Figure III-2 summarize the change from the No-Action Alternative in the gross revenue by region and crop.

NET INCOME FROM IRRIGATED LANDS

The estimated change in net farm income associated with the irrigated crops in each region includes several components:

- Net income from a change in acreage irrigated. This includes net income directly attributed to an increase or decrease in acreage, plus the effect of crop price changes on all lands in production. These two effects may move in the same or in opposite directions.
- Change in the cost of groundwater pumping.
- Change in the cost of irrigation systems and management.
- Change in the cost of CVP water, including tiered prices, restoration charge, and Friant-Kern surcharge.

In addition to these components, Alternative 3 also includes water acquired for restoration purposes, and the revenue from this water becomes another component of income to the agricultural sector. Table III-34 summarizes these components for the average 1922-1990 condition. Dry and wet conditions would show similar relationships to average as in Alternative 1.

Approximately $67.4 million in lost net income is offset by about $13.7 million increase from higher crop prices plus an estimated $2 million in payments from the Land Retirement Program and $67.9 million in revenue from selling water for restoration purposes. The net result is an **increase** in net income of about $16.3 million per year. This increase masks significant winners and losers, with winners being growers able to sell water at a high price, and losers being primarily CVP water service contractors. Their losses are similar to the estimates shown in

TABLE III-33

GROSS REVENUE IN ALTERNATIVE 3 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.72	0.68	0.69
Alfalfa	0.53	0.77	0.57
Sugar Beets	-0.14	-0.08	-0.13
Other Field Crops	-1.25	-1.16	-1.26
Rice	-10.38	-9.47	-10.56
Truck Crops	-0.13	-0.22	-0.12
Tomatoes	0.13	-0.04	0.15
Deciduous Orchard	0.16	0.16	0.16
Small Grain	-0.49	-0.52	-0.49
Grapes	-0.04	-0.04	-0.04
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-10.89	-9.92	-11.03
San Joaquin River Region			
Pasture	-9.32	-9.11	-9.28
Alfalfa	-10.28	-9.27	-10.49
Sugar Beets	-0.44	-0.34	-0.51
Other Field Crops	-12.59	-12.64	-12.71
Rice	-2.37	-2.13	-2.43
Truck Crops	-4.14	-3.86	-4.54
Tomatoes	-2.76	-1.47	-2.94
Deciduous Orchard	-2.30	-2.30	-2.30
Small Grain	-2.70	-3.26	-2.68
Grapes	-1.35	-1.35	-1.35
Cotton	-29.34	-18.46	-30.15
Subtropical Orchard	-0.07	-0.07	-0.07
Subtotal	-77.66	-64.26	-79.45
Tulare Lake Region			
Pasture	0.15	0.13	0.16
Alfalfa	0.65	0.62	0.59
Sugar Beets	-0.12	-0.06	-0.13
Other Field Crops	-1.00	-1.05	-1.01
Rice	0.00	0.00	0.00
Truck Crops	-1.75	-0.93	-2.01
Tomatoes	-0.02	-0.01	-0.02
Deciduous Orchard	0.33	0.33	0.33
Small Grain	-0.38	-0.60	-0.40
Grapes	0.50	0.50	0.50
Cotton	-8.80	-6.67	-9.72
Subtropical Orchard	0.01	0.01	0.01
Subtotal	-10.43	-7.73	-11.70
San Felipe Division			
Pasture and Hay	-0.08	-0.07	-0.07
Other Field Crops	-0.39	-0.14	-0.34
Vegetable	-14.55	-5.22	-12.47
Tree and Vine	-2.07	-2.07	-2.07
Subtotal	-17.09	-2.07	-2.07
Total	**-116.08**	**-89.41**	**-104.27**

NOTE:
All values in million dollars/year.

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Alternative 1. Also, workers and businesses dependent on crop production will lose work in regions selling significant quantities of water (third party impacts are discussed in the Regional Economics Technical Appendix).

TABLE III-34

CHANGE IN NET REVENUE IN ALTERNATIVE 3 AS COMPARED TO NO-ACTION ALTERNATIVE

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Felipe Division	Total
Fallowed Land	-2.4	-13.4	-1.6	-1.6	-19.0
Groundwater Pumping	-3.2	-14.2	3.8	0.0	-13.6
Irrigation Cost	-0.3	-3.7	-0.7	0.0	-4.7
CVP Water Cost	-0.3	-12.9	-16.5	-0.4	-30.0
Total Reduction	-6.2	-44.1	-15.0	-2.0	-67.4
Increase From Higher Crop Prices	4.0	5.7	4.1	0.0	13.7
Increase From Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase From Water Sales	8.7	57.6	1.6	0.0	67.9
Combined Net Revenue Change	6.5	20.1	-8.3	-2.0	16.3

NOTE:
All values in million dollars/year.

AGRICULTURAL WATER USE

Water use reported here represents an estimate of the change in water actually applied to the field for crop growth, rather than diversions or deliveries to contractors. The numbers in Table III-35 represent the net effect of reductions in CVP delivery, increases in SWP delivery in Tulare Lake Region (see Surface Water Technical Appendix for discussion), reductions due to water acquisition, and changes in groundwater use. Figure III-3 also illustrates changes in water applied for irrigation.

The most important difference from Alternative 1 is the acquisition of water for restoration. Some water is acquired in all three regions for Level 2 refuge water supply, and additional water is purchased for instream flow in the Sacramento River and San Joaquin River regions. Because Alternative 3 allows expenditure for water acquisition beyond what is currently authorized in the Restoration Fund, substantially more water is acquired than in Alternative 2.

Groundwater use increases slightly more in Alternative 3 than in Alternative 1 (121,000 acre-feet vs. 115,000 acre-feet). This occurs because of a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping. In the aggregate numbers reported, a portion of that shift is offset by the delta export of some acquired water, as allowed by

TABLE III-35

APPLIED IRRIGATION WATER IN ALTERNATIVE 3 AS COMPARED TO NO-ACTION ALTERNATIVE

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Surface Water	-195	-229	-179
Groundwater	80	123	63
Total Applied	-115	-106	-116
San Joaquin River Region			
Surface Water	-697	-619	-704
Groundwater	124	62	133
Total Applied	-573	-557	-571
Tulare Lake Region			
Surface Water	26	58	-24
Groundwater	-83	-109	-36
Total Applied	-57	-51	-60
San Felipe Division (1)			
CVP Water	-10	-16	-9
Total			
Surface Water	-876	-806	-916
Groundwater	121	76	160
Total Applied	-755	-730	-756

NOTES:
(1) Non-CVP supplies are not estimated for the San Felipe Division.

All values in 1,000 acre-feet/year.

Alternative 3 assumptions. This additional surface water exported to the west side and southern San Joaquin Valley displaces some groundwater pumping. Total Tulare Basin surface water applied would increase by about 26,000 acre-feet per year compared to the No-Action Alternative. Groundwater use declines by more than this amount because of the Land Retirement Program. SFD CVP water declines by about 10,000 acre-feet per year.

Table III-36 shows average irrigation efficiency by region. Average irrigation efficiency changes very little in the Sacramento River and Tulare Lake Regions compared to the No-Action Alternative. A modest increase in efficiency is estimated in the San Joaquin River Region (from 71.8 percent to 72.7 percent). Valley-wide, the irrigation efficiency rises about 0.4 percent, similar to Alternatives 1 and 2. Because a portion of this increase is caused by a change in crop mix, the analysis does not indicate any significant investment in irrigation technology as a result of implementing Alternative 3.

TABLE III-36

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 3

Region	Applied Water (1,000 acre-feet)	ET of Applied Water (1,000 acre-feet)	Irrigation Efficiency (percentage)
Sacramento River	7,012	4,638	66.1
San Joaquin River	7,307	5,312	72.7
Tulare Lake	6,001	4,436	73.9
Total	**20,320**	**14,386**	**70.8**

NOTE:
Non-CVP supplies are not estimated for the San Felipe Division.

IMPACTS ON CONSUMERS

Using surplus to consumers of Central Valley produce as a measure of losses caused by lower supply and higher prices of farm goods, losses are estimated to be about $13.6 million per year.

The reduction in hay and pasture in Alternative 3 represents about 9 percent of Central Valley production. If all the reduction is replaced by forage from outside the Central Valley, which costs about 40 percent more, forage cost would increase 3.6 percent (40 percent of 9 percent). Feed cost represents about 50 percent of the total cost of milk production, so the impact on the cost of producing milk would be less than 2 percent. Localized impacts could be larger.

FEDERAL COMMODITY PAYMENTS

Alternative 3 would decrease agricultural revenues from USDA farm programs because retired land would lose eligibility for farm program payments. These revenues are an expense for the federal government. Table III-37 shows agricultural commodity acreage idled by Alternative 3 and the direct reduction of about $10.2 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. Almost 90

percent of the cost savings is associated with the retirement or permanent fallowing of cotton and rice acreage. Some additional savings may also result indirectly from higher crop prices.

The 1996 Farm Bill recently signed into law revises the way commodity payments are determined, and decouples the size of the payment from the actual production level. There remains, however, some uncertainty about how USDA will handle lands that are part of a grower's base acreage yet are retired or fallowed as CVPIA is implemented. For purposes of analysis we assume that USDA will remove such lands from the grower's base acreage and reduce the deficiency payment accordingly.

TABLE III-37

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 3

Region	Commodity Acreage Retired (1,000 acres)	Farm Program Cost Savings (million $ per year)
Sacramento River	17.0	4.4
San Joaquin River	56.0	4.7
Tulare Lake	11.5	1.1
San Felipe Division	0.0	0.0
Total	**84.5**	**10.2**

VARIABILITY, RISK, AND UNCERTAINTY

Most of the impacts from risk and uncertainty in Alternative 3 are the same as in Alternative 1. Additional risk or uncertainty might occur due to water acquisition. Land fallowing or retirement, if concentrated in a small area, could threaten the infrastructure of suppliers, farm labor, and processors available to the remaining producers. Some additional uncertainty is placed on those who divert downstream from areas selling water for restoration. Changes in the timing of streamflows and availability of irrigation return flows could also affect some growers' pattern or costs of diversion.

Growers who sell water may be able to reduce financial risk. A steady income from water sales can combine with more variable crop revenues to provide a less risky income stream. Water sold can also be used to finance other production costs that otherwise would be funded through borrowing.

LAND VALUES

Land values in areas of higher water costs or losses of supply would be affected as in Alternative 1. Average reduction to land values in the most affected region, the San Joaquin River Region, could be $320 per acre based on the regional change in net income.

Areas selling water would either be unaffected or increase in land value, as long as the water remained attached, or allocated, to the land. In other words, if the right to sell water depends on ownership or control of the land, then profit from selling the water would be capitalized into the price of the land. For example, if water is sold for $20 more per acre-foot than its net value in producing crops, then at 3 acre-feet per acre, profit would increase by $60 per acre and land value might increase by $750 per acre (capitalizing the annual profit at a 4 percent real rate). But if the right to sell water is separated from ownership of land, then the price of that land could fall (though the decline would be more than compensated by the stream of profits on water sales).

FINANCE AND CREDIT

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. Therefore, changes in conditions that reduce profit, increase risk, or reduce the value of land can be expected to reduce lenders' willingness to lend money or to increase the interest rate they charge. The same potential increases in risk and reduction in profit discussed in Alternative 1 also apply in Alternative 3.

Growers able to sell water for restoration can potentially increase net income and reduce risk, which would increase credit worthiness.

COSTS OF WATER CONSERVATION AND MEASUREMENT

Conservation and measurement costs for Alternative 3 would be similar to Alternative 1. In summary, net costs of conservation provisions will probably not be significant for districts that already measure water to customers. For districts that do not currently measure delivery to each customer, the cost per acre could be $4 to $33 per year. With the exception of measurement, most mandatory provisions are either inexpensive or would be required even without the CVPIA. Discretionary provisions may be avoided if their costs are burdensome or far exceed the benefits.

SUPPLEMENTAL ANALYSIS 3a : WATER TRANSFER OPPORTUNITIES

Assumptions

The supplemental analysis of water transfers without fees is based upon most of the same assumptions as in the No-Action Alternative transfers scenario. The major differences are the use of Alternative 3 hydrology, water pricing, and water acquisitions, and the assumption that all CVP water is transferable with specific costs imposed. These costs and assumptions are detailed in the Municipal Water Costs and Water Transfer Opportunities Technical Appendices.

Results shown here should be viewed as an example of the relative magnitude of the impacts of CVPIA on water transfers. Actual water transfers occurring in the future will be determined by a number of specific conditions that cannot be predicted in a programmatic analysis.

Results

The results of Supplemental Analysis 3a are presented in Table III-38. Under conditions assumed for 3a, total water transfers are estimated at 144,000 acre-feet in an average year and 839,000 acre-feet in a dry year. Most average year transfers are estimated to be from the San Joaquin River and Tulare Lake regions to urban uses in the Central and South Coast regions. The lower average and dry year demand in 3a than that in Supplemental Analysis 1e is due primarily to greater availability of CVP and SWP water south of the Delta, a result of the assumption that water acquired for instream flow in the Eastside San Joaquin subregions could be exported south. Agriculture in the San Joaquin River Region is a net buyer of water in the average year, but a net seller of water in dry years due to the much higher demands and prices offered by urban areas.

TABLE III-38

SUPPLEMENTAL ANALYSIS 3a AS COMPARED TO ALTERNATIVE 3

	Agricultural Water Transfer (1) (1,000) acre-feet)		Land Fallowed as a Result of Transfer (2) (1,000 acres)		Receipts from Transfers (3) ($1,000)		Net Revenue Change (4) ($1,000)	
Region	**Average**	**Dry**	**Average**	**Dry**	**Average**	**Dry**	**Average**	**Dry**
Sacramento River	-5	-225	-1	-49	358	16,594	280	12,810
San Joaquin River	10	-213	0	-66	-644	32,971	256	24,483
Tulare Lake	-149	-401	-41	-129	17,055	73,696	11,197	56,783
Total	**-144**	**-839**	**-42**	**-244**	**16,769**	**123,261**	**11,733**	**94,076**

NOTES:

(1) Negative number indicates water transferred out of the region; positive number indicates water transferred into the region.

(2) Negative number indicates decreased crop acreage due to water transferred out; positive number indicates increased crop acreage due to water transferred in.

(3) Positive number indicates revenue received for water transferred out; negative number indicates payment for water transferred in.

(4) Net revenue change represents the gains from trade in a region. For selling regions, this equals receipts from water sold (net of its cost) minus the net revenue lost from lower crop acreage. For buying regions, net revenue change equals net revenue from added crop acres plus the avoided cost of groundwater pumping minus payment for water purchased.

The San Felipe Division was not explicitly considered in the quantitative analysis of water transfer opportunities. It is not expected to be a seller of water but might participate as a buyer.

Land fallowing as a result of water transfers in an average year is estimated to be 42,000 acres, less than 1 percent of the total irrigated acreage in the three regions. Higher demands for transferred water in dry years increases the land fallowing to about 244,000 acres, or about 4 percent. In general, crop lands idled by transfers are pasture, hay, grain, field crops, rice, and cotton.

Anticipated change in net revenues to agricultural water users has been estimated by combining net revenue loss due to crop reductions, the cost of any water purchased, and the income from water sales. In all cases sellers are expected to benefit from water transfers. Gains range from $12 million ($50-$75 per acre-foot sold) in an average year to $94 million ($55-$140 per acre-foot sold) in a dry year, when urban users bid up water prices to make up for shortfalls in supplies from their normal water sources. The estimates of gains to sellers do not include any cost of tilling, weed control, etc. that may be needed for temporarily fallowed land. If these activities cost $25-$30 per acre, this would reduce the net gain per acre-foot by about $10.

The estimates above focus on interregional transfers. Local transfers within a region are not included in these estimates, but would not have the system-wide implications and impacts that interregional transfers are likely to have. The ability to transfer water to other regions may reduce local transfers by increasing the competition for water.

ALTERNATIVE 4

Alternative 4 includes the same assumptions for the agricultural production analysis as Alternative 3, except that both dedicated water and acquired water are prescribed for in-Delta purposes, therefore reducing the ability of the CVP and SWP to export that water. In order to prevent groundwater replacement of acquired surface water, the analysis attempted to hold groundwater pumping to no more than the Alternative 1 level in subregions where water is acquired.

IRRIGATED LAND USE

Starting from DWR's 2020 baseline land use, the water supplies estimated in the surface water and groundwater analysis were used to estimate resulting irrigated land use. Results are summarized for the three Central Valley regions and the SFD and compared to the No-Action Alternative results in Table III-39 and Figure III-1.

Changes from the No-Action Alternative are determined by land targeted for the retirement program and by the dedicated water, as in Alternative 1, plus lands fallowed due to water acquisition. The San Joaquin River Region shows the largest decline in acreage, about 149,000 acres (5.8 percent), followed by the Sacramento River Region, with a decline of about 23,000 acres (1.2 percent). Tulare Lake Region declines about 19,000 acres (0.9 percent). SFD lands served by CVP water would decline by about 10,000 acres. Total reduction is about 200,000 acres, or about 3 percent of the No-Action Alternative irrigated acreage.

San Joaquin River Region's decline results from the combination of the Land Retirement Program, additional fallowing due to reduced CVP delivery, and substantial fallowing due to

TABLE III-39

IRRIGATED ACREAGE IN ALTERNATIVE 4 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	-5.3	-5.2	-5.4
Alfalfa	-0.3	0.5	-0.3
Sugar Beets	-0.2	-0.1	-0.2
Other Field Crops	-2.7	-2.4	-2.7
Rice	-12.6	-11.6	-13.1
Truck Crops	0.0	-0.1	0.0
Tomatoes	-0.2	-0.1	-0.2
Deciduous Orchard	-0.3	-0.3	-0.3
Small Grain	-1.7	-2.0	-1.7
Grapes	-0.1	-0.1	-0.1
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-23.4	-21.4	-24.0
San Joaquin River Region			
Pasture	-49.2	-48.3	-48.7
Alfalfa	-24.3	-23.7	-24.0
Sugar Beets	-0.8	-0.8	-0.8
Other Field Crops	-21.7	-21.4	-21.3
Rice	-3.2	-3.1	-3.2
Truck Crops	-0.7	-0.6	-0.7
Tomatoes	-3.2	-2.7	-3.1
Deciduous Orchard	-2.3	-2.3	-2.3
Small Grain	-4.7	-5.4	-4.4
Grapes	-1.1	-1.1	-1.1
Cotton	-37.2	-32.0	-36.0
Subtropical Orchard	0.0	0.0	-0.0
Subtotal	-148.4	-141.4	-145.6
Tulare Lake Region			
Pasture	0.0	-0.1	0.0
Alfalfa	-3.6	-5.2	-3.7
Sugar Beets	-0.2	-0.3	-0.2
Other Field Crops	-1.2	-2.1	-1.3
Rice	0.0	0.0	0.0
Truck Crops	-0.2	-0.2	-0.2
Tomatoes	0.0	0.0	0.0
Deciduous Orchard	-0.2	-0.2	-0.2
Small Grain	-0.5	-1.4	-0.6
Grapes	-0.1	-0.1	-0.1
Cotton	-12.7	-18.0	-13.2
Subtropical Orchard	0.0	0.0	0.0
Subtotal	-18.8	-27.6	-19.6
San Felipe Division			
Pasture and Hay	-0.7	-0.6	-0.5
Other Field Crops	-1.3	-1.1	-1.0
Vegetable	-4.9	-4.0	-3.5
Tree and Vine	-2.9	-2.9	-2.9
Subtotal	-9.8	-8.6	-2.9
Total	-200.4	-198.9	-192.1

NOTES:
All values in 1,000 acres.

water acquisition. Pasture, alfalfa hay, cotton, and other field crops show the largest reduction. Cotton reduction occurs mostly on the west side of the region, while pasture, alfalfa hay, and field crops decline primarily as part of east-side water acquisition.

Tulare Lake Region's decline is due largely to the Land Retirement Program. Acreage declines more in Alternative 4 than in Alternative 1 because of the assumption that dedicated water is also used for in-Delta purposes. This reduces the amount of CVP and SWP water pumped from the Delta.

In the Sacramento River Region, about 12,600 acres of rice (about 2.7 percent) and 5,300 acres of pasture (3.2 percent) account for most of the fallowed land. This is almost entirely a result of the water acquisition program.

Similar patterns of change are estimated under dry and wet conditions for the San Joaquin River and Tulare Lake regions. Acreage fallowed increases significantly under dry conditions (compared to the No-Action Alternative dry condition) in the Sacramento River Region, due to higher water acquisition in dry years.

GROSS REVENUE FROM IRRIGATED LANDS

The Central Valley reduction in gross revenue is estimated to be $117.1 million per year. This estimate accounts for crop price increases expected to occur because production has declined. (Without this price increase, the gross revenue would decline another $15.4 million per year.) Most of the decline is in the field crop categories, consistent with the change in acreage. The reduction in value produced from fruit and vegetable crops in the San Joaquin River Region is also notable even though the acreage decline is fairly small. The total decline in Central Valley gross revenue represents about 1.2 percent of the No-Action Alternative value. SFD gross revenue would decline about $34.4 million in an average year. Table III-40 and Figure III-2 summarize the change from the No-Action Alternative in the gross revenue by region and crop.

NET INCOME FROM IRRIGATED LANDS

The estimated change in net farm income associated with the irrigated crops in each region includes several components:

- Net income from a change in acreage irrigated. This includes net income directly attributed to an increase or decrease in acreage, plus the effect of crop price changes on all lands in production. These two effects may move in the same or in opposite directions.
- Change in the cost of groundwater pumping.
- Change in the cost of irrigation systems and management.
- Change in the cost of CVP water, including tiered prices, restoration charge, and Friant-Kern surcharge.

TABLE III-40

GROSS REVENUE IN ALTERNATIVE 4 AS COMPARED TO NO-ACTION ALTERNATIVE

Crop	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Pasture	0.84	0.35	0.76
Alfalfa	1.40	1.03	0.93
Sugar Beets	-0.22	-0.33	-0.12
Other Field Crops	-1.51	-2.25	-1.24
Rice	-14.60	-9.50	-10.70
Truck Crops	-0.12	-0.23	-0.14
Tomatoes	0.21	0.34	0.35
Deciduous Orchard	2.43	0.19	0.19
Small Grain	-0.70	-0.60	-0.49
Grapes	0.10	-0.04	-0.04
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-12.17	-8.84	-10.50
San Joaquin River Region			
Pasture	-9.76	-9.62	-9.64
Alfalfa	-12.53	-12.28	-12.40
Sugar Beets	-0.67	-0.63	-0.68
Other Field Crops	-13.69	-13.44	-13.44
Rice	-2.58	-2.47	-2.58
Truck Crops	-4.34	-3.73	-4.22
Tomatoes	-4.13	-3.56	-4.01
Deciduous Orchard	-2.40	-2.40	-2.40
Small Grain	-2.43	-2.60	-2.27
Grapes	-1.36	-1.36	-1.36
Cotton	-39.21	-33.60	-37.82
Subtropical Orchard	-0.07	-0.07	-0.07
Subtotal	-93.17	-85.76	-90.89
Tulare Lake Region			
Pasture	0.15	0.11	0.15
Alfalfa	-0.35	-1.35	-0.39
Sugar Beets	-0.19	-0.25	-0.19
Other Field Crops Crops	-0.81	-1.37	-0.88
Rice	0.00	0.00	0.00
Truck Crops	-0.98	-1.22	-1.14
Tomatoes	-0.04	-0.05	-0.04
Deciduous Orchard	0.26	0.26	0.26
Small Grain	-0.24	-0.75	-0.29
Grapes	0.48	0.48	0.48
Cotton	-12.16	-17.99	-12.79
Subtropical Orchard	0.00	0.00	0.00
Subtotal	-13.88	-22.13	-14.83
San Felipe Division			
Pasture and Hay	-0.16	-0.14	-0.14
Other Field Crops	-0.79	-0.65	-0.65
Vegetable	-24.25	-24.01	-24.01
Tree and Vine	-4.17	-4.17	-4.17
Subtotal	-34.40	-29.00	-28.97
Total	**-151.49**	**-145.72**	**-145.17**

NOTE:
All values in million dollars/year.

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In addition to these components, Alternative 4 also includes water acquired for restoration purposes, and the revenue from this water becomes another component of income to the agricultural sector. Table III-41 summarizes these components for the average 1922-1990 condition. Dry and wet conditions would show similar relationships to average as Alternative 1.

TABLE III-41

CHANGE IN NET REVENUE IN ALTERNATIVE 4 AS COMPARED TO NO-ACTION ALTERNATIVE

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Felipe Division	Total
Fallowed Land	-2.4	-15.6	-2.3	-3.3	-23.2
Groundwater Pumping	-3.9	-22.5	-2.0	0.0	-28.4
Irrigation Cost	-0.3	-3.7	-0.7	0.0	-4.7
CVP Water Cost	-0.3	-11.4	-16.3	-0.3	-28.3
Total Reduction	-6.8	-53.1	-21.3	-3.6	-84.6
Increase From Higher Crop Prices	4.5	6.5	4.9	0.0	15.9
Increase From Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase From Water Sales	8.8	58.5	1.7	0.0	68.9
Combined Net Revenue Change	6.5	12.7	-13.6	-3.6	2.3

NOTE:
All values in million dollars/year.

Approximately $84.6 million in lost net income is offset by about $15.9 million increase from higher crop prices plus an estimated $2 million in annual payments for land retirement and $69 million in revenue from selling water for restoration purposes. The net result is an **increase** in net income of about $2.3 million per year. This increase masks significant winners and losers, with winners being growers able to sell water at a high price, and losers being primarily CVP contract water users. Their losses are similar to the estimates shown in Alternative 1. Also, workers and businesses dependent on crop production will lose work (third party impacts are discussed in the Regional Economics Technical Appendix).

The net income estimates are not detailed by crop because the analysis treats the farm as an entire operation. Different water sources are not designated to specific crops, so an increase in water cost cannot be apportioned to individual crops.

AGRICULTURAL WATER USE

Water use reported here represents an estimate of the change in water actually applied to the field for crop growth, rather than diversions or deliveries to contractors. The numbers in Table III-42 represent the net effect of reductions in CVP delivery, changes in SWP delivery in Tulare Lake Region, reductions due to water acquisition, and changes in groundwater use. Figure III-3 also illustrates the changes in applied irrigation water.

TABLE III-42

APPLIED IRRIGATION WATER IN ALTERNATIVE 4 AS COMPARED TO NO-ACTION ALTERNATIVE

Source	Average (1922-90)	Dry (1928-34)	Wet (1967-71)
Sacramento River Region			
Surface Water	-194	-229	-178
Groundwater	82	125	62
Total Applied	-112	-104	-116
San Joaquin River Region			
Surface Water	-854	-804	-815
Groundwater	213	151	192
Total Applied	-641	-653	-623
Tulare Lake Region			
Surface Water	-69	-52	-97
Groundwater	-9	-64	18
Total Applied	-78	-116	-79
San Felipe Division (1)			
CVP Water	-20	-17	-16
Total			
Surface Water	-1,137	-1,102	-1,106
Groundwater	286	212	272
Total Applied	-851	-890	-834

NOTES:
(1) Non-CVP supplies are not estimated for the San Felipe Division.

All values in 1,000 acre-feet/year.

The two most important differences from Alternative 1 are the acquisition of water for restoration and the use of dedicated water for in-Delta purposes. Some water is acquired in all three regions for Level 2 refuge water supply, and additional water is purchased for instream flow in the Sacramento River and San Joaquin River Regions. Because Alternative 4 allows expenditure for water acquisition beyond what is currently authorized in the Restoration Fund, substantially more water is acquired than in Alternative 2.

Groundwater use increases more in Alternative 4 than in Alternative 1 (286,000 acre-feet vs. 115,000 acre-feet). This occurs because additional use of groundwater to replace a greater loss of supply to dedicated water, plus a shift of acreage from the areas selling water for restoration, where groundwater substitution is not allowed, to areas not selling water, where Interior has no means to prevent additional groundwater pumping.

Table III-43 shows average irrigation efficiency by region. Average irrigation efficiency changes very little in the Sacramento River and Tulare Lake regions compared to the No-Action Alternative. A modest increase in efficiency is estimated in the San Joaquin River Region (from 71.8 percent to 72.7 percent). Valley-wide, the irrigation efficiency rises about 0.4 percent, similar to Alternatives 1 and 2. Because a portion of this increase is caused by a change in crop mix, the analysis does not indicate any significant investment in irrigation technology as a result of implementing Alternative 4.

TABLE III-43

IRRIGATION WATER USE AND EFFICIENCY IN ALTERNATIVE 4

Region	Applied water (1,000 acre-feet)	ET of applied water (1,000 acre-feet)	Irrigation Efficiency (%)
Sacramento River	7,015	4,640	66.1
San Joaquin River	7,239	5,261	72.7
Tulare Lake	5,979	4,420	73.9
Total	**20,233**	**14,321**	**70.8**

NOTE:
Non-CVP supplies are not estimated for the San Felipe Division.

IMPACTS ON CONSUMERS

Using surplus to consumers of Central Valley produce as a measure of losses caused by lower supply and higher prices of farm goods, losses are estimated to be about $15.6 million per year.

The reduction in hay and pasture in Alternative 4 represents about 10 percent of Central Valley production. If all the reduction is replaced by forage from outside the Central Valley, which costs about 40 percent more, forage cost would increase 4 percent (40 percent of 10 percent). Feed cost represents about 50 percent of the total cost of milk production, so the impact on the cost of producing milk would be about 2 percent. Localized impacts could be larger.

FEDERAL COMMODITY PAYMENTS

Alternative 4 would decrease agricultural revenues from USDA farm programs because retired land would lose eligibility for farm program payments. These revenues are an expense for the federal government. Table III-44 shows agricultural commodity acreage idled by Alternative 4 and the direct reduction of about $11.6 million in annual farm program costs. Cost savings are estimated based on average deficiency payment rates over the 1987 to 1990 period. Over 90 percent of the cost savings is associated with the retirement or permanent fallowing of rice and cotton acreage. Some additional savings may also result indirectly from higher crop prices.

TABLE III-44

ACREAGE OF COMMODITY CROPS RETIRED AND CORRESPONDING REDUCTION IN FEDERAL FARM PROGRAM COSTS IN ALTERNATIVE 4

Region	Commodity Acreage Retired (1,000 acres)	Farm Program Cost Savings (million $ per year)
Sacramento River	17.0	4.4
San Joaquin River	66.8	5.8
Tulare Lake	14.4	1.4
San Felipe Division	0.0	0.0
Total	**98.2**	**11.6**

The 1996 Farm Bill recently signed into law revises the way commodity payments are determined, and decouples the size of the payment from the actual production level. There remains, however, some uncertainty about how USDA will handle lands that are part of a grower's base acreage yet are retired or fallowed as CVPIA is implemented. For purposes of analysis we assume that USDA will remove such lands from the grower's base acreage and reduce the deficiency payment accordingly.

VARIABILITY, RISK, AND UNCERTAINTY

Most of the impacts from risk and uncertainty in Alternative 4 are the same as in Alternative 1. Additional risk or uncertainty might occur due to water acquisition. Land fallowing or retirement, if concentrated in a small area, could threaten the infrastructure of suppliers, farm labor, and processors available to the remaining producers. Some additional uncertainty is placed on those who divert downstream from areas selling water for restoration. Changes in the timing of streamflows and availability of irrigation return flows could also affect some growers' pattern or costs of diversion.

Growers who sell water may be able to reduce financial risk. A steady income from water sales can combine with more variable crop revenues to provide a less risky income stream. Water sold

can also be used to finance other production costs that otherwise would be funded through borrowing.

LAND VALUES

Land values in areas of higher water costs or losses of supply would be affected as in Alternative 1. Average reductions in land values in the most affected region, San Joaquin River Region, could be $320 per acre based on the regional change in net income.

Areas selling water would either be unaffected or increase in land value, as long as the water remained attached, or allocated, to the land. In other words, if the right to sell water depends on ownership or control of the land, then profit from selling the water would be capitalized into the price of the land. For example, if water is sold for $20 more per acre-foot than its net value in producing crops, then at 3 acre-feet per acre, profit would increase by $60 per acre and land value might increase by $750 per acre (capitalizing the annual profit at a 4 percent real rate). But if the right to sell water is separated from ownership of land, then the price of that land could fall (though the decline would be more than compensated by the stream of profits on water sales).

FINANCE AND CREDIT

Availability of credit for farming depends largely on the expected profitability of production, the risk or variability of profitability, and the collateral available to secure the lender's money. Therefore, changes in conditions that reduce profit, increase risk, or reduce the value of land can be expected to reduce lenders' willingness to lend money or to increase the interest rate they charge, and vice versa. The same potential increases in risk and reduction in profit discussed in Alternative 1 also apply in Alternative 4.

Growers able to sell water for restoration can potentially increase net income and reduce risk, which would increase credit worthiness.

COSTS OF WATER CONSERVATION AND MEASUREMENT

Conservation and measurement costs for Alternative 4 would be similar to Alternative 1. In summary, net costs of conservation provisions will probably not be significant for districts that already measure water to customers. For districts that do not currently measure delivery to each customer, the cost per acre could be $4 to $33 per year. With the exception of measurement, most mandatory provisions are either inexpensive or would be required even without the CVPIA. Discretionary provisions may be avoided if their costs are burdensome or far exceed the benefits.

SUPPLEMENTAL ANALYSIS 4a : WATER TRANSFER OPPORTUNITIES

Assumptions

The supplemental analysis of water transfers without fees is based upon most of the same assumptions as in the No-Action Alternative transfers scenario. The major differences are the use of Alternative 4 hydrology, water pricing, and water acquisitions, and the assumption that all

CVP water is transferable with specific costs imposed. These costs and assumptions are detailed in the Municipal Water Costs and Water Transfer Opportunities Technical Appendices.

Results shown here should be viewed as an example of the relative magnitude of the impacts of CVPIA on water transfers. Actual water transfers occurring in the future will be determined by a number of specific conditions that cannot be predicted in a programmatic analysis.

Results

The results of Supplemental Analysis 4a are presented in Table III-45. Under conditions assumed for 4a, total water transfers are estimated at 160,000 acre-feet in an average year and 969,000 acre-feet in a dry year. Most average year transfers are estimated to be from the San Joaquin River and Tulare Lake regions to urban uses in the Central and South Coast regions. The higher average year demand in 4a than that in Supplemental Analysis 1e is due primarily to agricultural and urban purchases to replace some of the additional shortage imposed by reduced Delta pumping.

TABLE III-45

SUPPLEMENTAL ANALYSIS 4a AS COMPARED TO ALTERNATIVE 4

	Agricultural Water Transfer (1) (1,000 acre-feet)		Land Fallowed as a Result of Transfer (2) (1,000 acres)		Receipts from Transfers (3) ($1,000)		Net Revenue Change (4) ($1,000)	
Region	**Average**	**Dry**	**Average**	**Dry**	**Average**	**Dry**	**Average**	**Dry**
Sacramento River	-5	-400	-1	-90	359	35,112	278	28,122
San Joaquin River	29	-206	3	-58	-2,257	28,824	386	21,810
Tulare Lake	-184	-364	-52	-124	22,481	68,488	14,840	52,368
Total	**-160**	**-970**	**-50**	**-272**	**20,583**	**132,424**	**15,504**	**102,300**

NOTES:

(1) Negative number indicates water transferred out of the region; positive number indicates water transferred into the region.

(2) Negative number indicates decreased crop acreage due to water transferred out; positive number indicates increased crop acreage due to water transferred in.

(3) Positive number indicates revenue received for water transferred out; negative number indicates payment for water transferred in.

(4) Net revenue change represents the gains from trade in a region. For selling regions, this equals receipts from water sold (net of its cost) minus the net revenue lost from lower crop acreage. For buying regions, net revenue change equals net revenue from added crop acres plus the avoided cost of groundwater pumping minus payment for water purchased.

The San Felipe Division was not explicitly considered in the quantitative analysis of water transfer opportunities. It is not expected to be a seller of water but might participate as a buyer.

Land fallowing as a result of water transfers in an average year is estimated to be 50,000 acres, or less than 1 percent of the total irrigated acreage in the three regions. Higher demands for transferred water in dry years increase the land fallowing to about 272,000 acres, or four percent. In general, crop lands idled by transfers are pasture, hay, grain, field crops, rice, and cotton.

Anticipated change in net revenues to agricultural water users has been estimated by combining net revenue loss due to crop reductions, the cost of any purchased water, and the income from water sales. In all cases sellers are expected to benefit from water transfers. Gains range from $15.5 million ($55-$80 per acre-foot sold) in an average year to $102 million ($70-$140 per acre-foot sold) in a dry year, when urban users bid up water prices to make up for shortfalls in supplies from their normal water sources. The estimates of gains to sellers do not include any cost of tilling, weed control, etc. that may be needed for temporarily fallowed land. If these activities cost $25-$30 per acre, this would reduce the net gain per acre-foot by about $10.

The estimates above focus on interregional transfers. Local transfers within a region are not included in these estimates, but would not have the system-wide implications and impacts that interregional transfers are likely to have. The ability to transfer water to other regions may reduce local transfers by increasing the competition for water.

SUMMARY COMPARISON OF ALTERNATIVES

This section summarizes the major analytical results for the main four alternatives. Summary tables show information by region for the 1922-1990 average hydrologic and water delivery conditions. The major features of the alternatives are as follows:

- Alternative 1 implements most of the provisions of CVPIA, except for water acquisition. Impacts to agriculture are: reductions in CVP project delivery due to dedicated water, reoperation, and Level 2 supply for wildlife refuges; higher cost of CVP water due to restoration charges and tiered water pricing; reduced land in irrigation due to the land retirement program and additional fallowing; additional cost for groundwater pumping and water conservation measures, including irrigation system changes.

- Alternative 2 differs from Alternative 1 in water acquired, which is purchased from, by assumption, willing agricultural sellers. Therefore any additional direct impacts on agriculture due to water acquisition beyond Alternative 1 is assumed to be compensated through the payments for acquiring water. Alternative 2 water acquisitions are assumed to be limited to what is affordable by the Restoration Fund.

- Alternative 3 increases the quantity of acquired water compared to Alternative 2, and allows the export of water acquired for instream flow, if consistent with water quality and environmental constraints.

- Alternative 4 assumes the same water acquisition program as Alternative 3, but also prescribes the use of dedicated and acquired water in the Delta. The primary impact of this distinction appears as further reductions in CVP contract delivery, mostly south of Delta. Acquired water is used for enhancing Delta outflow, and cannot be exported.

Impacts on third parties due to water acquisition (farm labor, agricultural suppliers and processors, downstream users of return flows) become increasingly larger as greater amounts of water are acquired, and these impacts are described here and in other Technical Appendices. Tables III-46 through III-49 summarize the comparison of each alternative to the No-Action Alternative for the key, quantified impact assessment variables.

TABLE III-46

IRRIGATED ACREAGE
1922-1990 AVERAGE CONDITION

		Changes Compared to No-Action Alternative			
	No-Action Alternative	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Alternative 4**
Sacramento River Region					
Pasture and Hay	280	-0.3	0.3	-6.0	-5.6
Rice	473	-1.2	-4.3	-12.7	-12.6
Cotton	0	0.0	0.0	0.0	0.0
Other Field	615	-0.1	-1.8	-4.6	-4.6
Vegetable	250	0.0	-0.2	-0.2	-0.2
Tree and Vine	400	0.0	0.0	-0.3	-0.3
Subtotal	**2,020**	**-1.6**	**-6.0**	**-23.8**	**-23.3**
San Joaquin River Region					
Pasture and Hay	338	-3.9	-22.3	-67	-73.5
Rice	14	-0.1	-0.9	-3.0	-3.2
Cotton	465	-18.7	-25.5	-27.7	-37.2
Other Field	479	-5.5	-12.2	-25.8	-27.2
Vegetable	462	-2.4	-3.0	-2.9	-3.9
Tree and Vine	800	-0.2	-1.0	-3.3	-3.4
Subtotal	**2,558**	**-30.9**	**-64.9**	**-129.7**	**-148.5**
Tulare Lake Region					
Pasture and Hay	191	-2.7	-2.4	-1.3	-3.6
Rice	0	0.0	0.0	0.0	0.0
Cotton	646	-9.7	-9.3	-9.2	-12.7
Other Field	304	-2.7	-1.9	-2.4	-1.9
Vegetable	211	-0.3	-0.3	-0.3	-0.2
Tree and Vine	657	-0.2	-0.2	-0.2	-0.3
Subtotal	**2,009**	**-15.6**	**-14.1**	**-13.4**	**-18.8**
San Felipe Division					
Pasture and Hay	2	-0.7	-0.7	-0.4	-0.7
Rice	0	0.0	0.0	0.0	0.0
Cotton	0	0.0	0.0	0.0	0.0
Other Field	3	-1.2	-1.2	-0.7	-1.3
Vegetable	12	-4.4	-4.4	-2.4	-4.9
Tree and Vine	8	-2.7	-2.7	-1.5	-2.9
Subtotal	**25**	**-9.0**	**-9.0**	**-5.0**	**-9.8**
Total	**6,611**	**-57.1**	**-94.0**	**-171.9**	**-200.3**

NOTE:
All values in thousand acres.

TABLE III-47

IRRIGATION WATER APPLIED
1922-1990 AVERAGE CONDITION

Source	No-Action Alternative	Change Compared to No-Action Alternative			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River Region					
Surface Water	4,524	-39	-72	-195	-194
Groundwater	2,603	25	38	80	82
Total Applied	7,127	-14	-34	-115	-112
San Joaquin River Region					
Surface Water	4,453	-302	-480	-697	-854
Groundwater	3,427	134	182	124	213
Total Applied	7,880	-168	-298	-573	-641
Tulare Lake Region					
Surface Water	2,761	-22	-39	26	-69
Groundwater	3,297	-44	-23	-83	-9
Total Applied	6,058	-66	-62	-57	-78
Total Central Valley					
Surface Water	11,738	-363	-591	-866	-1,117
Groundwater	9,327	115	197	121	286
Total Applied	21,065	-248	-394	-745	-831
San Felipe Division (1)					
CVP Water	71	-18	-18	-10	-20

NOTES:
(1) Non-CVP supplies are not estimated for the San Felipe Division.
All values in thousand acre-feet per year.

TABLE III-48

GROSS REVENUE
1922-1990 AVERAGE CONDITION

Crop	No-Action Alternative	Changes Compared to No-Action Alternative			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River Region					
Pasture and Hay	89	0.3	0.9	1.2	1.7
Rice	401	-1.0	-3.6	-10.4	-10.3
Cotton	0	0.0	0.0	0.0	0.0
Other Field	269	0.0	-0.7	-1.9	-1.9
Vegetable	615	0.4	0.2	0.0	0.2
Tree and Vine	455	0.0	0.1	0.1	0.2
Subtotal	**1,828**	**-0.3**	**-3.0**	**-10.9**	**-10.0**
San Joaquin River Region					
Pasture and Hay	145	-1.5	-7.4	-19.6	-22.3
Rice	12	-0.1	-0.7	-2.4	-2.6
Cotton	503	-20.5	-27.2	-29.3	-39.2
Other Field	276	-3.2	-7.4	-15.7	-16.8
Vegetable	2,095	-5.8	-7.2	-6.9	-8.5
Tree and Vine	1,405	-0.2	-1.1	-3.7	-3.8
Subtotal	**4,436**	**-31.3**	**-51.1**	**-77.6**	**-93.2**
Tulare Lake Region					
Pasture and Hay	114	-1.2	-0.5	0.8	-0.2
Rice	0	0.0	0.0	0.0	0.0
Cotton	713	-9.6	-9.0	-8.8	-12.2
Other Field	186	-1.7	-1.2	-1.5	-1.2
Vegetable	1,265	-1.8	-1.6	-1.8	-1.0
Tree and Vine	1,616	-0.3	0.0	0.8	0.7
Subtotal	**3,893**	**-14.5**	**-12.4**	**-10.4**	**-13.9**
San Felipe Division					
Pasture and Hay	0	-0.1	-0.1	-0.1	-0.2
Rice	0	0.0	0.0	0.0	0.0
Cotton	0	0.0	0.0	0.0	0.0
Other Field	2	-0.7	-0.7	-0.4	-0.8
Vegetable	75	-26.6	-26.6	-14.6	-29.3
Tree and Vine	11	-3.8	-3.8	-2.1	-4.2
Subtotal	**88**	**-31.2**	**-31.2**	**-17.1**	**-34.4**
Total	**10,245**	**-77.3**	**-97.7**	**-116.1**	**-151.5**

NOTE:
All values in million dollars per year.

TABLE III-49

CHANGE IN NET REVENUE
1922-1990 AVERAGE CONDITION

Component	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Felipe Division	Total
NO-ACTION ALTERNATIVE					
Net Revenue	268	558	522	8	1356
ALTERNATIVE 1 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	0.6	-1.9	-0.4	-3.0	-4.8
Groundwater Pumping	-1.4	-18.0	2.1	0.0	-17.4
Irrigation Cost	-0.3	-3.8	-0.8	0.0	-4.8
CVP Water Cost	-0.3	-11.9	-16.5	-0.3	-29.0
Total Reduction	-1.4	-35.6	-15.6	-3.3	-56.0
Increase from Higher Crop Prices	1.1	1.6	1.2	0.0	3.9
Increase from Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase from Water Sales	0.0	0.0	0.0	0.0	0.0
Combined Net Revenue Change	-0.3	-33.1	-13.4	-3.3	-50.1
ALTERNATIVE 2 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	-0.7	-7.2	-1.8	-3.0	-12.7
Groundwater Pumping	-1.8	-20.0	0.5	0.0	-21.3
Irrigation Cost	-0.3	-3.7	-0.8	0.0	-4.7
CVP Water Cost	-0.3	-12.5	-16.5	-0.3	-29.6
Total Reduction	-3.1	-43.4	-18.6	-3.3	-68.4
Increase from Higher Crop Prices	1.7	3.1	2.4	0.0	7.2
Increase from Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase from Water Sales	1.2	13.7	2.6	0.0	17.5
Combined Net Revenue Change	-0.2	-25.7	-12.5	-3.3	-41.7
ALTERNATIVE 3 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	-2.4	-13.4	-1.6	-1.6	-19.0
Groundwater Pumping	-3.2	-14.2	3.8	0.0	-13.6
Irrigation Cost	-0.3	-3.7	-0.7	0.0	-4.7
CVP Water Cost	-0.3	-12.9	-16.5	-0.4	-30.0
Total Reduction	-6.2	-44.1	-15.0	-2.0	-67.4
Increase from Higher Crop Prices	4.0	5.7	4.1	0.0	13.7
Increase from Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase from Water Sales	8.7	57.6	1.6	0.0	67.9
Combined Net Revenue Change	6.5	20.1	-8.3	-2.0	16.3
ALTERNATIVE 4 COMPARED TO NO-ACTION ALTERNATIVE					
Fallowed Land	-2.4	-15.6	-2.3	-3.3	-23.2
Groundwater Pumping	-3.9	-22.5	-2.0	0.0	-28.4
Irrigation Cost	-0.3	-3.7	-0.7	0.0	-4.7
CVP Water Cost	-0.3	-11.4	-16.3	-0.3	-28.3
Total Reduction	-6.8	-53.1	-21.3	-3.6	-84.6
Increase from Higher Crop Prices	4.5	6.5	4.9	0.0	15.9
Increase from Land Retirement	0.0	0.9	1.1	0.0	2.0
Increase from Water Sales	8.8	58.5	1.7	0.0	68.9
Combined Net Revenue Change	6.5	12.7	-13.6	-3.6	2.0

NOTE:
All values in million dollars per year.

CHAPTER IV

BIBLIOGRAPHY

Chapter IV

BIBLIOGRAPHY

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ATTACHMENT A

ANALYTICAL RESULTS BY SUBREGION

Attachment A

ANALYTICAL RESULTS BY SUBREGION

The main body of the Agricultural Economics and Land Use Technical Appendix provides a summary of results, using a level of aggregation appropriate for a programmatic analysis. As appropriate, the discussion also highlights smaller areas that might be especially affected. We recognize that some readers have interests in particular areas or districts, so this attachment provides some additional detail to assist them. However, we caution that the analysis for this PEIS was not designed or intended to provide district-level or site-specific impact analysis.

This attachment provides the detailed analytical results underlying the results of the No-Action Alternative and the four main alternatives presented in the body of the Technical Appendix. Descriptions of the 22 CVPM subregions are presented in Table A-1. Tables A-2 through A-11 present acreage and gross revenue estimates for the 22 subregions in the CVPM model of the Central Valley. Table A-12 provides summary acreage estimates by crop and subregion for the average year condition. The subregions are shown in Figure A-1, except that the figure's Subregion 3 is divided for the analysis into Subregion 3, which includes Glenn-Colusa Irrigation District and other water rights contractors, and Subregion 3B, which encompasses the Tehama-Colusa Service Area.

TABLE A-1

CVPM SUBREGIONS AND DESCRIPTIONS

CVPM Subregion	Description of Major Water Users
1	CVP Users: Anderson Cottonwood, Clear Creek, Bella Vista, Sacramento River miscellaneous users.
2	CVP Users: Corning Canal, Kirkwood, Tehama, Sacramento River miscellaneous users.
3	CVP Users: Glenn Colusa ID, Provident, Princeton-Codora, Maxwell, and Colusa Basin Drain MWC.
3b	Tehama Colusa Canal Service Area. CVP Users: Orland-Artois WD, most of County of Colusa, Davis, Dunnigan, Glide, Kanawha, La Grande, Westside WD.
4	CVP Users: Princeton-Codora-Glenn, Colusa Irrigation Co., Meridian Farm WC, Pelger Mutual WC, Recl. Dist. 1004, Recl. Dist. 108, Roberts Ditch, Sartain M.D., Sutter MWC, Swinford Tract IC, Tisdale Irrigation, Sac River miscellaneous users.
5	Most Feather River Region riparian and appropriative users.
7	Sacramento Co. north of American River. CVP Users: Natomas Central MWC, Sac River miscellaneous users, Pleasant Grove-Verona, San Juan Suburban.
6	Yolo, Solano Counties. CVP Users: Conaway Ranch, Sac River Miscellaneous users.
9	Delta Regions. CVP Users: Banta Carbona, West Side, Plainview.
8	Sacramento Co. south of American River, San Joaquin Co.
10	Delta Mendota Canal. CVP Users: Panoche, Pacheco, Del Puerto, Hospital, Sunflower, West Stanislaus, Mustang, Orestimba, Patterson, Foothill, San Luis WD, Broadview, Eagle Field, Mercy Springs, Pool Exchange Contractors, Schedule II water rights, more.
11	Stanislaus River water rights: Modesto ID, Oakdale ID, South San Joaquin ID.
12	Turlock ID.
13	Merced ID. CVP Users: Madera, Chowchilla, Gravely Ford.
14	CVP Users: Westlands WD.
15	Tulare Lake Bed. CVP Users: Fresno Slough, James, Tranquillity, Traction Ranch, Laguna, Real. Dist. 1606.
16	Eastern Fresno Co. CVP Users: Friant-Kern Canal. Fresno ID, Garfield, International.
17	CVP Users: Friant-Kern Canal. Hills Valley, Tri-Valley Orange Cove.
18	CVP Users: Friant-Kern Canal, County of Fresno, Lower Tule River ID, Pixley ID, portion of Rag Gulch, Ducor, County of Tulare, most of Delano Earlimart, Exeter, Ivanhoe, Lewis Cr., Lindmore, Lindsay-Strathmore, Porterville, Sausalito, Stone Corral, Tea Pot Dome, Terra Bella, Tulare.
19	Kern Co. SWP Service Area.
20	CVP Users: Friant-Kern Canal. Shafter-Wasco, S. San Joaquin.
21	CVP Users: Cross Valley Canal, Friant-Kern Canal. Arvin Edison.

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TABLE A-2

IRRIGATED ACREAGE IN THE NO-ACTION ALTERNATIVE

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	27	26	27
2	195	194	195
3	294	290	295
3B	88	80	88
4	276	274	276
5	364	363	365
6	280	278	280
7	92	91	92
8	284	283	285
9	425	419	426
10	430	428	431
11	174	174	174
12	201	200	200
13	535	533	535
14	525	512	525
15	604	585	605
16	111	111	112
17	260	254	260
18	592	577	595
19	259	253	259
20	203	199	204
21	368	361	369

NOTES:
1. All acreage values in thousands.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

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TABLE A-3

IRRIGATED ACREAGE IN ALTERNATIVE 1

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	27	26	27
2	195	194	195
3	292	288	293
3B	87	86	88
4	276	274	276
5	364	362	365
6	281	280	281
7	91	91	91
8	284	282	284
9	425	419	426
10	427	427	427
11	174	174	174
12	200	200	201
13	533	532	534
14	500	489	500
15	601	577	603
16	111	110	112
17	260	256	260
18	592	577	595
19	254	248	254
20	203	199	204
21	359	354	359

NOTES:
1. All acreage values in thousands.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

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TABLE A-4

IRRIGATED ACREAGE IN ALTERNATIVE 2

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	27	26	27
2	195	194	195
3	291	287	292
3B	87	86	88
4	271	269	271
5	365	363	365
6	281	280	281
7	92	91	91
8	285	283	285
9	425	417	426
10	415	415	415
11	167	167	167
12	196	195	195
13	523	522	526
14	500	488	500
15	601	577	603
16	111	110	112
17	260	255	260
18	594	577	595
19	253	246	253
20	203	199	203
21	359	354	359

NOTES:
1. All acreage values in thousands.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

TABLE A-5

IRRIGATED ACREAGE IN ALTERNATIVE 3

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	27	27	27
2	196	194	195
3	291	287	292
3B	88	86	88
4	271	269	271
5	352	350	353
6	281	280	281
7	92	91	92
8	272	271	272
9	425	413	426
10	427	428	421
11	140	139	140
12	180	180	181
13	494	495	497
14	500	499	501
15	602	577	605
16	112	110	112
17	260	255	260
18	594	577	596
19	254	250	254
20	203	199	204
21	359	359	359

NOTES:
1. All acreage values in thousands.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

TABLE A-6

IRRIGATED ACREAGE IN ALTERNATIVE 4

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	27	27	27
2	196	194	195
3	291	287	292
3B	88	86	88
4	271	269	271
5	352	350	353
6	281	280	281
7	92	91	92
8	272	270	272
9	425	413	426
10	412	414	410
11	140	139	140
12	180	180	180
13	494	495	497
14	496	488	498
15	602	577	603
16	112	110	112
17	260	255	260
18	594	577	596
19	249	241	250
20	203	199	204
21	358	350	359

NOTES:
1. All acreage values in thousands.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

TABLE A-7

GROSS REVENUE IN THE NO-ACTION ALTERNATIVE

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	8	8	8
2	190	189	189
3	301	299	302
3B	68	64	68
4	261	260	261
5	320	319	321
6	220	220	220
7	62	62	62
8	300	299	300
9	427	425	427
10	1,017	1,017	1,018
11	208	208	208
12	231	231	231
13	712	711	712
14	1,282	1,268	1,281
15	686	672	688
16	224	224	224
17	566	561	566
18	974	962	976
19	438	433	439
20	604	600	605
21	1,057	1,051	1,058

NOTES:
1. All revenue values are in million dollars.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

C-082861

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TABLE A-8

GROSS REVENUE IN ALTERNATIVE 1

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	8	8	8
2	190	189	190
3	300	298	301
3B	68	67	68
4	261	260	261
5	320	319	321
6	221	221	221
7	62	62	62
8	300	300	300
9	427	425	427
10	1,016	1,016	1,016
11	208	208	208
12	231	231	231
13	711	711	712
14	1,254	1,241	1,254
15	685	665	686
16	224	224	225
17	566	562	566
18	975	963	977
19	434	429	434
20	604	601	605
21	1,048	1,043	1,048

NOTES:
1. All revenue values are in million dollars.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

TABLE A-9

GROSS REVENUE IN ALTERNATIVE 2

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	8	8	8
2	190	189	190
3	300	297	300
3B	68	68	68
4	261	257	258
5	320	319	321
6	221	221	221
7	62	62	62
8	300	300	300
9	427	425	428
10	1,016	1,006	1,006
11	208	205	205
12	231	229	229
13	711	705	707
14	1,254	1,241	1,254
15	685	666	686
16	224	224	225
17	566	562	566
18	975	963	977
19	434	427	433
20	604	601	605
21	1,048	1,043	1,048

NOTES:
1. All revenue values are in million dollars.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

C-082863

C-082863

TABLE A-10

GROSS REVENUE IN ALTERNATIVE 3

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	9	9	9
2	190	190	190
3	300	297	301
3B	68	68	68
4	258	257	258
5	313	312	313
6	221	221	221
7	63	62	63
8	297	296	297
9	428	423	428
10	1,016	1,016	1,011
11	195	195	195
12	221	221	221
13	688	688	690
14	1,254	1,253	1,254
15	686	666	688
16	225	224	225
17	566	562	566
18	977	963	979
19	434	430	434
20	605	601	605
21	1,048	1,048	1,048

NOTES:
1. All revenue values are in million dollars.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

C-082864

C-082864

TABLE A-11

GROSS REVENUE IN ALTERNATIVE 4

CVPM Subregion	Average Year (1922-90)	Dry Year (1928 -34)	Wet Year (1967-71)
1	9	9	9
2	190	190	190
3	300	297	301
3B	68	68	68
4	258	257	258
5	313	312	313
6	221	221	222
7	63	62	63
8	297	296	297
9	428	423	428
10	1,004	1,006	1,003
11	195	195	195
12	221	221	221
13	688	688	689
14	1,250	1,241	1,251
15	687	667	687
16	225	224	225
17	566	562	566
18	977	964	979
19	430	423	430
20	605	601	606
21	1,048	1,041	1,049

NOTES:
1. All revenue values are in million dollars.
2. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

C-082865

C-082865

TABLE A-12

IRRIGATED ACREAGE
1922-1990 AVERAGE CONDITION

CVPM Subregion	Crop Category	No-Action Alternative	Changes Compared to No-Action Alternative			
			Alternative 1	Alternative 2	Alternative 3	Alternative 4
1	Pasture	18.3	-0.1	0.1	0.3	0.4
1	Alfalfa	0.9	0.0	0.0	0.0	0.0
1	Other Field Crops	1.2	0.0	0.0	0.0	0.0
1	Deciduous Orchard	3.8	0.0	0.0	0.0	0.0
1	Small Grain	2.4	0.0	0.0	0.0	0.0
	Subtotal	**26.6**	**-0.1**	**0.1**	**0.3**	**0.4**
2	Pasture	34.1	0.0	0.2	0.7	0.7
2	Alfalfa	9.5	0.0	0.0	0.1	0.1
2	Sugar Beets	4.0	0.0	0.0	0.0	0.0
2	Other Field Crops	17.3	0.0	0.0	0.0	0.0
2	Rice	4.5	0.0	0.0	0.0	0.0
2	Truck Crops	15.5	0.0	0.0	0.0	0.0
2	Deciduous Orchard	86.0	0.0	0.0	0.0	0.0
2	Small Grain	14.0	0.0	0.0	0.0	0.0
2	Subtropical Orchard	10.2	0.0	0.0	0.0	0.0
	Subtotal	**195.0**	**0.0**	**0.2**	**0.7**	**0.7**
3	Pasture	8.2	-0.2	-0.3	-0.1	-0.1
3	Alfalfa	18.5	-0.1	-0.2	-0.1	-0.1
3	Sugar Beets	9.9	0.0	0.0	0.0	0.0
3	Other Field Crops	15.9	-0.1	-0.2	-0.2	-0.2
3	Rice	141.6	-1.1	-2.0	-1.9	-1.9
3	Truck Crops	25.2	0.0	0.0	0.0	0.0
3	Tomatoes	26.0	0.0	-0.1	-0.1	0.0
3	Deciduous Orchard	17.8	0.0	0.0	0.0	0.0
3	Small Grain	30.7	-0.1	-0.2	-0.2	-0.2
	Subtotal	**293.9**	**-1.6**	**-2.9**	**-2.5**	**-2.5**
3B	Pasture	5.7	-0.1	0.0	0.1	0.0
3B	Alfalfa	10.1	0.0	0.0	0.0	0.1
3B	Sugar Beets	5.6	0.0	0.0	0.0	0.0
3B	Other Field Crops	13.5	0.0	0.0	0.0	0.0
3B	Rice	9.6	0.0	0.0	0.0	0.0
3B	Truck Crops	0.6	0.0	0.0	0.0	0.0
3B	Tomatoes	6.1	0.0	0.0	0.0	0.0
3B	Deciduous Orchard	26.9	0.0	0.0	0.0	0.0
3B	Small Grain	8.5	0.0	0.0	0.0	0.0
3B	Subtropical Orchard	1.0	0.0	0.0	0.0	0.0
	Subtotal	**87.6**	**-0.2**	**-0.1**	**0.0**	**0.0**

C-082866

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TABLE A-12. CONTINUED

CVPM Subregion	Crop Category	No-Action Alternative	Changes Compared to No-Action Alternative			
			Alternative 1	Alternative 2	Alternative 3	Alternative 4
4	Pasture	1.2	-0.0	-0.1	-0.1	-0.1
4	Alfalfa	6.8	0.0	-0.2	-0.2	-0.2
4	Sugar Beets	10.3	-0.0	-0.1	-0.1	-0.1
4	Other Field Crops	40.1	-0.0	-0.9	-0.9	-0.9
4	Rice	88.0	0.0	-2.7	-2.7	-2.7
4	Truck Crops	17.1	-0.0	-0.0	-0.0	-0.0
4	Tomatoes	34.0	0.0	-0.1	-0.1	-0.1
4	Deciduous Orchard	30.6	0.0	-0.0	-0.0	-0.0
4	Small Grain	47.5	0.0	-0.6	-0.6	-0.6
	Subtotal	**275.6**	**0.0**	**-4.7**	**-4.7**	**-4.6**
5	Pasture	21.3	-0.0	0.2	-2.6	-2.5
5	Alfalfa	4.7	0.0	0.0	-0.2	-0.2
5	Sugar Beets	2.0	0.0	0.0	-0.0	-0.0
5	Other Field Crops	15.4	-0.0	0.0	-0.6	-0.6
5	Rice	166.0	-0.1	0.4	-8.0	-7.8
5	Truck Crops	6.6	0.0	0.0	-0.0	-0.0
5	Tomatoes	1.6	0.0	0.0	-0.0	-0.0
5	Deciduous Orchard	121.6	0.0	0.0	-0.2	-0.2
5	Small Grain	22.3	-0.0	0.0	-0.5	-0.5
5	Subtropical Orchard	2.5	0.0	0.0	0.0	0.0
	Subtotal	**364.1**	**-0.1**	**0.7**	**-12.1**	**-11.8**
6	Pasture	12.1	0.1	0.2	0.4	0.4
6	Alfalfa	28.6	0.1	0.2	0.3	0.3
6	Sugar Beets	21.2	0.0	0.0	0.0	0.0
6	Other Field Crops	59.4	0.1	0.1	0.1	0.1
6	Rice	12.9	0.0	0.0	0.0	0.0
6	Truck Crops	3.4	0.0	0.0	0.0	0.0
6	Tomatoes	45.7	0.0	0.0	0.0	0.1
6	Deciduous Orchard	24.6	0.0	0.0	0.0	0.0
6	Small Grain	64.3	0.1	0.1	0.1	0.1
6	Grapes	8.0	-0.0	0.0	0.0	0.0
	Subtotal	**280.2**	**0.6**	**0.7**	**0.9**	**1.0**
7	Pasture	14.6	-0.1	0.0	0.2	0.2
7	Alfalfa	3.1	0.0	0.0	0.0	0.0
7	Sugar Beets	2.5	-0.0	0.0	0.0	0.0
7	Other Field Crops	3.8	-0.0	-0.0	-0.0	-0.0
7	Rice	48.3	-0.1	-0.1	-0.0	-0.0
7	Truck Crops	0.3	0.0	0.0	0.0	0.0
7	Tomatoes	0.5	0.0	0.0	0.0	0.0
7	Deciduous Orchard	8.9	-0.0	0.0	0.0	0.0
7	Small Grain	9.4	-0.0	0.0	0.0	0.0
7	Grapes	0.2	0.0	0.0	0.0	0.0
	Subtotal	**91.6**	**-0.1**	**-0.0**	**0.2**	**0.2**

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TABLE A-12. CONTINUED

CVPM Subregion	Crop Category	No-Action Alternative	Changes Compared to No-Action Alternative			
			Alternative 1	Alternative 2	Alternative 3	Alternative 4
8	Pasture	47.4	-0.1	0.1	-7.9	-7.9
8	Alfalfa	12.2	0.0	0.0	-0.8	-0.7
8	Sugar Beets	12.8	-0.0	-0.0	-0.2	-0.2
8	Other Field Crops	42.7	-0.0	-0.0	-1.9	-2.0
8	Rice	4.5	-0.0	-0.0	-0.3	-0.3
8	Truck Crops	17.1	0.0	0.0	-0.0	-0.0
8	Tomatoes	12.9	-0.0	0.0	-0.1	-0.1
8	Deciduous Orchard	46.9	0.0	0.0	-0.1	-0.1
8	Small Grain	29.0	-0.0	-0.0	-0.8	-0.8
8	Grapes	58.9	0.0	0.0	-0.1	-0.1
	Subtotal	**284.5**	**-0.2**	**0.0**	**-12.3**	**-12.3**
9	Pasture	24.5	-0.0	0.1	0.3	0.3
9	Alfalfa	43.6	0.1	0.1	0.1	0.2
9	Sugar Beets	28.6	-0.0	-0.0	-0.0	-0.0
9	Other Field Crops	114.8	-0.0	-0.1	-0.2	-0.2
9	Rice	0.9	-0.0	0.0	0.0	0.0
9	Truck Crops	46.0	0.0	0.0	0.0	0.0
9	Tomatoes	42.4	0.0	0.0	0.0	0.0
9	Deciduous Orchard	21.3	0.0	0.0	0.0	0.0
9	Small Grain	96.8	-0.0	-0.0	-0.1	-0.1
9	Grapes	5.8	-0.0	0.0	0.0	0.0
	Subtotal	**424.8**	**0.0**	**0.1**	**0.1**	**0.2**
10	Pasture	58.9	0.0	0.0	-0.1	-0.1
10	Alfalfa	41.4	-0.5	-3.8	-0.8	-4.3
10	Sugar Beets	14.0	-0.0	-0.2	-0.1	-0.3
10	Other Field Crops	48.7	-0.6	-2.3	-0.6	-2.8
10	Rice	3.0	-0.0	-0.3	-0.1	-0.3
10	Truck Crops	113.0	-0.0	-0.1	-0.0	-0.2
10	Tomatoes	40.3	-0.1	-0.6	-0.1	-0.7
10	Deciduous Orchard	36.6	-0.0	-0.1	-0.0	-0.1
10	Small Grain	14.1	-0.2	-0.4	-0.1	-0.4
10	Grapes	1.0	-0.0	0.0	0.0	0.0
10	Cotton	104.1	-1.0	-5.6	-1.4	-6.6
10	Subtropical Orchard	0.1	0.0	0.0	0.0	0.0
	Subtotal	**430.0**	**-2.8**	**-15.3**	**-3.4**	**-17.9**

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TABLE A-12. CONTINUED

CVPM Subregion	Crop Category	No-Action Alternative	Changes Compared to No-Action Alternative			
			Alternative 1	Alternative 2	Alternative 3	Alternative 4
11	Alfalfa	8.4	0.0	-0.7	-3.4	-3.3
11	Sugar Beets	0.4	0.0	-0.0	-0.0	-0.0
11	Other Field Crops	17.9	-0.0	-0.8	-3.9	-3.8
11	Rice	4.4	0.0	-0.4	-1.8	-1.8
11	Truck Crops	6.3	0.0	-0.0	-0.0	-0.0
11	Tomatoes	0.8	0.0	-0.0	-0.0	-0.0
11	Deciduous Orchard	80.8	0.0	-0.2	-0.8	-0.8
11	Small Grain	1.8	0.0	-0.0	-0.1	-0.1
11	Grapes	10.4	0.0	-0.0	-0.1	-0.1
	Subtotal	**174.2**	**0.0**	**-7.2**	**-34.6**	**-34.5**
12	Pasture	18.2	-0.1	-1.8	-7.6	-7.6
12	Alfalfa	18.2	-0.0	-1.2	-5.4	-5.4
12	Sugar Beets	0.1	0.0	0.0	-0.0	-0.0
12	Other Field Crops	41.2	-0.1	-1.4	-5.8	-5.9
12	Truck Crops	3.0	0.0	0.0	-0.0	-0.0
12	Deciduous Orchard	94.0	-0.0	-0.1	-0.6	-0.6
12	Small Grain	10.0	-0.0	-0.2	-0.6	-0.7
12	Grapes	14.0	0.0	-0.0	-0.1	-0.1
12	Cotton	1.0	-0.0	-0.0	-0.2	-0.2
12	Subtropical Orchard	1.0	0.0	0.0	0.0	0.0
	Subtotal	**200.7**	**-0.2**	**-4.8**	**-20.3**	**-20.4**
13	Pasture	40.2	-0.6	-3.5	-11.6	-11.7
13	Alfalfa	42.2	-0.4	-2.5	-8.7	-8.6
13	Sugar Beets	5.0	-0.0	-0.0	-0.2	-0.2
13	Other Field Crops	55.1	-0.3	-1.8	-6.2	-6.3
13	Rice	3.9	-0.0	-0.2	-0.8	-0.8
13	Truck Crops	18.0	-0.0	-0.0	-0.1	-0.1
13	Tomatoes	7.0	-0.0	-0.0	-0.2	-0.2
13	Deciduous Orchard	135.0	-0.0	-0.2	-0.6	-0.6
13	Small Grain	47.0	-0.1	-0.7	-2.3	-2.3
13	Grapes	99.0	-0.0	-0.2	-0.7	-0.7
13	Cotton	72.2	-0.4	-2.6	-8.9	-8.9
13	Subtropical Orchard	9.9	-0.0	0.0	-0.0	-0.0
	Subtotal	**534.6**	**-2.1**	**-11.8**	**-40.4**	**-40.5**

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TABLE A-12. CONTINUED

CVPM Subregion	Crop Category	No-Action Alternative	Changes Compared to No-Action Alternative			
			Alternative 1	Alternative 2	Alternative 3	Alternative 4
14	Pasture	0.1	-0.0	-0.0	-0.0	-0.0
14	Alfalfa	15.6	-1.6	-1.5	-1.5	-2.5
14	Sugar Beets	5.0	-0.1	-0.1	-0.1	-0.2
14	Other Field Crops	20.7	-2.3	-2.4	-2.4	-1.8
14	Truck Crops	136.9	-0.6	-0.6	-0.6	-0.5
14	Tomatoes	78.6	-1.7	-1.7	-1.7	-2.2
14	Deciduous Orchard	25.0	-0.1	-0.1	-0.1	-0.1
14	Small Grain	11.9	-1.5	-1.6	-1.6	-0.7
14	Grapes	7.0	-0.0	-0.0	-0.0	-0.0
14	Cotton	223.6	-17.1	-17.1	-17.1	-21.3
14	Subtropical Orchard	1.0	-0.0	0.0	0.0	0.0
	Subtotal	**525.5**	**-25.0**	**-25.0**	**-25.0**	**-29.2**
15	Pasture	4.0	-0.1	-0.0	0.0	0.0
15	Alfalfa	84.0	-0.5	-0.4	-0.1	0.0
15	Sugar Beets	5.0	-0.0	-0.0	-0.0	-0.0
15	Other Field Crops	86.6	-0.4	-0.4	-0.4	-0.4
15	Rice	0.1	0.0	0.0	0.0	0.0
15	Truck Crops	12.0	0.0	0.0	0.0	0.0
15	Tomatoes	2.0	0.0	0.0	0.0	0.0
15	Deciduous Orchard	38.0	-0.0	-0.0	-0.0	-0.0
15	Small Grain	71.3	-0.2	-0.2	-0.2	-0.2
15	Grapes	56.0	-0.0	-0.0	-0.0	-0.0
15	Cotton	243.6	-1.0	-1.0	-0.9	-0.9
15	Subtropical	1.0	0.0	0.0	0.0	0.0
	Subtotal	**603.5**	**-2.2**	**-2.1**	**-1.7**	**-1.5**
16	Pasture	6.2	-0.0	0.0	0.1	0.1
16	Alfalfa	5.1	0.0	0.0	0.0	0.0
16	Other Field Crops	6.1	0.0	0.0	0.0	0.0
16	Truck Crops	5.0	0.0	0.0	0.0	0.0
16	Deciduous Orchard	16.0	-0.0	0.0	0.0	0.0
16	Small Grain	4.0	-0.0	-0.0	-0.0	-0.0
16	Grapes	55.0	-0.0	0.0	0.0	0.0
16	Cotton	5.0	0.0	0.0	0.0	0.0
16	Subtropical	9.0	0.0	0.0	0.0	0.0
	Subtotal	**111.4**	**-0.0**	**0.0**	**0.1**	**0.2**

TABLE A-12. CONTINUED

CVPM Subregion	Crop Category	No-Action Alternative	Changes Compared to No-Action Alternative			
			Alternative 1	Alternative 2	Alternative 3	Alternative 4
17	Pasture	3.0	-0.0	-0.1	-0.0	-0.0
17	Alfalfa	5.0	-0.0	-0.1	-0.1	-0.1
17	Sugar Beets	0.1	0.0	0.0	0.0	0.0
17	Other Field Crops	8.0	-0.0	-0.1	-0.1	-0.1
17	Truck Crops	10.0	0.0	0.0	0.0	0.0
17	Tomatoes	1.0	0.0	0.0	0.0	0.0
17	Deciduous Orchard	73.0	-0.0	-0.0	-0.0	-0.0
17	Small Grain	6.0	-0.0	-0.0	-0.0	-0.0
17	Grapes	109.0	-0.0	-0.1	-0.0	-0.0
17	Cotton	10.0	-0.0	-0.1	-0.1	-0.1
17	Subtropical	35.0	0.0	0.0	0.0	0.0
	Subtotal	**260.2**	**-0.1**	**-0.5**	**-0.4**	**-0.4**
18	Pasture	4.0	-0.0	0.1	0.1	0.1
18	Alfalfa	62.2	-0.0	0.6	0.7	0.8
18	Sugar Beets	1.9	0.0	0.0	0.0	0.0
18	Other Field Crops	78.1	-0.1	0.3	0.2	0.2
18	Truck Crops	13.0	0.0	0.0	0.0	0.0
18	Tomatoes	0.0	0.0	0.0	0.0	0.0
18	Deciduous Orchard	69.0	0.0	0.0	0.0	0.0
18	Small Grain	41.0	-0.0	0.1	0.0	0.0
18	Grapes	56.0	0.0	0.0	0.0	0.0
18	Cotton	170.2	-0.0	0.7	0.6	0.6
18	Subtropical	97.0	0.0	0.0	0.0	0.0
	Subtotal	**592.5**	**-0.2**	**1.8**	**1.7**	**1.7**
19	Pasture	0.0	-0.0	0.0	0.0	-0.0
19	Alfalfa	26.7	-0.7	-1.2	-0.6	-2.1
19	Sugar Beets	5.0	-0.0	-0.1	-0.0	-0.1
19	Other Field Crops	7.0	-0.3	-0.1	-0.3	-0.3
19	Truck Crops	24.0	-0.0	-0.0	-0.0	-0.0
19	Tomatoes	1.7	-0.0	-0.0	-0.0	-0.0
19	Deciduous Orchard	51.0	-0.1	-0.1	-0.1	-0.1
19	Small Grain	8.0	-0.5	-0.2	-0.5	-0.3
19	Grapes	10.0	-0.0	-0.0	-0.0	-0.0
19	Cotton	121.2	-3.3	-3.6	-3.3	-6.2
19	Subtropical	4.0	-0.0	0.0	0.0	0.0
	Subtotal	**258.5**	**-4.9**	**-5.3**	**-4.9**	**-9.2**

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TABLE A-12. CONTINUED

CVPM Subregion	Crop Category	No-Action Alternative	Changes Compared to No-Action Alternative			
			Alternative 1	Alternative 2	Alternative 3	Alternative 4
20	Pasture	10.0	-0.0	-0.0	-0.0	-0.0
20	Alfalfa	12.0	0.0	0.1	0.1	0.1
20	Sugar Beets	0.5	0.0	0.0	0.0	0.0
20	Other Field Crops	3.0	0.0	0.0	0.0	0.0
20	Truck Crops	41.0	0.0	0.0	0.0	0.0
20	Tomatoes	0.3	0.0	0.0	0.0	0.0
20	Deciduous Orchard	52.0	0.0	0.0	0.0	0.0
20	Small Grain	1.0	0.0	0.0	0.0	0.0
20	Grapes	33.0	0.0	0.0	0.0	0.0
20	Cotton	33.0	0.0	0.1	0.1	0.1
20	Subtropical	27.0	0.0	0.0	0.0	0.0
	Subtotal	**202.9**	**0.0**	**0.2**	**0.3**	**0.2**
21	Pasture	0.9	-0.1	-0.1	-0.1	-0.1
21	Alfalfa	29.2	-1.4	-1.4	-1.3	-2.4
21	Sugar Beets	7.5	-0.1	-0.1	-0.1	-0.1
21	Other Field Crops	17.0	-1.0	-1.0	-1.1	-0.8
21	Rice	0.0	0.0	-0.0	-0.0	-0.0
21	Truck Crops	108.0	-0.3	-0.3	-0.3	-0.1
21	Tomatoes	1.0	-0.0	-0.0	-0.0	-0.0
21	Deciduous Orchard	25.0	-0.0	-0.0	-0.0	-0.0
21	Small Grain	2.0	-0.2	-0.2	-0.2	-0.1
21	Grapes	37.0	-0.1	-0.1	-0.1	-0.1
21	Cotton	126.5	-5.7	-5.7	-5.8	-6.3
21	Subtropical	14.0	-0.0	-0.0	-0.0	-0.0
	Subtotal	**368.2**	**-8.9**	**-8.9**	**-8.9**	**-10.0**

NOTES:
1. All acreage values in thousands.
2. A negative value represents a lower acreage in an alternative than in the No-Action Alternative.
3. Not all 12 crops are grown in all subregions.
4. Subregions 3 and 3B should be added together to get the complete subregion 3 shown in Figure A-1. 3B represents the area within this subregion served by the Tehama Colusa Canal.

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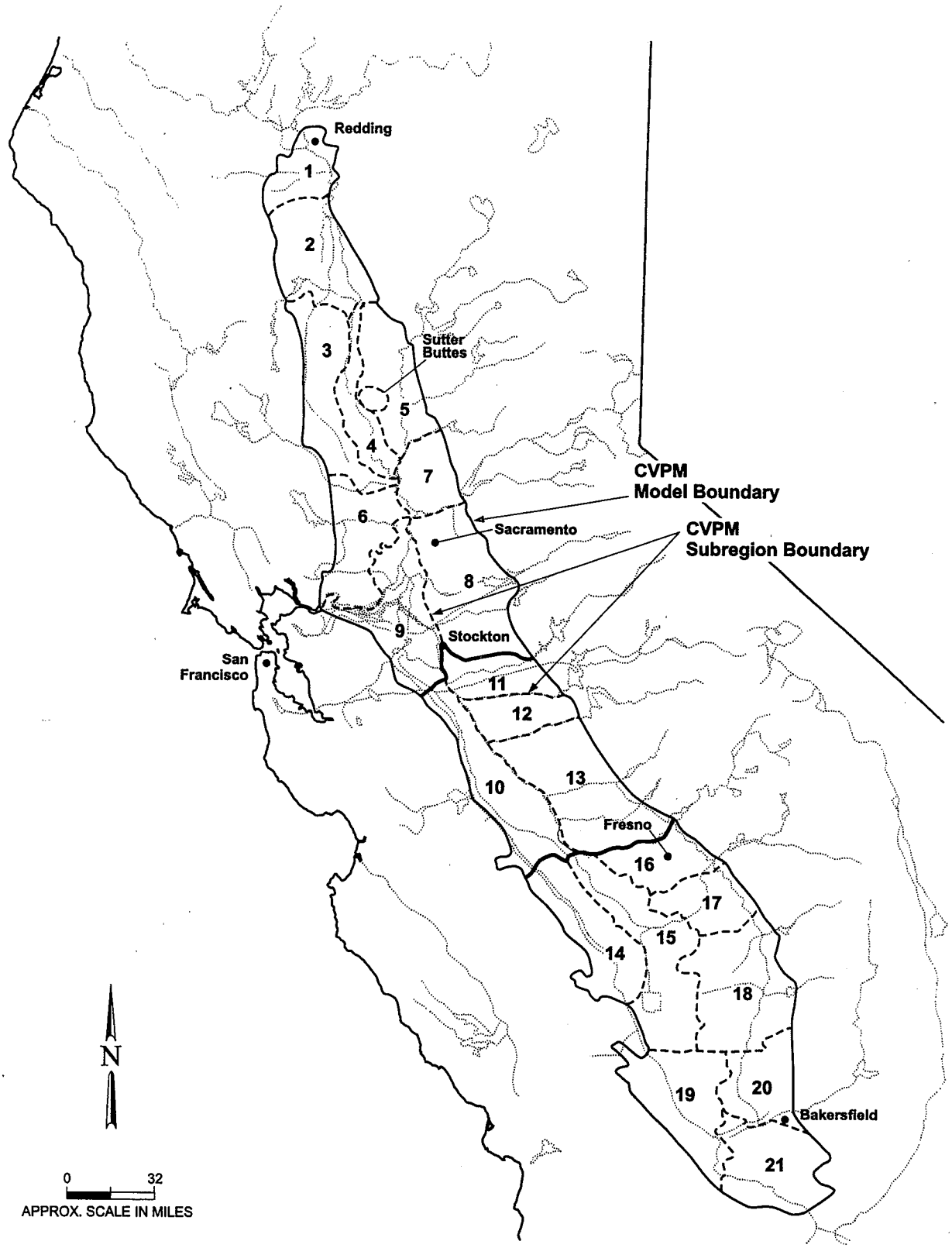

FIGURE A-1

DEFINITION OF CVPM SUBREGIONS

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ATTACHMENT B

IMPACTS AND COSTS OF AGRICULTURAL CONSERVATION AND WATER MEASUREMENT

Attachment B

IMPACTS AND COSTS OF AGRICULTURAL CONSERVATION AND WATER MEASUREMENT

Section 3405(e) of the CVPIA, titled Water Conservation Standards, requires that the Department of the Interior (Interior) establish an office to cooperatively "develop criteria for evaluating the adequacy of all water conservation plans." The criteria should promote "the highest level of water use efficiency reasonably achievable by project contractors using best available cost effective technology and best management practices... ." Interior must "review and evaluate... all existing conservation plans... to determine whether they meet the conservation and efficiency criteria... ."

Reclamation's Mid-Pacific Region has begun implementing these requirements through its "Criteria for Evaluating Water Conservation Plans" issued in April of 1993 and the "Guidebook for Preparing Water Conservation Plans" issued in July of 1993. The criteria were reviewed and revised in 1996. This attachment does not consider the 1996 revisions. The criteria required public co-ordination, a description of the district and its water resources, review of past conservation activities, identification of best management practices, and information regarding scheduling, budget and planning, implementation and monitoring programs. The guidebook was prepared with DWR to help contractors meet the criteria. It provided explanation about the criteria, commonly asked questions and answers, example conservation programs, and a sample conservation plan.

The guidebook required an eight-step plan. The first four steps required that the water user coordinate with other agencies and the public, describe the district, inventory water resources and review past plans and activities. These parts of the conservation plans were reviewed by, and if adequate, approved by DWR.

In Step 5, the contractor identified best management practices (BMPs) to be implemented from two lists. One list, A-1 through A-14 in Table B-1, consisted of "Key Best Management Practices for All Districts," or mandatory practices, which must be implemented by all districts except that a district could be excused from practices A-6 through A-14 if the BMP did not apply to that district.

The second group of BMPs (B-1 to B-12) were discretionary. A discretionary practice did not need to be implemented if the district could show 1) the BMP is not applicable, 2) its not legal, 3) implementation would create environmental damage, 4) the costs exceed the benefits, or 5) there are financial limitations (the money can not be raised).

The remainder of the conservation plan showed how any selected BMPs will be implemented. Step 6 of a conservation plan showed schedules, budgets, and projected results of each identified BMP. Step 7 required the plan to be reviewed, evaluated and adopted, and Step 8 required that the plan be implemented, monitored and updated.

TABLE B-1

LIST OF CONSERVATION PRACTICES

Practice Number	Description of Practice	Factors Limiting CVPIA Impact
A-1	Measure volume of water delivered to customers to plus or minus 6 percent within 5 years of contract renewal or 1999	Not clear that CVPIA requires meters at customer level, many already metered
A-2	Implement pricing and billing policies to provide incentive for efficient use	Many already done, little cost
A-3	Designate water conservation coordinator	Designation itself is costless
A-4	Provide or support the availability of educational materials	
A-5	Provide or support conservation services	Water quality provision may not apply
A-6	If over an aquifer, begin work with others on groundwater management plan	AB3030 also requires, no additional cost
A-7	If district delivers 2,000 or more af of M&I water, implement M&I BMPs	For M&I BMP signatories, little added cost
A-8	If district is in a California drainage problem area, identify lands eligible for voluntary retirement.	Limited part of Central Valley (CV), and already required for Regional Water Quality Control Board (RWQCB)
A-9	If district is in a California drainage problem area, develop guidelines for orderly retirement	Part of CV, already required for RWQCB
A-10	If district is in a California drainage problem area, districts in northern subarea shall investigate impacts of stricter San Joaquin salinity standards.	Part of CV, already required for RWQCB
A-11	If district is in Grasslands subarea, organize a regional drainage entity	Part of CV, already required for RWQCB, and already done
A-12	If district is in Grasslands subarea, intensify and complete local demonstration projects on source control and drainage treatment.	Part of CV, already required for RWQCB
A-13	If district is in Westlands subarea, accelerate and increase field demonstrations of source control and drainage treatment.	Part of CV, already required for RWQCB
A-14	If district is in Tulare subarea, develop a formal association of districts for joint management of drainage problems.	Part of CV, already required for RWQCB
B-1	Line ditches and canals or use pipes	
B-2	Construct or line regulatory reservoirs	Does not apply to many
B-3	Tiered block water pricing or other structure to promote effective water management	Cost calculated by CVPM
B-4	Modify distribution facilities and policies to increase flexibility of water deliveries	Piped systems are generally flexible already
B-5	Construct operational spill reuse systems	
B-6	Facilitate on-farm water management	
B-7	Increase conjunctive use	
B-8	Facilitate new uses for drainage-problem lands	Mostly not applicable
B-9	Measure water by crop and field and provide data to customers	
B-10	Facilitate voluntary transfers that do not unreasonably affect the district, environment or third parties	
B-11	Evaluate district and private pump efficiencies	
B-12	Evaluate district and Reclamation flexibility	

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IMPACTS OF MANDATORY PROVISIONS

Step 5A of the guidebook required the contractor to describe efforts taken to implement the mandatory BMPs. These BMPs must be undertaken by all districts regardless of their economics or potential for water savings.

The No-Action Alternative includes conservation measures that have already been implemented and conservation that would occur even without the CVPIA. The effects of the action conservation provisions are above and beyond any conservation included in the No-Action Alternative. There are few initiatives that would require agricultural water conservation without the CVPIA. The Reclamation Reform Act of 1982 required conservation plans, but most were about two pages in length and less than 5 percent were adequate or nearly adequate for the guidelines. AB 3616, enacted in 1990, "charged DWR to establish an Advisory Committee... to develop a list of Efficient Water Management Practices for agricultural water supplies. Approximately 29 practices are under consideration." (DWR, 1994). There was no single statewide initiative in place as of 1992 to require agricultural water conservation. However, there are many other factors that may limit costs of the CVPIA conservation requirements. Some BMPs are specific to districts only in certain regions. In addition, many districts have already implemented some of the measures, while some measures were mandated by laws enacted prior to the CVPIA. There are several laws and initiatives at the state level that would have resulted in some of the required actions even without the CVPIA.

The mandatory conservation provisions and some of their economic costs are discussed in the following paragraphs. Cost data have been obtained from approved water conservation plans where available. Data from approved plans have been entered into a conservation database maintained by DWR with support from Reclamation. Many districts have not yet submitted plans or their plans have not been approved, so their data cannot be used in the analysis. A sample of disapproved plans and statements of conservation experts suggest that districts who have not submitted plans have conservation costs significantly higher on average than approved plans. On the other hand, some of the costs reported in the approved plans are not attributable to the CVPIA alone. Nonetheless, some data from approved plans are believed to be representative of expected costs. The plans do not require a quantitative assessment of benefits, so no data have been compiled.

A-1 WATER MEASUREMENT

The additional costs attributable to the CVPIA will depend on a variety of circumstances. First, it is not clear that the CVPIA requires water measurement to customers. If measurement to customers is not required, then additional measurement costs will be minimal. This analysis assumes that the CVPIA requires measurement of each customer as detailed in the water conservation guidebook.

Water measurement costs can include the costs of equipment and additional ongoing costs of reading meters or gages, maintenance, repair, record-keeping, and administration. Existing accounts that are not measured will require all of these costs. Some existing accounts are measured, but measurement accuracy must be improved to be within 6 percent according to the guidebook.

Many water districts in the Central Valley already measure water deliveries to individual customers. Of the districts with approved plans included in the conservation database as of late 1995, no districts had reported that they measure no deliveries, and only seven measured some deliveries. The remainder, 42 of 49, measured 100 percent of water delivered to customers. Many districts who have not yet submitted conservation plans may not meter or measure individual deliveries, so this provision will have a larger effect on this group.

The largest group of irrigation districts in the Central Valley that do not measure water deliveries is located in the Sacramento Valley. Measurement designs and data were developed from several phone conversations, review of CVP contractor conservation plans, and review of technical material. Still, to derive associated costs, many assumptions were required.

Flow Measurement Assumption. The water conservation guidelines required measurement of flow at all points of delivery as part of improvements in irrigation delivery and thus conservation of water supply. Measurement of irrigation deliveries is not an exact science. Strictly interpreted, the 6 percent accuracy level would be difficult for users to achieve in the field. Based on discussions with conservation program experts (Farwell pers. comm., 1995), the intention was not that flow over time will be measured within 6 percent. Instead, the devices that are installed should be able to measure the flow at a particular point in time to within 6 percent. This interpretation makes a tremendous difference in potential costs associated with implementation. For example, many propeller-type flow meters and flumes can accurately measure the flow within 6 percent given proper calibration and constant upstream and downstream pressure heads. However, these same devices will not measure at this level of accuracy over a period of time, such as over months or even a few hours. This loss of accuracy is due primarily to changes in water levels in upstream delivery canals as well as loss of calibration in the measuring device over time.

In order to increase the level of accuracy at many turnouts, additional control of water levels in delivery canals is required. Control can sometimes be obtained simply by placing more weir structures (long-crested) in canals, although this requires additional head loss that may not be available. Expensive, automated control gates can also be installed but at much higher costs. Any additional control results in additional cost and may change how a district operates. In many cases controlling canal levels will be difficult without large-scale restructuring of the delivery system. Costs of restructuring the delivery systems are not included at this time.

Measurement Program Assumptions. Measurement at each turnout requires a measurement program that operates and maintains all measurement devices. For example, assume a turnout is equipped with a flume just downstream of the gated turnout structure and a staff gage is installed downstream in the users canal. When the user needs to irrigate, a district employee (ditchrider) will open the turnout and measure the level of water downstream. Measurement may take place after several turnouts are open to allow the water to stabilize on the downstream side. This measurement is recorded into a notebook, along with all other turnouts being operated. Later in the day, a second or even a third measurement is taken and recorded. At the end of the day the records are received at the district office and entered into a computer. At the end of a month (or other period of time), a report with the particular turnouts use is printed and mailed to the user. This may be used for billing or simply to supply information to the user. After a year or two of operation, this flume will require recalibration.

A measurement program needs these four essential pieces:

- measurement device;
- measurement reading and recording (timing will vary with the type of device and the flow conditions present at each turnout);
- record-keeping and record distribution (method and distribution will vary with each district); and
- maintenance and recalibration program (method and period will vary).

Measurement Device Options and Costs. Measurement devices come in many forms but function primarily in one of two ways; measurement of velocity or measurement of pressure heads. Using the velocity or pressure head measurements, volume of flow is calculated using tables, formulas, or computer routines. When velocity is measured, flow rate is determined using the basic equation:

Q(flow rate) = Velocity * Area

Pressure head measurements are used in equations that describe the particular flow characteristics of the device such as the following for a rectangular weir:

Q(flow rate) = C (coefficient of device) * L (length of weir) $*H^{1.5}$ (pressure head)

Many of the available devices only allow measurement of the flow rate. To compute volume of flow with these devices, the amount of water that has passed the device over a given amount of time, requires the assumption that the flow rate has held constant for that period of time. This assumption tends to limit the accuracy of these devices for computing volume of water delivered. Examples of devices that measure flow rate include:

- weirs
- flumes
- canal meter gates
- differential head gates
- current meters
- stream gaging stations
- venturi meters
- weir rules (Cal Poly, 1995)

To directly measure flow rate <u>and</u> volume, more sophisticated equipment is needed, usually in conjunction with one of the above devices. These can include a propeller meter with totalizer, and any calibrated device (weir, flume, etc.) equipped with a properly designed micro-processor that takes flow rate measurements at frequent intervals (Cal Poly, 1995).

Many of these devices, such as weirs and flumes, require a loss in pressure head across the device to facilitate measurement. Without this drop from upstream to downstream,

measurements will be invalid and useless. A drop can range from only a few inches to several inches depending on the device. However, in many instances, field situations do not allow for a drop of several inches. Such a drop may place the water surface in a users field ditch below grade, making gravity fed irrigation impossible. In these cases, use of meters or canal meter gates is required. These devices, however, require a full flowing pipeline between the delivery canal and the users field ditch. In many cases, such a pipeline already exists as part of a turnout when the turnout passes under an access roadway or through a canal berm. Cases where water is diverted by pumping out of below grade delivery facilities, such as rivers or drains, use of a propeller meter with a totalizer is the best option.

Cost Estimates. The cost of a measurement device depends on the conditions into which the device is being placed and the level of accuracy desired. Some devices, such as flumes and weirs, may require a relatively small investment in materials but can become expensive when installation is included. Current meters, or other propeller type devices, are relatively easy to install but have much higher purchase prices. Once installed, different measurement devices are similar in cost regardless of the type.

Discussions with Reclamation representatives and others with expertise in flow measurement suggest a range in cost from $500 to $1,500 per turnout. This cost is only for the installed device (with initial calibration) and does not include operation and maintenance costs. The upper end of the cost range represents installation of propeller meters with totalizers, assuming a pipeline exists for mounting. Additional installation of pipelines can increase the cost to over $2,000 per turnout. These devices come bench-calibrated from the factory and are ready for installation. The lower end of the range includes measuring devices such as a staff gage at existing turnout structures and ditch-bank rehabilitation of the turnout to produce consistent results. These estimates include the cost of initial field calibration.

Because it is not feasible to determine the situation that might best fit each individual district, an average cost for an installed flow measuring device of $1,000 is assumed with an expected life of 10 years.

Associated Costs of Operations and Maintenance. Operation and maintenance costs are incurred through activities such as daily field recording of flow data, entering field data into a data base at the district office, cleaning of silt and debris at turnouts, repairing damaged devices, and bi-annual recalibration of devices. It is assumed that the equivalent of one additional worker per 100 to 200 turnouts is needed full-time to account for all the necessary activities with the exception of recalibration. Based on 150 turnouts and paying a worker between $30,000 and $50,000 in salary, benefits and overhead, an additional $200 to $300 per turnout can be added to the annual cost of a measurement program.

The frequency of recalibration of measurement devices varies depending on field conditions. Propeller meters and other factory calibrated devices should be returned to the manufacturer every other year for recalibration. Removing the meters, shipping, recalibration and reinstallation can cost $300 to $400. Annually, this will add $150 to $200 to the cost of operations. Bi-annual recalibration is recommended for field calibrated devices. This will require the services of a professional engineer or other person experienced in calibration. In some instances, movement of staff gages or modifications to the original device may be required.

Depending on needed adjustments, this may cost $200 per turnout, or an additional $100 annually. Additional time required by the General Manager or Chief of Operations to oversee a program is assumed to be included in the role each currently plays and should not add a significant additional cost.

Summary of Agricultural Measurement Costs. A flow measurement program needs to include installation of new or calibration of existing devices, field recording, office records, maintenance and recalibration. All of these activities need to be closely managed to ensure that the program is meeting its intended purpose of accurately (to the extent feasible) measuring the water being delivered to CVP customers. The following is a summary of associated costs per turnout. All values are dependent on the type of turnout selected and the field conditions into which it is installed.

- purchase and installation of device = $1,000 (10-year life)
- field measurement and office record-keeping = $200 to $300 (annually)
- recalibration = $100 to $200 (annually)

The estimated annual cost of the device assuming 4 percent real interest is $123.29. The entire measurement program cost per turnout per year is $473.29 to $673.29.

Agricultural production costs are typically measured on a per-acre basis, and measurement costs per acre can be estimated with information on the number of acres served per turnout. This factor varies substantially between regions and water districts. For row crops, anywhere from 60 to 200 acres may be served by each turnout. For permanent crops, as few as 20 acres may be served. With a range of 20 to 200 acres, the cost per acre per year is on the order of $4 to $33. Typical production costs per acre are on the order of $300 to $800 for row crops and over $2,000 for permanent crops.

Therefore, new water measurement costs could be as high as 10 percent of production costs per acre in locations where low production costs coincide with unmeasured water deliveries to small fields. The cost of measurement is not expected to be significant on a regional basis, but costs could be important for some districts in the Sacramento Valley.

A-2 Implement Pricing and Billing Procedures That Provide Incentive for More Efficient Use

This has been interpreted to mean charging a price for CVP water and not using a declining block rate structure. Additional administrative and billing costs are required, but these are estimated to be relatively small. Only one of 49 districts in the water conservation database reported a 1995 cost ($5,000) associated with this BMP.

A-3 Designate a Water Conservation Coordinator

This practice is also believed to have a negligible economic effect. The designation of a person has no cost, and the costs of work required by this person are covered under other BMPs. Still, many districts reported some cost associated with this BMP. Twelve of 49 districts in the conservation database reported some 1995 cost averaging $.40 per acre.

A-4 and A-5. Provide or Support the Availability Of Educational Programs, Materials, Etc. and Conservation Services for Water Users and Staff

These BMPs may have an economic cost. Cost data from the water conservation database have been complied. Reported costs vary considerably between districts, but reported costs for both A-4 and A-5 are positively and significantly related to acreage. Some statistics for the two practices are shown in Table B-2. The simple average cost per acre ($.49 total) is close to the expected cost ($.50) based on a simple regression of the form

(total cost) = a + b*(district acres), where
b, estimated with ordinary least squares, is the expected cost.

TABLE B-2

SUMMARY STATISTICS FROM WATER CONSERVATION DATABASE, MANDATORY BMPs 4 AND 5, 1995 DATA

	BMP #4	BMP #5
Number of Districts Reporting Some Cost	21	18
Acreage of Districts Reporting Some Cost	1,099,100	945,911
Adjusted Correlation with Acreage	.88	.73
Average Cost per Acre	$.28	$.21
Expected Cost per Acre Based on Simple Regression	$.33	$.17

Not all of these costs can be attributed to the CVPIA since some of the cost represents ongoing programs, and the costs are probably insignificant relative to costs of agricultural production.

A-6 with Others, Develop a Groundwater Management Plan If the District Overlies Groundwater

The actions required by BMP A-6 are already required by state law AB3030. Therefore, there is no significant effect. Costs of complying with this BMP are provided in the conservation database. Fourteen districts reported an average 1995 cost of $.16 per acre.

A-8 to A-14

These mandatory provisions were specific to regions of the San Joaquin Valley. In California drainage problem areas, identification of lands eligible for voluntary retirement, and guidelines for retirement and management of retired lands are required. The Northern subarea must investigate measures to cope with stricter San Joaquin River salinity standards. The Grasslands subarea must establish an agency to manage drainage problems and conduct more demonstration of source control. The Tulare subarea must develop a district association to coordinate drainage management and increase the pace of demonstrations, and the Kern subarea must intensify

ground water studies, establish an agency to coordinate management, and conduct more demonstration of source controls, drainage water treatment and reuse.

Practices A-8 through A-14, as described in the report "A Management Plan for Agricultural Subsurface Drainage and Related Problems on the Westside San Joaquin Valley" are already required by regional water quality control boards. Therefore, the CVPIA will have no incremental effect. Little or no cost has been identified by districts who have had conservation plans approved.

Summary of Effects of Mandatory Provisions

Based on considerations of other existing initiatives that require actions similar to the mandatory provisions, and in consideration of the average costs reported by those districts who have had conservation plans approved, we find that all mandatory BMPs except for A-1 will not have a significant adverse economic impact on a regional basis. We find that the costs of water measurement for existing non-metered customers may be significant in some districts. Costs of agricultural measurement may be significant for some districts in the Sacramento Valley, and costs of M&I measurement may be significant for some districts in the parts of the Sacramento Area and San Joaquin Valley.

Again, it is not clear that the CVPIA requires measurement at the customer level. If required, the significance of costs of water measurement will depend on 1) the existing water measurement configuration, if any, 2) the existing water delivery system, 3) the average size of accounts, 4) the efficiency with which the district meets the measurement requirements, and 5) the amount of cost savings that occur because of water measurement.

IMPACTS OF DISCRETIONARY PROVISIONS

Section 5B required that "Each District shall develop a program to implement the following best management practices unless the District demonstrates that the practice does not make sense for the District to implement."

Some of the impacts of tiered water rates and water transfers on water use and costs are described in this technical appendix. For tiered water rates, we assume that the tiered prices charged by Reclamation are passed on to individual water users. The water transfer analysis allows transfers to occur unimpeded by any constraints imposed by districts except that only 20 percent of contract water may be sold.

The costs of the other measures depend on unique local conditions. The Water Conservation database suggests that many districts are implementing the discretionary BMPs. Table B-3 shows the number of districts who reported some cost associated with each BMP and the cost reported in 1994 and 1995. There were 23 reports of a cost associated with the practices in 1994 for a total of $1.586 million. In 1995, the number of reported costs increased to 79 for a total of $3.803 million. It cannot be said with certainty that this cost increase was caused by the CVPIA, but it seems likely that the CVPIA contributed. The largest increase in number of districts reporting some cost occurs for Practices 3 (tiered block water pricing), 4 (modify distribution facilities), 6 (facilitate on-farm management) and 11 (evaluate pump efficiencies).

TABLE B-3

IMPLEMENTATION OF DISCRETIONARY PROVISIONS
(Number of Districts Reporting Some Cost and Amount of Cost, 1994 and 1995)

BMP Number	Number Reporting		Cost Reported ($)	
	1994	1995	1994	1995
1	5	6	575,640	735,390
2	2	3	400,900	1,733,566
3	2	16	61,600	90,160
4	1	7	63,056	517,781
5	2	5	5,026	32,500
6	5	12	6,990	94,530
7	1	6	345,400	269,900
8	0	0	0	0
9	4	11	74,480	70,500
10	0	1	0	1,000
11	1	12	53,100	257,775
12	0	0	0	0
Total	**23**	**79**	**1,586,192**	**3,803,102**

In general, the largest expense per acre would be incurred in the Sacramento Valley where fewer conservation measures are already in place. For example, Glenn-Colusa Irrigation District (1993) estimated that the cost of implementing all discretionary conservation measures would amount to about $150 per irrigated acre annually. This would be significant in comparison to production costs of $500 to $1,000 an acre.

The discretionary BMPs are not expected to have an adverse economic effect on individual districts because the district need not implement the BMP if it can show that costs exceed benefits. However, districts will pay some costs to demonstrate that the BMPs are not economical. This cost is included in the cost of preparing conservation plans.

OTHER ECONOMIC COSTS AND BENEFITS

Many districts have undertaken significant efforts to comply with the new criteria, especially the preparation of an initial conservation **plan**. As of October of 1995, about 120 districts or other water users had been requested to submit plans. Of these, about 50 have complete and approved plans. Initial costs of developing the plans have ranged from two weeks of internal effort to over $20,000 for consultants and services. This cost is not believed to be significant on a regional basis.

There are many potential economic benefits associated with irrigation water conservation. Potential benefits associated with hydrology and water quality are discussed below. In summary,

water conservation might reduce farm and district costs for water by reducing water deliveries at the farm and district level. This is often not a regional economic benefit, however, because much of the saved water is just "paper" water. The water savings are matched elsewhere by a water supply reduction. Therefore, water cost savings are not likely to be a significant benefit of water conservation on a regional basis.

Water conservation can create significant economic benefits through improved crop yields and quality. Especially, poor irrigation efficiency is often associated with uneven distribution of water over fields. Some part of the field gets too much water and some not enough, and both problems can lead to reduced crop yield. Conservation that improves irrigation uniformity can have significant economic benefits, especially in high-value crops such as fruits and vegetables.

In most cases, the hydrologic benefits of water conservation are more related to water management and water quality than to quantity. Water management is enhanced because water "savings" often represent water that is kept in storage rather than becoming diffuse return flows and percolation. Storage can be controlled and managed, but diffuse flows can not.

Conservation the could significantly affect water quality downstream. Important constituents, depending on location, include salinity, nutrients and pesticides. Return flows often carry pollutants in dissolved or suspended form or attached to sediment particles. In general, water quality effects associated with conservation are beneficial because return flows are reduced.

HYDROLOGIC IMPACTS

Reducing percolation and return flow can avoid the need to re-pump the water and can reduce the leaching of nitrates and other chemicals. However, much of the water "losses" that are saved by conservation are not losses from the perspective of the larger hydrologic system. Conservation in the form of reduced application per acre or reduced diversion losses often reduces return flows or percolation to groundwater that would have become water supplies. Irrigation water conservation can reduce water supplies needed at the farm level, but there are less net savings at the district, regional or basin level.

Return flows and percolation are often reused within the district. In this case it is appropriate to credit conserved water to the district. The amount of diversion reduction caused by conservation should be made available for other uses within the district because the conserved water was being used by these other uses before conservation. This can be accomplished simply by not reducing a districts' diversion right in response to conservation within the district.

On the other hand, if the conserved water was being used outside of the district prior to conservation and this outside use has a valid claim to the water, then the conserved water should not be credited to the district. Improved application efficiency reduces applied water per acre and increases the share of applied water that is consumptively used. Water conservation can actually increase total consumptive use of water if water users are allowed to apply the paper water "saved" by conservation to additional acreage.

In some cases, water "losses" are actually lost to the hydrologic system, so water conservation does result in water savings at the basin level. For example, some diversion and application losses in the western San Joaquin Valley flow to saline groundwater that is not only unusable, it is also costly to manage and dispose of. In this situation, water conservation results in real savings of usable water.

IMPACT SUMMARY

The net costs of conservation provisions will likely not be significant for districts that already measure water to customers. With the exception of measurement, most mandatory provisions would be required even without the CVPIA, or they need not be expensive. Discretionary provisions and their costs can be avoided if their costs exceed the benefits. The hydrologic benefits of the additional water conservation will also not be significant at the regional level. Water quality benefits and crop yield benefits cannot be quantified at this time.

CENTRAL VALLEY PROJECT IMPROVEMENT ACT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

DRAFT TECHNICAL APPENDIX

Water Transfer Opportunities

September 1997

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LIST OF ABBREVIATIONS AND ACRONYMS

CCWD	Contra Costa Water District
CEQA	California Environmental Quality Act
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWC	California Water Code
ET	evapotranspiration
IID	Imperial Irrigation District
KCWA	Kern County Water Agency
M&I	municipal and industrial
MWD	Metropolitan Water District of Southern California
PEIS	Programmatic Environmental Impact Statement
PROSIM	Project Simulations Model
Reclamation	U.S. Bureau of Reclamation
SBA	South Bay Aqueduct
SCVWD	Santa Clara Valley Water District
SWP	State Water Project
SWRCB	State Water Resources Control Board
WEF	Water Education Foundation
Western	Western Area Power Administration

CHAPTER I

INTRODUCTION

Chapter I

INTRODUCTION

Water transfers play several different, but related, roles within the California Valley Project Improvement Act (CVPIA). Most importantly, expanding the use of voluntary water transfers is identified as one of the purposes of CVPIA (section 3402(d)). Specifically, section 3405(a) states that individuals or districts receiving Central Valley Project (CVP) water may transfer all or a portion of that water to any other California water user or water agency for any purpose recognized as beneficial under state law. Various provisions of the CVPIA place restrictions, conditions, and costs on the transfer of CVP water. Water purchases are also a major vehicle by which the water acquisition program can obtain additional supplies of water for fish and wildlife purposes, as described in Section 3406(b)(3).

The water transfer analysis is designed to assess the programmatic impacts that transfers might have on municipal water supply costs, agricultural economics, and costs of the water acquisition program. The purposes of the water transfer analysis are as follows:

- Identify opportunities for water transfers and show how these opportunities change under different PEIS alternatives.
- Indicate potential buying and selling regions and estimate relative price ranges for water sales in different regions.
- Estimate potential change in water use, the amount of land fallowing, and the change in agricultural net revenue resulting from transfers.
- Estimate costs of water acquired for fish and wildlife purposes under conditions of competition with other potential water buyers.

The analysis is based primarily on results and implications of the Central Valley Production and Transfer Model (CVPTM). CVPTM is a regional planning model to evaluate CVPIA provisions and conduct other sensitivity and policy analyses. It is not used to estimate physical capacity to move water or to identify exactly who will be affected. It is not meant to be used to define which agencies will transfer water either as buyers or sellers. Many of the impacts potentially resulting from a water transfer are specific to the proposed transfer, and can only be described generally within a programmatic analysis. Local transfers (e.g., between adjacent water users or within a water district) and localized impacts of transfers are not part of this analysis.

The assumptions used in this analysis are designed to provide a programmatic assessment of the impacts of CVPIA on inter-regional water transfers. Many of the potential environmental impacts of a particular water transfer, including localized groundwater and other potential third party effects, will be unique to the situation and must be addressed within project-specific environmental review. The summary of assumptions for Water Transfer Opportunities is shown in Table I-1, and the summary of the impact assessment is shown in Table I-2.

TABLE I-1

SUMMARY OF ASSUMPTIONS FOR WATER TRANSFER OPPORTUNITIES

Alternative or Supplemental Analysis	Assumption
No-Action Alternative	Water transfer opportunities are not assessed as part of the No-Action Alternative. Instead, a Transfers Without CVPIA analysis is used to provide a base for comparison of the Supplemental Analyses with transfers. Water supplies estimated in the No-Action Alternative are used. CVP water service and exchange contract is assumed not transferred between regions. All other surface water delivery in the Central Valley is assumed transferable. Groundwater is assumed non-transferable. Only evapotranspiration and irrecoverable loss is assumed transferable.
1	No water transfers assessed.
1e	Alternative 1 water supplies are used. All CVP water is transferable subject to the charges and conditions specified in CVPIA. Groundwater is assumed non-transferable. Only evapotranspiration and irrecoverable loss is assumed transferable.
1f	Alternative 1 water supplies are used. All CVP water is transferable subject to the charges and conditions specified in CVPIA, plus an additional $50-per-acre-foot transfer fee paid to the Restoration Fund. Groundwater is assumed non-transferable. Only evapotranspiration and irrecoverable loss is assumed transferable.
2	No water transfers are assessed.
2b	Alternative 2 water supplies and acquisitions are used. All CVP water is transferable subject to the charges and conditions specified in CVPIA. Groundwater is assumed non-transferable. Only evapotranspiration and irrecoverable loss is assumed transferable.
2c	Alternative 2 water supplies and acquisitions are used. All CVP water is transferable subject to the charges and conditions specified in CVPIA, plus an additional $50-per-acre-foot transfer fee paid to the Restoration Fund. Groundwater is assumed non-transferable. Only evapotranspiration and irrecoverable loss is assumed transferable.
3	No water transfers are assessed.
3a	Alternative 3 water supplies and acquisitions are used. All CVP water is transferable subject to the charges and conditions specified in CVPIA. Groundwater is assumed non-transferable. Only evapotranspiration and irrecoverable loss is assumed transferable.
4	No water transfers are assessed.
4a	Alternative 4 water supplies and acquisitions are used. All CVP water is transferable subject to the charges and conditions specified in CVPIA. Groundwater is assumed non-transferable. Only evapotranspiration and irrecoverable loss is assumed transferable.

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TABLE I-2

SUMMARY OF IMPACT ASSESSMENT OF WATER TRANSFER OPPORTUNITIES

Affected Factors	Base Transfer Scenario	Supplemental Analysis 1e	Supplemental Analysis 1f	Supplemental Analysis 2b	Supplemental Analysis 2c	Supplemental Analysis 3a	Supplemental Analysis 4a
		Change from Base Transfer Scenario (Non-CVPIA Transfers)					
Water Transfer Opportunities	107,000 acre-feet transferred in an average year with an average cost of $260/acre-foot. 527,000 acre-feet transferred in a dry year with an average cost of $450/acre-foot.	27,000 acre-feet more transferred and $10 lower cost per acre-foot in an average year. 16,000 acre-foot more transferred in a dry year and $120 lower cost per acre-foot in a dry year.	Similar to 1e except less CVP water and more non-CVP water transferred. Restoration Fund collections would decline in an average year but could increase in a dry year.	31,000 acre-feet more transferred and $20 higher cost per acre-foot in an average year. 16,000 acre-foot more transferred in a dry year and $105 lower cost per acre-foot in a dry year.	Similar to 2b except less CVP water and more non-CVP water transferred. Restoration Fund collections would decline in an average year but could increase in a dry year.	24,000 acre-feet more transferred and $2 lower cost per acre-foot in an average year. 7,000 fewer acre-feet transferred in a dry year and $90 lower cost per acre-foot in a dry year.	30,000 acre-feet more transferred and $20 higher cost per acre-foot in an average year. 28,000 acre-feet more transferred in a dry year and $90 lower cost per acre-foot in a dry year.
Land Fallowing and Revenue Gains From Water Transfer	43,000 acres fallowed in an average year with net gains to sellers of $12 million. 293,000 acres fallowed in a dry year with net gains to sellers of $144 million.	$1 million lower net gains to sellers in an average year. 37,000 fewer acres fallowed in a dry year and $52 million lower net gains to sellers in a dry year.	Similar to 1e.	7,000 acres more fallowed and $3 million lower net gains to sellers in an average year. 41,000 fewer acres fallowed in a dry year and $49 million lower net gains to sellers in a dry year.	Similar to 2b.	1,000 fewer acres fallowed and $0.2 million higher net gains to sellers in an average year. 49,000 fewer acres fallowed in a dry year and $49 million lower net gains to sellers in a dry year.	6,000 fewer acres fallowed and $4 million higher net gains to sellers in an average year. 52,000 fewer acres fallowed in a dry year and $41 million lower net gains to sellers in a dry year.
Cost of Acquired Water for Instream Flows	Not Applicable	Not Applicable	Not Applicable	160,000 acre-feet acquired with a total cost of $10 million/year.	Similar to 2b.	765,000 acre-feet acquired with a total cost of $64 million/year.	Similar to 3a.

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CHAPTER II

AFFECTED ENVIRONMENT

Chapter II

AFFECTED ENVIRONMENT

INTRODUCTION

This chapter describes water transfers and related interests that may be affected by the Programmatic Environmental Impact Statement (PEIS) alternatives. Laws and regulations affecting water transfers in California are summarized. Water transfers prior to 1990 are reviewed, followed by discussion of the State Drought Water Bank and recent water transfers to municipal and industrial (M&I) providers. Finally, third party impacts of water transfers are discussed.

DATA SOURCES

The water transfer analysis draws substantially from information in the agricultural economics, municipal water costs, and surface water analyses. The data used in these studies are discussed in their respective technical appendices. A variety of state, federal and private publications related to water rights, water transfer laws, and water transfer markets such as the State Drought Water Bank were reviewed for this analysis.

REGULATORY CONTEXT

WATER RIGHTS AND TRANSFERS

California's water rights and water transfer laws are complex. Water marketing proponents say they can hamper water transfers. Others contend they are safeguards to control inappropriate transfers. Most water use in California is based on riparian and appropriative water rights. Riparian rights are based on ownership of land adjacent to a stream or river. In theory, riparian water rights cannot be transferred except for environmental and instream uses specifically described in Section 1707 of the California Water Code (CWC). In general, riparian owners can be paid not to exercise their right, but the unused water cannot be reserved for a specific agricultural or M&I use. The unused water would become available to all other riparian and appropriative users based on their priority of right.

The vast majority of water rights in California are appropriative rights, which are unrelated to riparian land ownership and are based on the principle of "first in time, first in right." Appropriative rights established before 1914 can be transferred if there is no adverse impact on other legal water users. If the holder of the right is a public agency, however, the transfer may be subject to provisions of the California Environmental Quality Act (CEQA). Appropriative rights established after 1914 require a water right permit. Approval from the State Water Resources

Control Board (SWRCB) is needed if the water transfer involves a change in the place or purpose of use, or in the point of diversion.

The CVP and State Water Project (SWP) are both post-1914 appropriative rights holders. Approval from the SWRCB is needed to transfer SWP water out of the SWP place of use defined under its water right permits. Users receiving CVP water under a water supply contract with Reclamation may transfer water without SWRCB approval within the CVP place of use defined under CVP water right permits.

LEGISLATION SUPPORTING TRANSFERS

The legislature has enacted procedures for seeking SWRCB approval for transfer of water under a water right permit or license. For a transfer of one year or less, the buyer can petition for a temporary change or a temporary urgency change. The temporary change does not require compliance with CEQA, but the temporary urgency change procedure does require such compliance. Long-term transfers of water are allowed under procedures provided in the CWC (Section 1735-1737). The long-term transfers must comply with the CEQA.

On April 6, 1992, the Governor of California stated that the following five criteria must be met in developing a fair and effective water transfer policy:

- Water transfers must be voluntary, and they must result in transfers that are real, not "paper" water. Above all, water rights of sellers must not be impaired.
- Water transfers must not harm fish and wildlife resources or their habitats.
- There need to be assurances that transfers will not cause overdraft or degradation of ground-water basins.
- Entities receiving transferred water should be required to show that they are making efficient use of existing water supplies, including carrying out urban Best Management Practices or agricultural Efficient Water Management Practices.
- Water districts and agencies that hold water rights or contracts for transferred water should have a strong role in deciding how transfers are carried out. Impacts on the fiscal integrity of the district or agency and on the economies of small agricultural communities must be considered.

The CWC includes many other important provisions that could limit transfers, as follows:

- limit land fallowed by transfers to 20 percent of water stored or supplied, unless the supplying agency approves a larger percent (Section 1745.05(b));
- prohibit use of public agency facilities to transfer water unless a finding is made that there is no unreasonable impact on the economy or environment of the county from which the water is being transferred (Section 1810(d));

- prohibit exports of groundwater from the Sacramento Valley and Delta-Central Sierra basins unless consistent with an approved groundwater management plan (Section 1220);

- prohibit substitution of groundwater for surface water transferred unless the additional groundwater use is either consistent with an approved groundwater management plan or is approved by the local water supply agency, which must determine that it will not create or contribute to long-term overdraft (Section 1745.10); and

- prohibit transfers that significantly reduce the quantity or quality of water available for fish and wildlife (Section 1810(d)). (California Department of Water Resources [DWR], 1993a.)

STATE WATER PROJECT TRANSFERS UNDER THE MONTEREY AGREEMENT

The Monterey Agreement is a statement of principles by the State Water Contractors and the State of California DWR that was used as a basis for amendments to SWP water entitlements. The agreement provides for several principles of importance to water transfers to and within the SWP including: 1) agricultural contractors agree to allow up to 130,000 acre-feet of entitlement from users in Kern County to be sold to urban contractors; 2) contractors paying for terminal reservoirs located south of the Tehachapi Mountains gained increased control of operations; 3) contractors gained the right to transport non-Project water in SWP facilities at the melded SWP power rate; and 4) limits on groundwater storage of SWP water outside a contractor's service area were specifically eliminated.

HISTORICAL PERSPECTIVE

Water transfers have recently increased in importance as a way to meet water demands. Prior to the drought of 1976 to 1977, and the more recent drought of 1987 to 1992, water supplies had been developed as needed and were usually adequate to meet demands. The recent droughts demonstrated the inadequacy of supplies to meet demands in dry conditions. Movement of developed water from areas of surplus to areas of deficit was seen as a method to improve efficiency of water use at a net economic gain for buyers and sellers. The potential demand for water transfers also increased with a growing economy and urban population. Table II-1 presents some short-term water transfers in California between 1982 to 1990, based on information from DWR Bulletin 160-93 and the Water Education Foundation (WEF, 1996).

The short-term water transfers before the State Drought Water Bank had the following characteristic:

- The amount of water transferred was small before 1988 but increased substantially thereafter.

- Yuba County Water Agency was the largest water seller during this period. The agency had long-standing commitments to deliver water to lands within its service boundaries, and used temporary water transfers to help generate capital to fund new conveyance systems. The Yuba County Water Agency earned about $30 million from water transfers between 1987 and 1990. (WEF, 1996)

- DWR/SWP was a major buyer during this period. Westlands Water District represented the single largest agricultural buyer.

TABLE II-1

SHORT-TERM WATER TRANSFERS, 1982-1990

Year	Transferred From	Transferred To	Amount Transferred (acre-feet)
1982	Yuba County Water Agency	Newhall	5,000
1987	Arvin-Edison Water Storage District	Dudley Ridge Water District	8,000
1988	Tulare Lake Basin Water Storage District	Westlands Water District	1,600
	Yuba County Water Agency	DWR/SWP	122,000
1989	Yuba County Water Agency	East Bay Municipal Utility District	66,000
	Yuba County Water Agency	DWR/SWP	200,000
	Kern County Water Agency	Westlands Water District	55,000
1990	La Hacienda	DWR/SWP	98,000
	Placer County Water Agency	Westlands Water District	70,000
	Oroville-Wyandotte Irrigation District	Westlands Water District	15,000
	Yuba County Water Agency	DWR/SWP	146,000

SOURCE:
DWR, 1994; WEF, 1996.

Water transfers between individual water users within a water district are very common in dry conditions, and such transfers are becoming increasingly common even in average water supply conditions. Water transfers between users within a district do not normally require approval from the SWRCB because there is no change in the place or purpose of use defined in the water right permit. A University of California study found that there were more than 3,000 within-district trades in the 1994-1995 season, involving some 380,000 acre-feet (Thompson, 1996). Water transfers within Westlands Water District have recently been facilitated by a new computerized "bulletin board" that gives real-time information on offers to buy and sell water.

RECENT CONDITIONS

This section describes water transfers during the 1991-1992 State Drought Water Bank, and reviews recent water transfers to M&I buyers.

STATE DROUGHT WATER BANK

The State Drought Water Bank was established in 1991 to acquire and transfer water to meet critical needs during the continuing and severe drought that year. In 1991, DWR bought 820,000 acre-feet of water from willing sellers. DWR paid $125 per acre-foot and sold the water for $175 per acre-foot. The difference between the purchase and sale price was largely due to Delta conveyance losses. About half of the purchased water came from growers who were paid not to irrigate their land (Table II-2). Approximately 170,000 acres were fallowed by both riparian and appropriative water users (Howitt et al., 1992). One-third of the water came from groundwater substitution and the remaining amount was from stored water, mostly from Yuba County Water Agency.

TABLE II-2

SOURCES AND ALLOCATIONS OF STATE DROUGHT WATER BANK 1991 AND 1992

Sources of 1991 and 1992 Supplies, 1,000 Acre-Feet		
	1991	**1992**
Fallowing	420	0
Groundwater	258	161
Storage	142	32
Total	820	193
Allocation of 1991 and 1992 Supplies, 1,000 Acre-Feet		
	1991	**1992**
Agriculture	83	95
Urban	307	39
Fish and Wildlife	0	25
Delta Outflow	165	34
In Storage	265	0
Total	820	193
SOURCE: DWR, 1993b.		

In 1992, DWR operated another Drought Water Bank but on a much smaller scale due to greater precipitation and reduced demand. Land fallowing was not allowed as a method of supplying water. The bank bought 193,000 acre feet of water at $50 per acre-foot and sold the water for $72 per acre-foot plus transportation costs. More than 80 percent of the water was provided by groundwater exchange.

Table II-2 shows that M&I users accounted for about one-third of the water delivered by the 1991 State Drought Water Bank. Another one-third of the purchased water was not taken by buyers and remained in storage at the end of the year. The rest of the water was purchased to satisfy Delta outflow requirements for through-Delta transfers or bought by agricultural users. In 1992, agricultural users bought more water than M&I users. About 60 percent of total agricultural purchases were made by Westlands Water District.

WATER TRANSFERS TO M&I BUYERS

M&I water users, taken as a group, were the largest buyers from the State Drought Water Bank. M&I users have been major buyers in other water transfers in recent years. M&I will continue to play an important role in future water marketing and transfers. M&I users are divided into four user groups consistent with the level of aggregation used in the municipal water costs analysis.

Sacramento River Region M&I Users

This group includes all M&I users from the Sacramento area north to Redding. These users have not been active as buyers in water transfer markets. Under existing conditions, water supplies are generally adequate to meet demands, but some conservation was practiced during the recent drought. Some Sacramento River Region users have been sellers of water. For example, the Placer County Water Agency transferred 15,000 acre-feet of water to San Francisco and 70,000 acre-feet to Westlands Water District in 1990.

Bay Area M&I Users

The North Bay Region has used the SWP facilities to transfer water to water users within the region. About 15,000 acre-feet of water were purchased from the Yuba County Water Agency in 1992, primarily for the City of Napa.

All three districts served by the South Bay Aqueduct (SBA) have purchased Drought Water Bank water. Zone 7 of Alameda County Flood Control and Water Conservation District and Alameda County Water District purchased 500 and 14,800 acre-feet respectively, in 1991. Santa Clara Valley Water District (SCVWD) bought 19,750 acre-feet from the 1991 Drought Water Bank. SCVWD also bought about 39,200 acre-feet from Placer and Yuba counties in 1991.

The San Francisco Water Department (SFWD) used the SBA to transfer 15,000 acre-feet of water from Placer County in 1990 and 33,000 acre-feet from the Drought Water Bank in 1991. San Francisco has also transferred Tuolumne River water through the Hetch Hetchy system to meet drought water demands.

Contra Costa Water District (CCWD) bought 6,700 acre-feet of water from the 1991 Drought Water Bank and 10,000 acre-feet from the 1992 Drought Water Bank. CCWD continues to investigate water transfers as a method of meeting future demand in dry periods.

Central Valley Cities

The Central Valley cities have not been active in water markets due to relatively adequate water supply conditions. Many of these cities rely upon groundwater or have water rights.

Central and South Coast

The Metropolitan Water District of Southern California (MWD) made substantial use of the Drought Water Bank, purchasing 215,000 acre-feet in 1991 and 10,000 acre-feet in 1992. MWD recently completed a two-year land fallowing demonstration program with Palo Verde Irrigation District. In this program, 20,000 acres were idled at a cost of $620 per acre to obtain 93,000 acre-feet of water per year (Georgeson, 1992). MWD also negotiated with Imperial Irrigation District (IID) to lease water at a price of $139 per acre-foot (Water Intelligence Monthly, 1993) and has agreed to pay for water conservation improvements within IID. These improvements are estimated to yield 106,110 acre-feet of water annually at a cost of about $100 per acre-foot. MWD is continuing discussions with Arvin-Edison Water District to purchase and store CVP water for use during dry periods. MWD eventually plans to acquire about 400,000 acre feet of

voluntary transfers through options agreements and spot market purchases for use in about 20 percent of years (MWD, 1995).

The other M&I providers in the South Coast Region have not participated in regional water markets to the same extent as MWD. San Diego County Water Authority is currently exploring options to transfer water from IID.

THIRD-PARTY IMPACTS OF WATER TRANSFERS

One key issue of water transfers is the effect on the economic base of rural farming communities. Farmers and other local interests fear that water transfers will lead to the idling of farmland, loss of jobs and local income, reduced government revenue and increased costs of social programs.

Third-party impacts of water transfers involve either 1) incidental or external physical effects, or 2) economic impacts on others not directly engaged in the transfer. The first category of third-party impacts frequently involves hydrology or land use. If the seller transfers more water than consumptive use and irrecoverable losses, if groundwater substitution is allowed, or if "excess" water is sold that may be needed, then other water users may be affected. Land fallowing may reduce return flows and incidental groundwater recharge. State and federal laws, including the CVPIA, have safeguards against these problems, but measurement and enforcement are difficult, potentially inaccurate, and expensive. Water transfer law may not protect third parties from weeds and pests harbored on fallowed land, from air quality problems caused by wind erosion, or from aesthetic losses caused by changes in land use.

The second category of third-party impacts is economic linkage through water transfers. Regional economic effects in the agricultural region of origin are often a major concern when land fallowing is proposed as the method of yielding water for the transfer. Many businesses and governments in rural economies depend on the expenditures of farmers and farm-related businesses. Water transfers that fallow land may eliminate portions of this expenditure, but some of the income from the sale of water is re-spent in the region. This spending reduces the overall negative economic impact of fallowing land. However, there are still distributional issues because those who gain through expenditure of the water transfer income may not be the same people who lose income because of fallowing. For example, agricultural labor losses are not compensated if the farmer spends the water transfer income outside the agricultural economy.

A study of the 1991 State Drought Water Bank (Howitt et al., 1992) reported that the total direct and indirect gains in water-importing regions exceeded losses in areas that sold water from land fallowing. Net benefits to the state were estimated at about $90 million per year. However, the third-party impacts were concentrated in certain locations, in particular San Joaquin and Yolo counties. The net loss from water transfers in terms of increased rural unemployment and other social service costs were estimated at $20 million in San Joaquin County and $3 million in Yolo County.

Although there are different opinions on the extent of third party impacts, most interests agree that potential adverse consequences should be addressed. Various measures have been suggested to mitigate third-party impacts, including limiting the numbers of acres taken out of production,

restricting the amount of water transferred out of an irrigation district, establishing a mitigation fund to settle damage claims, and use of part of the revenues to retrain agricultural workers for other jobs.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

Chapter III

ENVIRONMENTAL CONSEQUENCES

ANALYTICAL APPROACH AND ASSUMPTIONS

The primary tool for assessing opportunities for inter-regional water transfers is the Central Valley Production and Transfer Model (CVPTM), described in the CVPTM Modeling/Methodology Technical Appendix. CVPTM is linked with several other aspects of the impact analysis, including agricultural economic analysis, M&I economic analysis, hydrologic simulation, and water acquisition demand for fish and wildlife. Figure III-1 shows the interactions among CVPTM and the CVPM, the M&I Water Use and Cost Analysis, the Project Simulation Model (PROSIM), and the Water Acquisition Program. CVPM, M&I Water Use and Cost, PROSIM, and the Water Acquisition Program are described in their respective Methodology/Modeling Technical Appendices.

All of the information that follows represents estimates or preliminary calculations based on the best information available at the time the analysis was being developed. Water transfer assumptions, charges, available capacities, and conveyance losses are based on conversations with U.S. Bureau of Reclamation (Reclamation) personnel and information available at the time the analysis was being designed. These assumptions are believed to be reasonable for a programmatic analysis of the impact of CVPIA provisions on water transfers, but should not be viewed as final determinations of Reclamation policy.

WATER TRANSFER SUPPLY

The potential amounts and costs of water available for transfer are estimated from the CVPTM, which is described in the CVPTM Methodology/Modeling Technical Appendix.

WATER TRANSFER DEMAND

Potential buyers include agriculture, M&I users, and the Water Acquisition Program. Transfer demands by agricultural buyers are estimated within the CVPTM, based on the value of water for irrigation. Transfer demands for M&I buyers are obtained from the Municipal Water Costs Analysis. Transfer demands for the Water Acquisition Program are determined by assumption for the PEIS alternatives, and vary according to the alternative.

WATER TRANSFER FEASIBILITY

Water transfer feasibility represents the physical possibility of moving water from one location to another. The water transfer analysis allows two types of transfers: direct and exchange. In a direct transfer, water that would have been used by the seller is instead moved to the buyer. There are only two parties to the transfer. In an exchange transfer, there are at least three parties

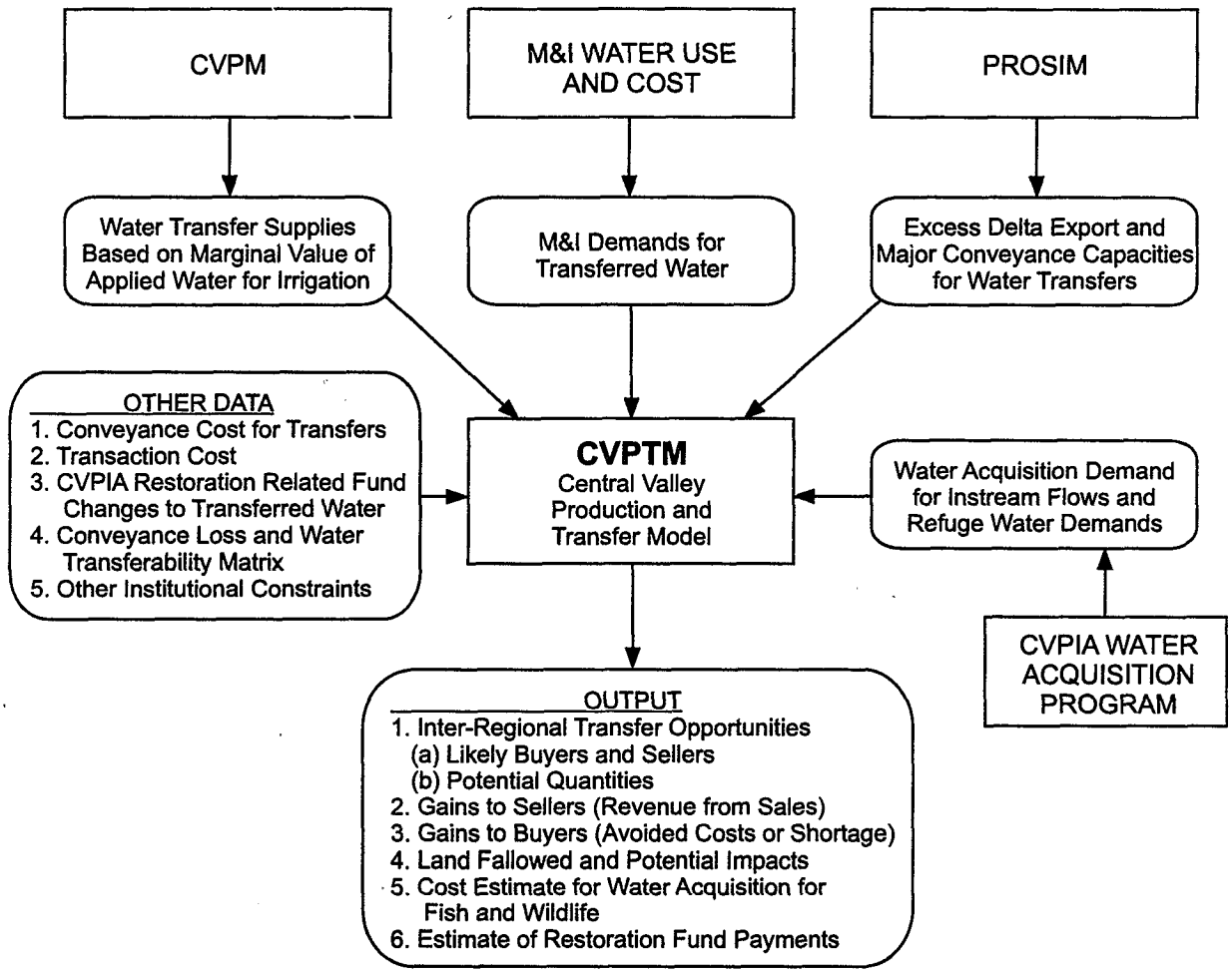

FIGURE III-1

CVPTM INTERACTION WITH CVPM, M&I ECONOMICS, PROSIM, AND WATER ACQUISITION PROGRAM

to the transfer, and the buyer does not usually obtain the seller's water. For example, in an exchange, the seller provides water to a willing third party, and the buyer receives water from another source that would have gone to the third party. For example, Kern County receives water from both the Friant-Kern Canal and the California Aqueduct, so a number of entities within Kern County could act as third parties in an exchange transfer between the service areas of those two canals.

WATER TRANSFER CONVEYANCE COST

Water transfer conveyance cost depends on source, destination, type of water (CVP, SWP, or non-Project), and conveyance facility used. For example, non-Project water conveyed through CVP facilities is paid for at the cost-of-service rate for CVP facilities and components used. The cost-of-service water rate consists of capital cost and O&M costs for storage, conveyance, pumping, and water marketing. In addition to conveyance facility costs, transfers of CVP water bear additional costs imposed by CVPIA. Further details on assumptions used for conveyance costs are contained in the CVPTM Modeling/Methodology Technical Appendix.

All of the water transfer analysis was conducted using 11 agricultural regions that are either potential buyers or sellers, 10 M&I regions that are potential buyers (aggregated to 4 for presenting results), and water acquisition for restoration as required for the particular alternative. Figure III-2 shows the 11 Central Valley agricultural regions and Figure III-3 shows the 10 urban demand regions. For purposes of this analysis, all water generated for sale is assumed to come from existing agricultural use, although in reality some water can be made available through re-operation of reservoirs and distribution systems. As a result, the land fallowing estimates are worst-case impacts. The following sections present and discuss water transfer opportunities (including transfer quantities and average costs), impacts of water transfers on agricultural regions, and impacts of water transfers on M&I water users. Results are shown for the No-Action Alternative with Non-CVPIA Transfers (Base Transfer Scenarios), Supplemental Analyses 1e and 1f, Supplemental Analyses 2b and 2c, Supplemental Analysis 3a, and Supplemental Analysis 4a. Results from the transfer analysis were used to estimate the cost of acquired water. Cost estimates of acquired water are reported for Alternatives 2, 3, and 4. The results of comparative analyses with and without water transfers are discussed in the M&I Water Use and Cost Technical Appendix and the Agricultural Economics Technical Appendix.

CONVEYANCE AND DELTA PUMPING CAPACITIES

The available monthly conveyance and pumping capacities for water transfers are estimated by PROSIM. Available transfer capacities for the San Felipe and South Bay Aqueduct service areas are estimated by comparing their monthly capacities to the estimated use from PROSIM. For this analysis, excess Delta export capacity in July through January was considered representative of available capacity because it is assumed that water transfer through the Delta would occur during this period. For the Hetch Hetchy system, the capacity is shown as an annual estimate. The Hetch Hetchy system is included because it can serve some of the same area served by the South Bay Aqueduct, so it could be used in potential exchange agreements.

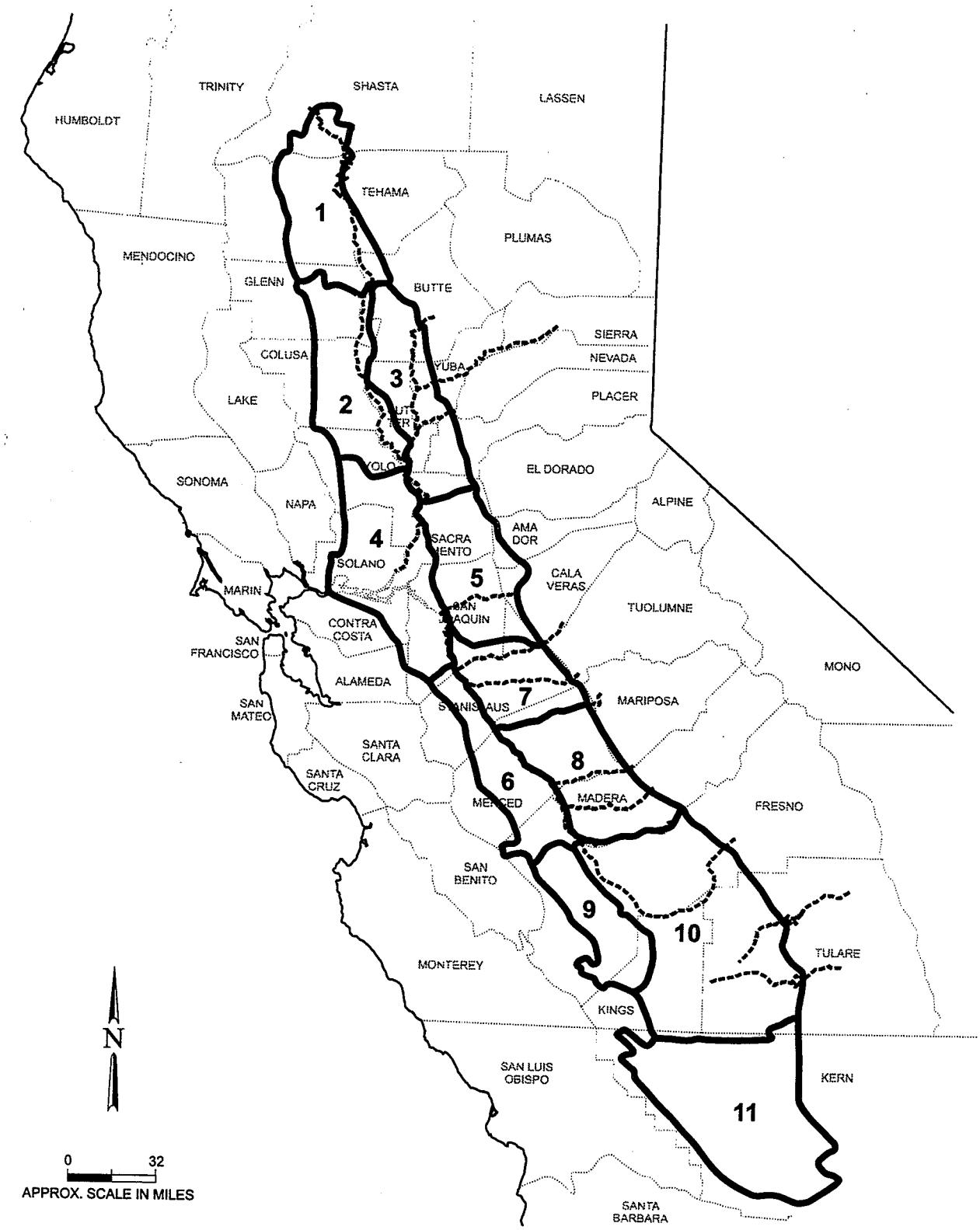

FIGURE III-2

AGRICULTURAL REGIONS

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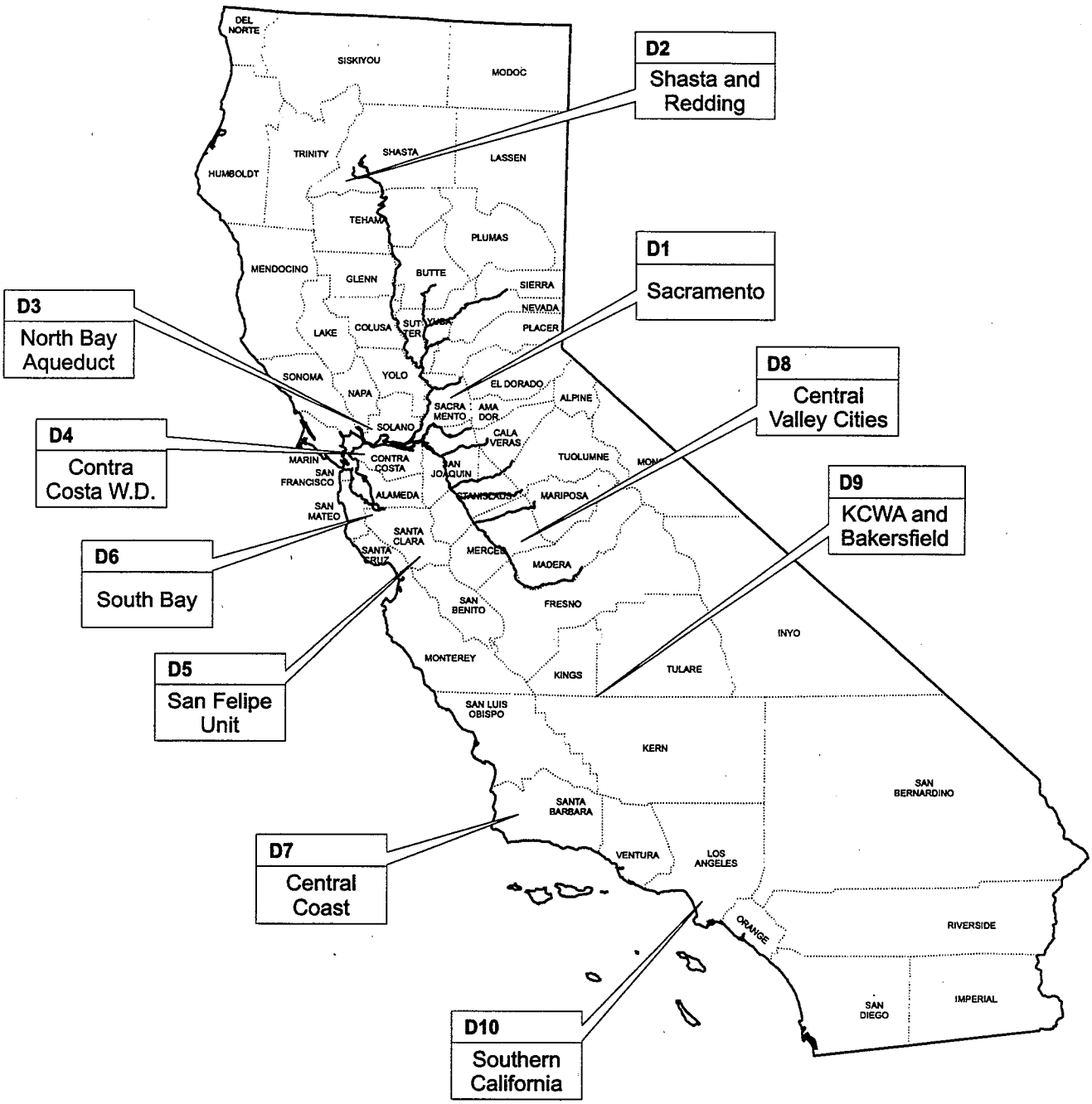

FIGURE III-3
URBAN DEMAND REGIONS

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C-082912

OTHER COSTS AND INSTITUTIONAL CONSTRAINTS

The information on CVPIA restoration fund charges and other institutional constraints related to water transfers is based on the CVPIA, CWC, and other laws and regulations that affect water transfers.

BASE TRANSFER SCENARIO: NO-ACTION ALTERNATIVE WITH NON-CVPIA TRANSFERS

Water transfers have occurred in California, and a water transfer market would continue to develop without the implementation of CVPIA. In order to assess the impact that CVPIA water transfer provisions could have on the transfer market, an analysis of transfers without CVPIA has been included. This analysis is needed to provide a basis for measuring only the incremental impact of CVPIA on opportunities for water transfers, and will be referred to subsequently as the Base Scenario. The analysis includes the assumptions of the No-Action Alternative plus additional assumptions regarding water transfers.

ASSUMPTIONS

- Section 1745.05(b) of the CWC limits the transfer of water made available by land fallowing to 20 percent of water that would have been applied or stored in that hydrological year, unless the supplying agency approves a larger percent. The water transfer analysis adopts a 20 percent upper limit on transfer of surface water out of a region.

- Sections 1220 and 1745.10 of the CWC prohibit groundwater transfer or substitution unless consistent with an approved groundwater management plan (or specifically authorized by the local agency). In addition, individual proposed transfers of groundwater or substitution with groundwater would require CEQA documentation. Because of the uncertain approval of long-term groundwater transfer or substitution under these conditions, we have assumed, for purposes of this transfer analysis, no groundwater transfer or substitution of groundwater for transferred water. A separate sensitivity analysis is included describing the potential effects of allowing groundwater substitution.

- The land fallowing component of 1991 State Drought Water Bank allowed only the transfer of the evapotranspiration (ET) portion of water provided by land fallowing. The Governor's 1992 water policy stated that water transfers should involve only real, not "paper" water. The water transfer analysis adopts the assumption that only ET or irrecoverable loss is transferable. Only the ET portion of water transferred through fallowing of land is assumed transferable. Savings from irrigation improvements that do not reduce ET or irrecoverable loss are not transferable. The share of applied water that may be transferred varies by crop and by region according to estimates of applied water and ET per acre for each crop as described in the CVPM Methodology/Modeling Technical Appendix.

- Water diverted under riparian right is transferable only for specific environmental or instream uses, as defined in section 1707 of the CWC. Because of these conditions on the transferability of water diverted under riparian rights, the analysis assumes this water is not

transferable for agricultural or M&I uses. The aggregate, regional structure of the modeling means that this may become a constraint only on water available for transfer in the Delta subregion.

- Water released or delivered by CVP facilities to satisfy water rights and the base supply under Sacramento River contracts (which CVPIA calls water rights settlement contracts) is assumed to be transferable subject to state law. CVP water delivered under San Joaquin River exchange contracts could not be transferred prior to CVPIA without amending those contracts. Although state and federal law did not prohibit the inter-regional transfer of CVP water delivered under water service or repayment contracts, no such large-scale, inter-regional transfers occurred prior to CVPIA. CVPIA provided clear authorization for districts or individuals to transfer CVP water to other regions and outside the CVP permitted place of use, and therefore makes such transfers much more likely. For purposes of measuring the potential impact of CVPIA, the Base Transfer Scenario assumes that CVP water delivered under water service contracts, repayment contracts, and San Joaquin River exchange contracts could not be transferred prior to CVPIA. This assumption applies for the inter-regional transfer analysis conducted, and not necessarily for local transfers, trades, and exchanges.

- Another important constraint considered in the water transfer analysis is the physical capacity of facilities that can be used for water transfers. The 1994 Bay-Delta Plan Accord generally restricts exports to no greater than 35 percent of Delta inflow between February and June and no greater than 65 percent of Delta inflow between July and January. The water transfer analysis assumes that buyers and sellers would attempt primarily to move water across the Delta during the July through January period. In cases where a portion of water purchased is available only outside this period, the contribution to Delta outflow would increase, raising the effective price of water received. Unused capacities of major conveyance and pumping facilities are based on information in the Water Facilities and Supplies Technical Appendix. Summary information on available Delta export and major conveyance capacities between July and January based on hydrologic modeling of the No-Action Alternative is presented in Table III-1.

- Other assumptions and constraints considered for the water transfer analyses, such as conveyance cost for transferred water and CVPIA Restoration Fund charges applicable to water transfers are discussed in detail in the CVPTM Methodology/Modeling Technical Appendix.

RESULTS FOR BASE TRANSFER SCENARIO

Water Transfer Opportunities. Water transfer quantities and average cost for the Base Transfer Scenario are presented in Table III-2. Prices and quantities shown in Table III-2 are measured at the **buyer's** destination. Under conditions assumed for this analysis, total water transfers are estimated at 107,000 acre-feet in an average year and 527,000 acre-feet in a dry year. Most average year transfers are estimated to be from the Tulare Lake Region to urban uses in the Central and South Coast Region. Transfers during the dry year condition are much higher because of higher M&I demand in the Central Coast, South Coast, and San Francisco (Bay Area) regions. The estimated price paid by buyers ranges from about $260 per acre-foot received in an

TABLE III-1

DELTA EXPORT AND MAJOR CONVEYANCE CAPACITIES AVAILABLE FOR WATER TRANSFERS BASE TRANSFER SCENARIO

Major Pumping and Conveyance Facilities Considered	Total Remaining Capacities Between July and January (1,000 acre-feet)	
	Average Year (1922 - 1990)	Dry Year (1928 - 1934)
Remaining Capacity at Tracy Pumping Plant	316	634
Remaining Capacity at Banks Pumping Plant	716	1370
Remaining Capacity Below Node 45 (DMC)	262	545
Remaining Capacity in the Hetch Hetchy System	N/A	48
Remaining Capacity in the South Bay Aqueduct	N/A	71
Remaining Capacity in the San Felipe Division	N/A	52

LEGEND:
N/A means not applicable since there are no transfer demands through these systems in an average year condition.

TABLE III-2

WATER TRANSFER OPPORTUNITIES BASE TRANSFER SCENARIO

Buyers	Agricultural Sellers (Net 1,000 acre-feet) (1)				
	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total	Average Cost $/acre-foot) (2)
Average Year					
San Luis Unit and East San Joaquin Agriculture	0	0	0	0	0.0
Bay Area M&I	0	1	1	2	143.9
Central Coast and South Coast M&I	0	2	103	105	263.4
Total Weighted Average	**0**	**4**	**103**	**107**	**261.2**
Dry Year					
Bay Area M&I	132	32	0	164	434.2
Central and South Coast M&I	99	138	127	363	461.7
Total Weighted Average (3)	**231**	**170**	**127**	**527**	**446.3**

NOTES:
(1) Net acre-feet are measured at buyer's destination. They equal gross acre-feet measured at seller's origin minus conveyance losses and Delta outflow requirement for cross-Delta transfers.
(2) Average unit cost per acre-foot includes price paid at seller's origin plus conveyance cost.
(3) The weighted average price is calculated using quantity transferred as weights.

average year condition to about $450 per acre-foot received in a dry condition, when supplies are lower and urban users bid up water prices to make up for shortfalls in supplies from their normal water sources. The Delta export and major conveyance constraints, as reported in Table III-1, are not binding except for the Hetch Hetchy system, the South Bay Aqueduct, and the San Felipe Division in a dry year condition.

The estimates above focus on inter-regional transfers. Local transfers within a region, especially between agricultural users, are also assumed to occur but are not explicitly counted by the analysis. Local transfers do not have the system-wide implications and impacts that inter-regional transfers are likely to have.

Impacts of Water Transfers On Agricultural Regions. Land fallowing and revenue gains from water transfers are presented in Table III-3. Quantities and values shown in Table III-2 are measured at the **seller's** location. The amount of water transferred out of an agricultural region reported in the table is measured as a reduction in applied irrigation water. Land fallowed as a result of water transfers in an average year is estimated to be 43,000 acres, or less than 1 percent of irrigated acreage in the Central Valley. Higher demands for transferred water in dry years increases the land fallowed to about 300,000 acres, or 5 percent of irrigated land. In general, major crops idled by transfers in an average year are pasture, hay, grain, field crops, rice, and cotton. The main crops idled in a dry year are grain, field crops, rice, and cotton.

TABLE III-3

LAND FALLOWING AND REVENUE GAINS FROM WATER TRANSFERS BASE TRANSFER SCENARIO

Region	Agricultural Water Transfer (1,000 acre-feet)		Land Fallowed as a Result of Transfer (1,000 acres)		Net Revenue Change (1) ($1,000)	
	Average	Dry	Average	Dry	Average	Dry
Sacramento River	0	561	0	150	0	71,986
San Joaquin River	6	276	2	71	105	48,808
Tulare Lake	148	184	41	72	11,413	22,783
Total	**154**	**1,021**	**43**	**293**	**11,518**	**143,577**

NOTE:
(1) Net revenue change represents the gains from trade in region. For selling regions, this equals receipts from water sold (net of its cost) minus net revenue lost from land fallowing. For buying regions, net revenue change equals net revenue from added crop acres plus avoided cost of groundwater pumping minus payment for water purchased.

Anticipated changes in net revenue to agricultural water users have been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. As expected for transactions among willing buyers and sellers, sellers would benefit from water transfers in all water selling regions. Estimated net revenue gains are $11.5 million in an average year and $143.6 million in a dry year. The estimates of gains to sellers do not include any cost of tilling, weed control, or other activities that may be needed for temporarily fallowed land. If these activities cost $25 to 30 per acre, the net gain per acre-foot would be reduced by about $10. Significant variation in selling price and gains from sales can be expected within a region and between regions.

Impacts of Water Transfers On M&I Water Use and Cost. Table III-4 provides a summary of results from the perspective of M&I water providers. The results of this analysis are described in detail in the Municipal and Industrial Water Use and Costs Technical Appendix, and results with and without transfers are compared. The methods and data used in this analysis are described in the Municipal Water Use and Costs Methodology/Modeling Technical Appendix.

TABLE III-4

M&I WATER TRANSFERS
BASE TRANSFER SCENARIO

	M&I Water Transfers Purchased (1,000 acre-feet)		Average Price Paid for Water Received ($/acre-feet)		Total Cost of Water Transfers ($million) (1)		Total Cost Savings from Transfers ($million) (2)	
Region	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)
Sacramento Valley	0	0	N/A	N/A	0.0	0.0	0.0	0.0
Bay Area	2	164	144	434	0.3	71.2	0.5	48.2
San Joaquin Valley	0	0	N/A	N/A	0.0	0.0	0.0	0.0
Central Coast and South Coast	105	363	263	452	27.6	164.1	36.0	226.6

NOTES:
(1) Total cost delivered to the treatment plant. Does not include treatment and distribution costs.
(2) Difference in M&I costs between the Base Transfer Scenario and the No-Action Alternative (without transfers). See Municipal and Industrial Water Use and Costs Technical Appendix.
(3) Dry condition estimates reflect water purchased in addition to the yield from the average year transfer, which is assumed to take a 50% deficiency in dry years.

In the average hydrologic condition, the Bay Area acquires 2,000 acre-feet of water transfers and the Central Coast and South Coast acquire 105,000 acre-feet. The South Coast is constrained to buy no more than 100,000 acre-feet; the remaining 5,000 acre-feet are purchased by the Central Coast. The Central Valley M&I regions (Sacramento Valley and San Joaquin Valley) do not participate in water markets because supplies are sufficient to accommodate demand.

In the dry condition, coastal region supplies are not sufficient to meet demand. Mandatory drought conservation can accommodate only part of the shortage, and both regions purchase water to eliminate most of the remaining shortage. Water transferred from agricultural regions in average water conditions would bear some deficiency under dry conditions, but the actual deficiency would depend on the details of the transfer agreement. For purposes of this analysis, average year transfers are assumed to bear a 50 percent deficiency in the dry condition. Additional water purchased in the dry condition is estimated to be 164,000 acre-feet in the Bay Area, and 363,000 acre-feet in the Central Coast and South Coast. The South Coast is

constrained to take no more than 350,000 acre-feet of transfers in drought, which is in addition to 50,000 acre-feet of yield from the average condition transfer.

Total cost for purchasing water transfers in the average condition is estimated to be about $0.3 million annually for the Bay Area and $27.6 million for the Central Coast and South Coast. The Bay Area, Central Coast, and South Coast transfers result in M&I cost savings of $.5 million and $36 million, respectively, relative to the No-Action Alternative without-transfer case. Additional purchases during the dry condition are estimated to cost about $71 million in the Bay Area and $164 million in the Central and South Coast. These transfers result in cost savings of $69 and $227 million, respectively, relative to the No-Action Alternative without-transfer case. Attachment A to the Municipal and Industrial Water Use and Cost Technical Appendix describes in detail the assumptions and results of this analysis.

Potential Effect of Groundwater Substitution On the Transfer Market. The analysis summarized above assumes that water transferred is generated by a reduction in irrigation water use by the seller, so that only real water is sold. In some cases, however, the state may allow substitution of groundwater for surface water sold. In order to assess the impact of this assumption on the water transfer market, the same transfer analysis was completed with groundwater substitution allowed. All other assumptions described for the Base Transfer Scenario were maintained. For both the average and dry conditions, the quantity of surface water transferred and the location of buyers and sellers changed very little. Some additional water was purchased by agricultural users in the average condition. The major effect of allowing substitution was to reduce the cost of water to buyers, in some cases by a substantial amount. In the average year condition, cost per acre-foot of water received at the destination dropped by a range of $10 to $50 per acre-foot, depending on location. In the dry condition the cost reduction was much more pronounced, with cost per acre-foot received declining by a range of $100 to over $200 per acre-foot. For example, a cost savings of $150 per acre-foot to a buyer of 100,000 acre-feet would result in a total savings of $15 million.

Groundwater substitution without any future replacement or recharge borrows future water availability for current use. In the short run it reduces the amount of land idled by a surface water transfer, and therefore reduces the associated third-party impacts. The long-term impact on groundwater levels, and potentially on groundwater quality and subsidence, can be significant. Groundwater substitution may only be viable in dry year conditions. A project-specific impact analysis would be required to assess these potential impacts.

SUPPLEMENTAL ANALYSES 1e AND 1f

ASSUMPTIONS

Water transfers out of the CVP service area are explicitly authorized by the CVPIA of 1992. Section 3405(a) states that individuals or districts receiving CVP water delivered under water service and repayment contracts and water rights settlement and exchange contracts, may transfer all or a portion of that water to any other California water user or water agency for any purpose recognized as beneficial under state law. Transfers must be approved by the U.S. Department of the Interior. Those that involve more than 20 percent of the CVP water under a long-term

contract between Reclamation and a water delivery agency are also subject to review by the agency.

The transfer analyses 1e and 1f use many of the same assumptions as in the Base Transfer Scenario, except that Alternative 1 hydrology and water pricing are used. This also results in a revised set of Delta export and major conveyance capacities for water transfers based on hydrologic and water delivery analyses. These are presented in Table III-5. In addition, a major difference from the Base Transfer Scenario is that all CVP water service and repayment contract and San Joaquin River exchange contract water is transferable, but with specific costs as described in the CVPTM Methodology/Modeling Technical Appendix.

TABLE III-5

DELTA EXPORT AND MAJOR CONVEYANCE CAPACITIES AVAILABLE FOR WATER TRANSFERS SUPPLEMENTAL ANALYSES 1e AND 1f

Major Pumping and Conveyance Facilities Considered	Total Remaining Capacities Between July and January (1,000 acre-feet)	
	Average Year (1922 - 1990)	Dry Year (1928 - 1934)
Remaining Capacity at Tracy Pumping Plant	451	756
Remaining Capacity at Banks Pumping Plant	677	1293
Remaining Capacity Below Node 45 (DMC)	382	635
Remaining Capacity in the Hetch Hetchy System	N/A	48
Remaining Capacity in the South Bay Aqueduct	N/A	68
Remaining Capacity in the San Felipe Division	N/A	65

LEGEND:
N/A means not applicable since there are no transfer demands through these systems in an average year condition.

RESULTS FOR SUPPLEMENTAL ANALYSIS 1e

Water Transfer Opportunities. Differences in water transfer quantities and average costs between Supplemental Analysis 1e and the Base Transfer Scenario analysis are presented in Table III-6. The total average year transfer under 1e is estimated to be 27,000 acre-feet more than under the Base Transfer Scenario. This increase is primarily the result of additional transfer demand by CVP agricultural contractors. Estimated dry year transfers are about 16,000 acre-feet more than those for the Base Transfer Scenario because of the higher transfer demand by the Bay Area. In general, less water is transferred out of the Sacramento River Region and more water transferred out of the Tulare Lake Region because of the availability of less expensive CVP water closer to the point of M&I demand. Compared with the Base Transfer Scenario, the estimated price paid by buyers under Alternative 1e is about $10 per acre-foot lower for the average year and $120 per acre-foot lower for the dry year. The lower prices of the transferred water are due to the greater availability of less expensive CVP water.

TABLE III-6

WATER TRANSFER OPPORTUNITIES IN SUPPLEMENTAL ANALYSIS 1e CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

Buyers	Agricultural Sellers (Net 1,000 acre-feet) (1)				
	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total	Average Cost ($/acre-foot) (2)
Average Year					
San Luis Unit and East San Joaquin Agriculture	0	4	22	27	N/A
Bay Area M&I	0	2	-1	1	-27
Central Coast and South Coast M&I	2	24	-27	-1	-8
Total Weighted Average	**2**	**29**	**-6**	**27**	**-9**
Dry Year					
Bay Area M&I	-32	-1	50	17	-144
Central Coast and South Coast M&I	-86	23	61	-1	-104
Total Weighted Average (3)	**-118**	**22**	**111**	**16**	**-118**

NOTES:
(1) Net acre-feet are measured at buyer's destination. They equal gross acre-feet measured at seller's origin minus conveyance losses and Delta outflow requirement for cross-Delta transfers.
(2) Average unit cost per acre-foot includes price paid at seller's origin plus conveyance cost and CVPIA Restoration Fund charges.
(3) The weighted average price is calculated using quantity transferred as weights.

The estimates above focus on inter-regional transfers. Local transfers within a region, especially between agricultural users, are also assumed to occur but are not explicitly counted by the analysis. Local transfers do not have the system-wide implications and impacts that inter-regional transfers are likely to have. Local water transfers out of CVP service area will be more likely with the greater availability of CVP service contracts and exchange contract water in Alternative 1.

The Delta export and major conveyance constraints considered for Alternative 1, as reported in Table III-5, are found to be not binding except for the Hetch Hetchy system, the South Bay Aqueduct, and the San Felipe Division in a dry year condition.

Impacts of Water Transfers On Agricultural Regions. Differences in land fallowing and revenue gains from water transfers between Supplemental Analysis 1e and the Base Transfer Scenario are shown in Table III-7. Land fallowed as a result of water transfers is estimated to be about the same in an average year, but 37,000 acres less in a dry year. The decrease in a dry year is caused by reductions in the amount of water contributed for Delta outflow and distribution and conveyance losses because of the purchase of CVP water closer to the point of M&I demand. In other words, for each acre-foot of water received, buyers under Supplemental Analysis 1e can buy CVP water closer to the destination and thus avoid some of the transport losses. As a result, less

water would need to be purchased and less land would need to be fallowed to meet the same transfer demand. In general, major crops idled by transfers in an average year are pasture, hay, grain, field crops, rice, and cotton. The main crops idled in a dry year are grain, field crops, rice, and cotton. The estimates of gains to sellers do not include any cost of tilling, weed control, or other activities that may be needed for temporarily fallowed land. If these activities cost $25 to $30 per acre, the net gain per-acre-foot would be reduced by about $10 per acre. Significant variation in selling price and gains from sales can be expected within a region and between regions.

TABLE III-7

LAND FALLOWING AND REVENUE GAINS FROM WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 1e CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

	Agricultural Water Transfer (1,000 acre-feet)		Land Fallowed as a Result of Transfer (1,000 acres)		Net Revenue Change (1) ($1,000)	
Region	Average	Dry	Average	Dry	Average	Dry
Sacramento River	5	-293	1	-88	228	-55,895
San Joaquin River	8	27	2	11	275	-18,209
Tulare Lake	-8	159	-3	39	-1,355	22,286
Total	**5**	**-107**	**0**	**-37**	**-851**	**-52,818**

NOTE:
(1) Net revenue change represents the gains from trade in region. For selling regions, this equals receipts from water sold (net of its cost) minus net revenue lost from land fallowing. For buying regions, net revenue change equals net revenue from added crop acres plus avoided cost of groundwater pumping minus payment for water purchased.

Anticipated changes in net revenue to agricultural water users have been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. For agricultural buyers, the net gain from transfers also includes some avoided cost of groundwater pumping. The net revenue gain for Supplemental Analysis 1e is estimated to be $0.9 million lower than that reported for the Base Transfer Scenario in an average year and $52 million lower in a dry year. These decreases are due to the lower prices received for water transfers because of the availability of CVP water transfers.

Impacts of Water Transfers On M&I Water Use and Cost. Table III-8 shows M&I results for Supplemental Analysis 1e. Results are expressed as the difference from the Base Transfer Scenario, where transfers of CVP water service contract and exchange water are not allowed.

Table III-8 shows that, in the average condition, the Bay Area buys more transfers than in the Base Transfer Scenario, but the availability of CVP contract and exchange water decreases the average cost per acre-foot of supplies acquired by $30. The price of water at the treatment plant in the Base Transfer Scenario is $140 per acre-foot versus $120 in Supplemental Analysis 1e.

The total cost of transfers increases slightly even though the price is lower, because quantity increases. In the Central and South Coast, the total cost of transfers declines by about $1.1 million.

TABLE III-8

M&I WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 1e CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

	M&I Water Transfers Purchased (1,000 acre-feet) (1)		Average Price Paid for Water Received ($/acre-foot) (1)		Total Cost of Water Transfers ($million) (1)		Total Cost of Alternative ($million) (2)	
Region	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)
Bay Area	1	17	-28	-139	0.9	-17.8	5	-27
Central Coast and South Coast	-1	-1	-8	-103	-1.1	-37.8	-31	-81

NOTES:
(1) Negative numbers indicate a reduction in quantities or cost relative to the No-Action Alternative.
(2) Costs shown include all measures implemented under that Alternative 1, not just water transfer provisions.
(3) Dry year estimates reflect water purchased in addition to the yield from the average year transfer, which is assumed to take a 50% deficiency in dry years.

Both regions have shortages in the dry condition, but the shortages are reduced in Supplemental Analysis 1e because of additional SWP supplies. In the Bay Area, the cost of transfers is less ($17.8 million less) because the average price is lower, even though more transfers (17,000 acre-feet more) are bought. The average transfer price per acre-foot is estimated to be about $430 in the Base Transfer Scenario versus $300 in Supplemental Analysis 1e. In the Central Coast and South Coast, Supplemental Analysis 1e also results in substantial cost savings relative to the Base Transfer Scenario: $38 million is saved on costs of water transfers, and additional savings are obtained from reduced use of drought supplies. The average transfer price per acre-foot at the treatment plant is estimated to be about $450 in the Base Transfer Scenario versus $350 in Supplemental Analysis 1e.

Table III-8 also shows total costs of Supplemental Analysis 1e relative to the Base Transfer Scenario. These results reflect numerous differences between Supplemental Analysis 1e and the Base Transfer Scenario, including changes in M&I water supplies, changes in water prices, and the transferability of CVP supplies. Attachment A to the Municipal and Industrial Water Use and Cost Technical Appendix describes in detail the assumptions and results of this analysis.

Cost Estimate for Water Acquisitions. Under Supplemental Analysis 1e, no water is acquired to meet instream flow and wildlife refuge demands.

Potential Effect of Groundwater Substitution On the Transfer Market. The Supplemental Analysis 1e assumes that water transferred is generated by a reduction in use by the seller so that only real water is sold. In some cases, however, transfers with groundwater substitution could be allowed. In order to assess the impact of this assumption on the water transfer market, the same transfer analysis was completed with groundwater substitution allowed. All other assumptions of Supplemental Analysis 1e were maintained. For both the average and dry conditions, the quantity of surface water transferred, and the location of buyers and sellers, changed very little. Some additional water was purchased by agricultural users in the average condition. The major effect of allowing substitution was to reduce the cost of water to buyers, in some cases by a substantial amount. The cost reduction was not as large as in the Base Transfer Scenario because of the greater availability of CVP water closer to demand regions in Supplemental Analysis 1e. In the average year condition, cost per acre-foot of water received at the destination dropped by a range of $20 to $40 per acre-foot, depending on location. In the dry condition the cost per acre-foot received declined by a range of $40 to $180 per acre-foot.

Groundwater substitution without any future replacement or recharge borrows future water availability for current use. In the short run it reduces the amount of land idled by a surface water transfer, and therefore reduces the associated third-party impacts. The long-term impact on groundwater levels, and potentially on groundwater quality and subsidence, can be significant. A project-specific impact analysis would be required to assess these potential impacts.

RESULTS FOR SUPPLEMENTAL ANALYSIS 1f

Supplemental Analysis 1f evaluates the impact of imposing a $50-per-acre-foot fee on CVP water transfers. The main effect of imposing the fee is to shift the transfer market away from CVP water to non-CVP water, with about a 20 percent reduction in water bought during the average year, but little change in the total amount purchased in a dry year. The reduction in purchases during the average year represents agricultural buyers of CVP water who are unwilling to purchase it with the additional fee. Table III-9 illustrates this result by showing transfers from CVP and non-CVP sources for both Supplemental Analyses 1e and 1f. In an average year condition, the $50-per-acre-foot fee would eliminate CVP water transfers to both agricultural and M&I buyers. In a dry year condition, imposing the fee is expected to decrease CVP water transfers to M&I buyers by 55 percent, compared with no fees. The total water transfer demand by M&I, however, is estimated to remain the same because of the increased transfers of non-CVP water.

Restoration Fund revenues from water transfers in Alternative 1e come from higher water prices paid to Reclamation (the "full-cost increment"), the Restoration Payment rising to $12 per acre-foot (1992 dollars) for water transferred to municipal uses, and the $25 per acre-foot surcharge paid by non-CVP municipal buyers. The reduction in CVP water transferred in Alternative 1f is estimated to cost the Restoration Fund up to $1 million in an average year condition, as compared to Alternative 1e. In a dry year condition, enough CVP water is still purchased in Alternative 1f that the extra $50 per acre-foot fee more than makes up for these other costs, and the Restoration Fund collections could increase by up to $6 million. These estimates are based on changes in CVP water sold rather than water received by buyers as shown in Table III-9. For example, 132,000 acre-feet sold by CVP sellers in a dry year results in 71,000 acre-feet received

by buyers, after accounting for sellers' recoverable losses, conveyance losses, and Delta outflow contribution.

SUPPLEMENTAL ANALYSES 2b AND 2c

ASSUMPTIONS

Supplemental Analyses 2b and 2c use many of the same assumptions as in 1e and 1f, except that Alternative 2 hydrology is used and additional water is acquired from willing sellers for instream flow and wildlife refuge demands. Delta export and major conveyance capacities available for Supplemental Analyses 2b and 2c water transfers are presented in Table III-10.

TABLE III-9

WATER TRANSFER ESTIMATES WITH AND WITHOUT A $50-PER-ACRE-FOOT FEE SUPPLEMENTAL ANALYSES 1e AND 1f

Supplemental Analysis	CVP Water Bought	Non-CVP Water Bought	Total
Average Year			
1e: Transfers without $50/acre-foot fee	46	88	132
1f: Transfers with $50/acre-foot fee	3	104	107
Dry Year			
1e: Transfers without $50/acre-foot fee	154	389	543
1f: Transfers with $50/acre-foot fee	71	472	543

NOTE:
Water is in thousand acre-feet per year, measured at the buyer's destination.

TABLE III-10

DELTA EXPORT AND MAJOR CONVEYANCE CAPACITIES AVAILABLE FOR WATER TRANSFERS IN SUPPLEMENTAL ANALYSES 2b AND 2c

Major Pumping and Conveyance Facilities Considered	Total Remaining Capacities Between July and January (1,000 acre-feet)	
	Average Year (1922 - 1990)	Dry Year (1928 - 1934)
Remaining Capacity at Tracy Pumping Plant	451	756
Remaining Capacity at Banks Pumping Plant	677	1293
Remaining Capacity Below Node 45 (DMC)	382	635
Remaining Capacity in the Hetch Hetchy System	N/A	48
Remaining Capacity in the South Bay Aqueduct	N/A	68
Remaining Capacity in the San Felipe Division	N/A	65

LEGEND:
N/A means not applicable since there are no transfer demands through these systems in an average year condition.

RESULTS FOR SUPPLEMENTAL ANALYSIS 2b

Water Transfer Opportunities. Differences in water transfer quantities and average prices between Supplemental Analysis 2b and the Base Transfer Scenario are presented in Table III-11. The total average year transfer under 2b is estimated to be 31,000 acre-feet more than under the Base Transfer Scenario. This increase is primarily the result of additional transfer demand by CVP agricultural contractors and other agricultural purchases by regions also selling water to the Water Acquisition Program. Estimated dry year transfers are about 16,000 acre-feet more than in the Base Transfer Scenario because of the increased demand by Bay Area M&I providers. In general, less water is transferred out of the Sacramento River Region and more water transferred out of the Tulare Lake Region because of the availability of CVP water closer to the point of M&I demand. The estimated price paid by buyers under Supplemental Analysis 2b is about $20 per acre-foot higher for the average year because water acquisition increases water price by more than the price reduction due to the availability of CVP supplies. The average price paid by buyers in a dry year is estimated to be $105 per acre-foot lower because of the availability of less expensive CVP water, more than offsetting the effect of water acquisition demands.

TABLE III-11

WATER TRANSFER OPPORTUNITIES IN SUPPLEMENTAL ANALYSIS 2b CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

Buyers	Agricultural Sellers (Net 1,000 acre-feet) (1)				
	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total	Average Cost ($/acre-foot) (2)
Average Year					
San Luis Unit and East San Joaquin Agriculture	0	9	22	30	N/A
Bay Area M&I	1	-1	2	1	8
Central Coast and South Coast M&I	2	0	-3	-1	18
Total Weighted Average	**3**	**7**	**21**	**31**	**17**
Dry Year					
Bay Area M&I	-19	-6	43	17	-130
Central Coast and South Coast M&I	-86	6	78	-1	-92
Total Weighted Average (3)	**-105**	**0**	**121**	**16**	**-105**

Notes:
(1) Net acre-feet are measured at buyer's destination. They equal gross acre-feet measured at seller's origin minus conveyance losses and Delta outflow requirement for cross-Delta transfers.
(2) Average unit cost per acre-foot includes price paid at seller's origin plus conveyance cost and CVPIA Restoration Fund charges.
(3) The weighted average price is calculated using quantity transferred as weights.

The Delta export and major conveyance constraints reported in Table III-10 are not binding in the average condition, but potentially binding for the Hetch Hetchy system, the South Bay Aqueduct, and the San Felipe Division in a dry year condition.

The estimates above focus on inter-regional transfers. Local transfers within a region, especially between agricultural users, are also assumed to occur, but are not counted by the analysis. Local transfers out of the CVP service area would also be more likely with the greater availability of CVP service contracts and exchange contract water in Supplemental Analysis 2b. Local transfers do not have the system-wide implications and impacts that inter-regional transfers are likely to have.

Impacts of Water Transfers On Agricultural Regions. Differences in land fallowing and revenue gains from water transfers between Supplemental Analysis 2b and the Base Transfer Scenario are shown in Table III-12. Land fallowing as a result of water transfers is estimated to be 7,000 acres higher in an average year, but 41,000 acres lower in a dry year. The increase in an average year is due to the fact that more water is sold to meet the higher demand by agricultural buyers. The decrease in a dry year is mainly caused by reductions in water provided for Delta outflow and distribution and conveyance losses because of the availability of CVP water closer to the point of M&I demand. For each acre-foot of water received, buyers under Supplemental Analysis 2b can buy CVP water closer to the destination and thus avoid some of the transport losses. As a result, less water would need to be purchased and less land would need to be fallowed to meet the same transfer demand. In general, major crops idled by transfers in an average year are pasture, hay, grain, field crops, rice, and cotton. Crops idled in a dry year are primarily grain, field crops, rice, and cotton.

TABLE III-12

LAND FALLOWING AND REVENUE GAINS FROM WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 2b CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

	Agricultural Water Transfer (1,000 acre-feet)		Land Fallowed as a Result of Transfer (1,000 acre)		Net Revenue Change (1) ($1,000)	
Region	Average	Dry	Average	Dry	Average	Dry
Sacramento River	7	-260	1	-89	264	-54,255
San Joaquin River	-32	-12	-2	-1	191	-20,300
Tulare Lake	29	173	7	49	2,786	25,887
Total	**3**	**-100**	**7**	**-41**	**3,241**	**-48,668**

NOTES:
(1) Net revenue change represents the gains from trade in region. For selling regions, this equals receipts from water sold (net of its cost) minus net revenue lost from land fallowing. For buying regions, net revenue change equals net revenue from added crop acres plus avoided cost of groundwater pumping minus payment for water purchased.

Anticipated changes in net revenue to agricultural water users have been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. For agricultural buyers, the net gain from transfers also includes some avoided cost of groundwater pumping. The net revenue changes for Supplemental Analysis 2b are estimated to be $3.2 million higher than those reported for the Base Transfer Scenario in an average year and $48 million lower in a dry year. The increases in an average year are due to more water being sold. The decreases in a dry year are due to the lower prices received for water transfers because

of the availability of less expensive CVP water transfers. The estimates of gains to sellers do not include any cost of tilling, weed control, or other activities that may be needed for temporarily fallowed land. Significant variation in selling price and gains from sales can be expected within a region and between regions.

Impacts of Water Transfers On M&I Water Use and Cost. Table III-13 shows M&I results for Supplemental Analysis 2b expressed as the difference from the Base Transfer Scenario.

Table III-13 shows that, in the average condition, the Bay Area buys about 1,000 acre-feet more transfers and the average cost per acre-foot of supplies bought increases by about $10. The price of water at the treatment plant in the Base Transfer Scenario is $140 per acre-foot versus $150 in Supplemental Analysis 2b. The cost of transfers increases by roughly $200,000 because quantity and price increase. In the Central and South Coast, the price paid for transfers would increase by about $20 per acre-foot relative to the Base Transfer Scenario, but 1,000 fewer acre-feet would be bought. The total cost of transfers would increase by $1.6 million.

TABLE III-13

M&I WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 2b CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

Region	M&I Water Transfers Purchased (1,000 acre-foot) (1)		Average Price Paid for Water Received ($/acre-foot) (1)		Total Cost of Water Transfers ($million) (1)		Total Cost of Alternative ($1,000) (2)	
	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)
Bay Area	1	17	8	-124	0.2	-14.9	5	-46
Central Coast and South Coast	-1	-1	18	-79	1.6	-29.2	-29	-73

NOTES:
(1) Negative numbers indicate a reduction in quantities or cost relative to the No-Action Alternative.
(2) Cost of alternative includes all measures under that alternative, not just water transfer provisions.
(3) Dry year estimates reflect water purchased in addition to the yield from the average year transfer, which is assumed to take a 50% deficiency in dry years.

Both regions have shortages in the dry condition, but the shortages are reduced in Supplemental Analysis 2b relative to the Base Transfer Scenario because of additional SWP deliveries. In the Bay Area, the cost of transfers is less ($14.9 million less) because the average price is lower, even though more transfers (17,000 acre-feet more) are bought. The average transfer price per acre-foot is estimated to be $430 in the Base Transfer Scenario and $310 in Supplemental Analysis 2b. In the Central and South Coast, Supplemental Analysis 2b also results in substantial cost savings relative to the Base Transfer Scenario: $29 million is saved on costs of water transfers, and additional savings are obtained from reduced use of drought supplies. The average transfer price per acre-foot at the treatment plant is estimated to be $450 in the Base Transfer Scenario versus $370 in Supplemental Analysis 2b.

Table III-13 also shows total costs of Supplemental Analysis 2b relative to the Base Transfer Scenario. These results reflect changes in M&I water supplies, changes in water prices due to Alternative 2 effects on agricultural water deliveries, and the transferability of CVP contract and exchange supplies. Attachment A to the Municipal and Industrial Water Use and Cost Technical Appendix describes in detail the assumptions and results of this analysis.

Cost Estimate for Water Acquisitions. Under Alternative 2, water would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers in order to increase the instream flows to meet targets identified for chinook salmon and steelhead. The total amount of water acquired is estimated to be 160,000 acre-feet. Supplemental Analysis 2b was used to estimate the cost of water acquisition under conditions of competition with other potential buyers. The cost estimates for acquired water are reported in Table III-14. The average cost is estimated to be about $64 per net-acre-foot, with a total cost of $10 million. The specific plans for water acquisitions would be developed on a case-by-case basis, and the actual price and terms would vary within a region and across regions.

TABLE III-14

COST ESTIMATE OF ACQUIRED WATER IN ALTERNATIVE 2

Rivers	Long-term Average Water Acquisition (1,000 acre-feet/year) (1) (2)	Average Unit Cost of Applied Water ($/acre-foot) (3)	Long-term Average Water Cost ($ million/year)
Yuba River	0	$0.0	$0.0
Calaveras River	0	$0.0	$0.0
Mokelumne River	0	$0.0	$0.0
Stanislaus River	51	$63.0	$3.1
Tuolumne River	60	$63.0	$3.7
Merced River	49	$66.0	$3.2
Total Average	**160**	**$63.9**	**$10.0**

NOTES:
(1) The cost estimate does not include Level 4 incremental refuge water acquisitions.
(2) The numbers are estimated by SANJASM and PROSIM.
(3) Prices per acre-foot shown are for net water delivered to the field. Net water delivered is somewhat less than the purchased quantities shown in the second column because of conveyance losses between the point of diversion and field delivery.

These cost estimates are made in the context of Supplemental Analysis 2b, so the water prices reflect potential competition from other buyers. Prices per acre-foot shown in Table III-14 are for net water delivered to the field. Net water delivered is somewhat less than the purchased quantities shown in Table III-14 because of conveyance losses between the point of diversion and field delivery.

Potential Effect of Groundwater Substitution on The Transfer Market. The changes in Supplemental Analysis 2b if groundwater substitution is allowed are similar to those described for Supplemental Analysis 1e.

RESULTS FOR SUPPLEMENTAL ANALYSIS 2c

Supplemental Analysis 2c evaluates the impact of imposing a $50-per-acre-foot fee on CVP water transfers. Results are similar to those reported under Supplemental Analysis 1f. The main effect of imposing the fee is to shift the transfer market away from CVP water to non-CVP water, with about a 20 percent reduction in water bought during the average year, but little change in the total amount purchased in a dry year. The reduction in purchases during the average year represents agricultural buyers of CVP water who are unwilling to purchase it with the additional fee. Table III-15 illustrates this result by showing transfers from CVP and non-CVP sources for both Supplemental Analyses 2a and 2f. In an average year condition, the $50-per-acre-foot fee would eliminate CVP water transfers to both agricultural and M&I buyers. In a dry year condition, imposing the fee is estimated to decrease CVP water transfers to M&I buyers by 50 percent, compared with no fees. The total water transfer demand by M&I, however, is estimated to remain the same because of the increased transfers of non-CVP water.

TABLE III-15

WATER TRANSFER ESTIMATES WITH AND WITHOUT A $50-PER-ACRE-FOOT FEE SUPPLEMENTAL ANALYSES 2b AND 2c

Supplemental Analysis	CVP Water Bought	Non-CVP Water Bought	Total
Average Year			
1e: Transfers without $50/acre-foot fee	41	96	137
1f: Transfers with $50/acre-foot fee	3	104	107
Dry Year			
1e: Transfers without $50/acre-foot fee	171	372	543
1f: Transfers with $50/acre-foot fee	88	455	543

NOTE:
Water bought is in thousand acre-feet per year, measured at the buyer's destination.

Restoration Fund revenues from water transfers in Alternative 2b come from higher water prices paid to Reclamation (the "full-cost increment"), the Restoration Payment rising to $12 per acre-foot (1992 dollars) for water transferred to municipal uses, and the $25 per acre-foot surcharge paid by non-CVP municipal buyers. The reduction in CVP water transferred in Alternative 2c is estimated to cost the Restoration Fund up to $0.5 million in an average year condition, as compared to Alternative 2b. In a dry year condition, enough CVP water is still purchased in Alternative 2c that the extra $50 per acre-foot fee more than makes up for these other costs, and the Restoration Fund collections could increase by up to $7 million. These estimates are based on changes in CVP water sold rather than water received by buyers as shown in Table III-15.

SUPPLEMENTAL ANALYSIS 3a

ASSUMPTIONS

Supplemental Analysis 3a uses many of the same assumptions as in Supplemental Analysis 1e and 2b, except that Alternative 3 hydrology is used and additional water is acquired from willing sellers for instream flow and wildlife refuge demands. Delta export and major conveyance capacities available for transfer Supplemental Analysis 3a are presented in Table III-16. Alternative 3 assumptions allow Delta export pumping of some acquired water, so the remaining available capacity shown in Table III-16 is lower than in Alternative 2.

TABLE III-16

DELTA EXPORT AND MAJOR CONVEYANCE CAPACITIES AVAILABLE FOR WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 3a

Major Pumping and Conveyance Facilities Considered	Total Remaining Capacities Between July and January (1,000 acre-feet)	
	Average Year (1922 - 1990)	Dry Year (1928 - 1934)
Remaining Capacity at Tracy Pumping Plant	401	653
Remaining Capacity at Banks Pumping Plant	574	1168
Remaining Capacity Below Node 45 (DMC)	345	551
Remaining Capacity in the Hetch Hetchy System	N/A	48
Remaining Capacity in the South Bay Aqueduct	N/A	71
Remaining Capacity in the San Felipe Division	N/A	65

NOTE:
N/A means not applicable since there are no transfer demands through these systems in an average year condition.

RESULTS FOR SUPPLEMENTAL ANALYSIS 3a

Water Transfer Opportunities. Differences in water transfer quantities and average prices between Supplemental Analysis 3a and the Base Transfer Scenario are presented in Table III-17. The total average year transfer under 3a is estimated to be 24,000 acre-feet more than the Base Transfer Scenario. This increase is primarily the result of additional transfer demand by CVP agricultural contractors and other agricultural purchases by regions also selling water to the Water Acquisition Program. Estimated dry year transfers are 7,000 acre-feet less than those for the Base Transfer Scenario. In general, there is less water transferred out of the Sacramento River Region and more water transferred out of the Tulare Lake Region because of the availability of CVP water closer to the point of M&I demand. Compared with the Base Transfer Scenario, the estimated price paid by buyers under Supplemental Analysis 3a is slightly less ($2 per acre-foot) in an average year condition and $90 per acre-foot less in a dry year condition.

The lower prices are mainly due to the availability of less expensive CVP water, which more than offsets the effect of water acquisition demands.

The Delta export and major conveyance constraints considered for Supplemental Analysis 3a, as reported in Table III-16, are not binding except for the Hetch Hetchy system, the South Bay Aqueduct, and the San Felipe Division in a dry year condition.

TABLE III-17

WATER TRANSFER OPPORTUNITIES IN SUPPLEMENTAL ANALYSIS 3a CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

Buyers	Agricultural Sellers (Net 1,000 acre-feet) (1)				
	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total	Average Cost ($/acre-foot) (2)
Average Year					
San Luis Unit and East San Joaquin Agriculture	0	5	22	27	N/A
Bay Area M&I	0	1	-1	0	-24
Central Coast and South Coast M&I	2	15	-20	-3	-1
Total Weighted Average	**2**	**21**	**1**	**24**	**-2**
Dry Year					
Bay Area M&I Buyers	-48	29	15	-4	-117
Central Coast and South Coast M&I	-90	-48	135	-3	-77
Total Weighted Average (3)	**-138**	**-19**	**150**	**-7**	**-89**

NOTES:
(1) Net acre-foot is measured at buyers' destination. It equals gross acre-foot measured at sellers' origin minus conveyance losses and Delta outflow requirement for cross-Delta transfers.
(2) Average unit cost per acre-foot includes price paid at sellers' origin plus conveyance cost and CVPIA Restoration Fund charges.
(3) The weighted average price is calculated using quantity transferred as weights.

The estimate above focuses on inter-regional transfers. Local transfers within a region, especially between agricultural users, are also assumed to occur, but not counted by the analysis. Local transfers out of the CVP service area would also be more likely with the greater availability of CVP service contracts and exchange contract water in Supplemental Analysis 3a. Local transfers do not have the system-wide implications and impacts that inter-regional transfers are likely to have.

Impacts of Water Transfers On Agricultural Regions. Differences in land fallowing and revenue gains from water transfers between Supplemental Analysis 3a and the Base Transfer Scenario are shown in Table III-18. Land fallowing as a result of water transfers is estimated to be 1,000 acres lower in an average year and 49,000 acres lower in a dry year. The decreases are mainly caused by reductions in Delta outflow requirements and distribution and conveyance losses because of the availability of CVP water closer to the point of M&I demand. In other

words, for each acre-foot of water received, buyers under Supplemental Analysis 3a can buy CVP water closer to the destination and thus avoid some of the transport losses. As a result, less water would have to be purchased and less land would need to be fallowed to meet the same transfer demand. In general, major crops idled by transfers in an average year are pasture, hay, grain, field crops, rice, and cotton. Crops idled in a dry year are primarily grain, field crops, rice, and cotton.

TABLE III-18

LAND FALLOWING AND REVENUE GAINS FROM WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 3a CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

	Agricultural Water Transfer (1,000 acres-feet)		Land Fallowed as a Result of Transfer (1,000 acres)		Net Revenue Change (1) ($1,000)	
Region	Average	Dry	Average	Dry	Average	Dry
Sacramento River	5	-336	1	-100	280	-59,176
San Joaquin River	-16	-63	-2	-5	152	-24,325
Tulare Lake	1	216	0	56	-217	34,000
Total	**-10**	**-182**	**-1**	**-49**	**214**	**-49,501**

NOTE:
(1) Net revenue change represents the gains from trade in a region. For selling regions, this equals receipts from water sold (net of its cost) minus net revenue lost from land fallowing. For buying regions, net revenue change equals net revenue from added crop acres plus avoided cost of groundwater pumping minus payment for water purchased.

Anticipated changes in net revenue to agricultural water users have been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. For agricultural buyers, the net gain from transfers also includes some avoided cost of groundwater pumping. The net revenue changes for Supplemental Analysis 3a are estimated to be $0.2 million higher than those reported for the Base Transfer Scenario in an average year and $49 million lower in a dry year. The decreases in a dry year are due to the lower prices received for water transfers because of the availability of less expensive CVP water transfers. The estimates of gains to sellers do not include any cost of tilling, weed control, or other activities that may be needed for temporarily fallowed land. Significant variation in selling price and gains from sales can be expected within a region and between regions.

Impacts of Water Transfers On M&I Water Use and Cost. Table III-19 shows M&I results for Supplemental Analysis 3a. Results are expressed as the difference from the Base Transfer Scenario, where transfers of CVP water service contract and water rights exchange water are not allowed.

Table III-19 shows that, in the average condition, the Bay Area buys about the same amount of transfers as in the Base Transfer Scenario, but with a lower cost per acre-foot. The price of water at the treatment plant in the Base Transfer Scenario and Supplemental Analysis 3a is $140 and $120, respectively. The cost of transfers decreases by roughly $100,000 because of decreased quantity and price. In the Central Coast and South Coast, the price paid for transfers is decreased

by $1 relative to the Base Transfer Scenario and 3,000 fewer acre-feet are bought. As a result, the total cost of transfers decreases by $8.8 million.

TABLE III-19

M&I WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 3a CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

	M&I Water Transfers Purchased (1,000 acre-feet) (1)		Average Price Paid for Water Received ($/acre-foot) (1)		Total Cost of Water Transfers ($million((1)		Total Cost of Alternative ($1000) (2)	
Region	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)
Bay Area	0	-4	-23	-116	-0.1	-20.1	5	-27
Central and South Coast	-3	-1	-1	-77	-8.8	-29.1	-96	-97

NOTES:
(1) Negative numbers indicate a reduction in quantities or cost relative to the Base Transfer Scenario.
(2) Cost of alternative includes all measures under that alternative, not just water transfer provisions.
(3) Dry year estimates reflect water purchased in addition to the yield from the average year transfer, which is assumed to take a 50% deficiency in dry years.

Both regions have shortages in the dry condition, but shortages are reduced relative to the Base Transfer Scenario by additional SWP supplies and expected pumping of some acquired water from the Delta. In the Bay Area, the cost of transfers is less ($20.1 million less) because the average price is lower. The average transfer prices per acre-feet in the Base Transfer Scenario and Supplemental Analysis 3a are about $430 and $320, respectively. In the Central and South Coast, Supplemental Analysis 3a also results in substantial cost savings relative to the Base Transfer Scenario: $29 million is saved on costs of water transfers, and additional savings are obtained from reduced use of drought supplies. The average transfer prices per acre-feet at the treatment plant in the Base Transfer Scenario and Supplemental Analysis 3a are about $450 and $370, respectively.

Table III-19 also shows total costs of 3a relative to the Base Transfer Scenario. These results reflect numerous differences between 3a and the Base Transfer Scenario, including changes in M&I water supplies, changes in water prices due to Alternative 3 effects on agricultural water deliveries, and the transferability of CVP contract and exchange supplies. Attachment A to the Municipal Water Cost Technical Appendix describes in detail the assumptions and results of this analysis.

Cost Estimate for Water Acquisitions. Under Alternative 3, additional water (beyond Alternative 2) would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers in order to increase the instream flows and attempt to meet targets identified for chinook salmon and steelhead. Additional water would be purchased on the Yuba, Calaveras, and Mokelumne rivers. The total amount of water acquired under Alternative 3 is estimated to be 765,000 acre-feet. The cost estimates for the acquired water are reported in Table III-20. The

average cost is estimated to be about $100 per acre-foot, with a total cost of $63.5 million. The specific plans for water acquisitions would be developed on a case-by-case basis, and the actual price and terms would vary within a region and across regions.

TABLE III-20

COST ESTIMATE OF ACQUIRED WATER IN ALTERNATIVE 3

Rivers	Long-term Average Water Acquisition (1,000 acre-feet/year) (1) (2)	Average Unit Cost of Applied Water ($/acre-foot) (3)	Long-term Average Water Cost ($million/year)
Yuba River	92	$44.0	$3.8
Calaveras River	27	$63.0	$1.4
Mokelumne River	66	$63.0	$3.4
Stanislaus River	192	$133.0	$20.9
Tuolumne River	196	$112.4	$18.0
Merced River	192	$102.0	$16.0
Total Average	**765**	**$99.7**	**$63.5**

NOTES:
(1) The cost estimate does not include Level 4 incremental refuge water acquisitions.
(2) The numbers are estimated by SANJASM and PROSIM.
(3) Prices per acre-foot shown are for net water delivered to the field. Net water delivered is somewhat less than the purchased quantities shown in the second column because of conveyance losses between the point of diversion and field delivery.

These cost estimates are made in the context of Supplemental Analysis 3a, so the water prices reflect potential competition from other buyers. Prices per acre-foot shown in Table III-20 are for net water delivered to the field. Net water delivered is somewhat less than the purchased quantities shown in Table III-20 because of conveyance losses between the point of diversion and field delivery.

Potential Effect of Groundwater Substitution On the Transfer Market. The changes in Supplemental Analysis 3a if groundwater substitution is allowed are similar to those described for Supplemental Analysis 1e.

SUPPLEMENTAL ANALYSIS 4a

ASSUMPTIONS

Supplemental Analysis 4a uses many of the same assumptions as Supplemental Analysis 1e, 2b, and 3a except that Alternative 4 hydrology is used. Delta export and major conveyance capacities available for Supplemental Analysis 4a are presented in Table III-21. Alternative 4 assumes the use of (b)(2) water in the Delta and no Delta export pumping of acquired water, so the remaining available capacity shown in Table III-21 is higher than in Alternative 3.

TABLE III - 21

DELTA EXPORT AND MAJOR CONVEYANCE CAPACITIES AVAILABLE FOR WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 4a

Major Pumping and Conveyance Facilities Considered	Total Remaining Capacities Between July and January (1,000 acre-feet)	
	Average Year (1922 - 1990)	Dry Year (1928 - 1934)
Remaining Capacity at Tracy Pumping Plant	429	757
Remaining Capacity at Banks Pumping Plant	693	1370
Remaining Capacity Below Node 45 (DMC)	355	633
Remaining Capacity in the Hetch Hetchy System	N/A	48
Remaining Capacity in the South Bay Aqueduct	N/A	71
Remaining Capacity in the San Felipe Division	N/A	65

LEGEND:
N/A means not applicable since there are no transfer demands through these systems in an average year condition.

RESULTS FOR SUPPLEMENTAL ANALYSIS 4a

Water Transfer Opportunities. Differences in water transfer quantities and average prices between Supplemental Analysis 4a and the Base Transfer Scenario are presented in Table III-22. The total average year transfer under 4a is estimated to be 30,000 acre-feet more than the Base Transfer Scenario. This increase is primarily the result of additional transfer demand by CVP agricultural contractors and other agricultural purchases by regions also selling water to the Water Acquisition Program. Estimated dry year transfers are 28,000 acre-feet more than those for the Base Transfer Scenario. In general, less water is transferred out of the Sacramento River Region and more water transferred out of the Tulare Lake Region because of the availability of CVP water closer to the point of M&I demand. Compared with the Base Transfer Scenario, the estimated price paid by buyers under Supplemental Analysis 4a is about $20 per acre-foot higher for the average year because water acquisition increases water price by more than the price reduction due to the availability of CVP supplies. The average price paid by buyers in a dry year is estimated to be $90 per acre-foot lower because the availability of less expensive CVP water more than offsets the effect of water acquisition demands.

The Delta export and major conveyance constraints considered for Supplemental Analysis 4a, as reported in Table III-21, are not binding except for the Hetch Hetchy system, the South Bay Aqueduct, and the San Felipe Division in a dry year condition.

TABLE III-22

WATER TRANSFER OPPORTUNITIES IN SUPPLEMENTAL ANALYSIS 4a CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

Buyers	Agricultural Sellers (Net 1,000 acre-feet) (1)				
	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	Total	Average Cost ($/acre-foot) (2)
Average Year					
San Luis Unit and East San Joaquin Agriculture	0	5	22	27	N/A
Bay Area M&I	0	-1	4	3	4
Central and South Coast M&I	2	-2	0	-0	25
Total Weighted Average	**2**	**1**	**26**	**30**	**21**
Dry Year					
Bay Area M&I	-6	10	25	28	-110
Centra Coast and South Coast M&I	-62	-39	100	0	-74
Total Weighted Average (3)	**-68**	**-29**	**125**	**28**	**-87**

NOTES:
(1) Net acre-foot is measured at buyers' destination. It equals gross acre-foot measured at sellers' origin minus conveyance losses and Delta outflow requirement for cross-Delta transfers.
(2) Average unit cost per acre-foot includes price paid at sellers' origin plus conveyance cost and CVPIA Restoration Fund charges.
(3) The weighted average price is calculated using quantity transferred as weights.

The estimate above focuses on inter-regional transfers. Local transfers within a region, especially between agricultural users, are also assumed to occur, but not counted by the analysis. Local transfers out of the CVP service area would also be more likely with the greater availability of CVP service contracts and exchange contract water in Supplemental Analysis 4a. Local transfers do not have the system-wide implications and impacts that inter-regional transfers are likely to have.

Impacts of Water Transfers On Agricultural Regions. Differences in land fallowing and revenue gains from water transfers between Supplemental Analysis 4a and the Base Transfer Scenario are shown in Table III-23. Land fallowing as a result of water transfers is estimated to be 6,000 acres higher in an average year but 52,000 acres lower in a dry year. The increase in an average year is due to more water sold to meet the higher demand by agricultural buyers. The decrease in a dry year is mainly caused by reductions in Delta outflow requirements and distribution and conveyance losses because of the availability of CVP water closer to the point of M&I demand. In other words, for each acre-foot of water received, buyers under Supplemental Analysis 4a can buy CVP water closer to the destination and thus avoid some of the transport losses. As a result, less water would need to be purchased and less land would need to be fallowed to meet the same transfer demand. In general, major crops idled by transfers in an average year are pasture, hay, grain, field crops, rice, and cotton. Crops idled in a dry year are primarily grain, field crops, rice, and cotton.

TABLE III-23

LAND FALLOWING AND REVENUE GAINS FROM WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 4a CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

Region	Agricultural Water Transfer (1,000 acre-feet)		Land Fallowed as a Result of Transfer (1,000 acres)		Net Revenue Change (1) ($1,000)	
	Average	Dry	Average	Dry	Average	Dry
Sacramento River	5	-161	1	-60	278	-43,864
San Joaquin River	-35	-70	-5	-13	281	-26,998
Tulare Lake	36	180	10	52	3,427	29,585
Total	**6**	**-52**	**7**	**-21**	**3,986**	**-41,277**

NOTE:
(1) Net revenue change represents the gains from trade in a region. For selling regions, this equals receipts from water sold (net of its cost) minus net revenue lost from land fallowing. For buying regions, net revenue change equals net revenue from added crop acres plus avoided cost of groundwater pumping minus payment for water purchased.

Anticipated changes in net revenue to agricultural water users have been estimated by combining net revenue loss due to crop fallowing, the cost of the water, and the income from water sales. For agricultural buyers, the net gain from transfers also includes some avoided cost of groundwater pumping. The net revenue changes for Supplemental Analysis 4a are estimated to be $3.9 million higher than those reported for the Base Transfer Scenario in an average year and $41 million lower in a dry year. The decreases in a dry year are due to the lower prices received for water transfers because of the availability of less expensive CVP water transfers. The estimates of gains to sellers do not include any cost of tilling, weed control, or other activities that may be needed for temporarily fallowed land. Significant variation in selling price and gains from sales can be expected within a region and between regions.

Impacts of Water Transfers on M&I Water Use And Cost. Table III-24 shows M&I results for Supplemental Analysis 4a expressed as the difference from the Base Transfer Scenario, where transfers of CVP water service contract and water rights exchange water are not allowed.

Table III-24 shows that, in the average condition, the Bay Area buys about 3,000 acre-feet more transfers than in the Base Transfer Scenario, and the average cost per acre-foot of supply bought increases by about $4. The price of water at the treatment plant in the Base Transfer Scenario and Supplemental Analysis 4a is about $140 and $150, respectively. The cost of transfers increases by about $400,000 because both quantity and price increase. In the Central and South Coast, the price paid for transfers would increase by about $25 relative to the Base Transfer Scenario, whereas the amount bought would remain about the same. As a result, the total cost of transfers would increase by an estimated $2.6 million.

TABLE III-24

M&I WATER TRANSFERS IN SUPPLEMENTAL ANALYSIS 4a CHANGES AS COMPARED TO THE BASE TRANSFER SCENARIO

	M&I Water Transfers Purchased (1,000 acre-feet) (1)		Average Price Paid for Water Received ($/acre-foot) (1)		Total Cost of Water Transfers ($million) (1)		Total Cost of Alternative ($1,000) (2)	
Region	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)	Average	Dry (3)
Bay Area	3	29	4	-110	0.4	-8.3	5	-14
Central Coast and South Coast	0	0	25	-74	2.6	-26.9	8	-22

NOTES:
(1) Negative numbers indicate a reduction in quantities or cost relative to the Base Transfer Scenario.
(2) Cost of alternative includes all measures under that alternative, not just water transfer provisions.
(3) Dry year estimates reflect water purchased in addition to the yield from the average year transfer, which is assumed to take a 50% deficiency in dry years.

Both regions have shortage in the dry condition, but the shortages are reduced relative to the Base Transfer Scenario by additional SWP supplies. In the Bay Area, the cost of transfers is less ($8.3 million less) because the average price is lower. The average transfer prices per acre-foot in the Base Transfer Scenario and Supplemental Analysis 3a are estimated to be about $430 and $320, respectively. In the Central and South Coast, Supplemental Analysis 4a also results in substantial cost savings relative to the Base Transfer Scenario. About $27 million is saved on costs of water transfers, and additional savings are obtained from reduced use of drought supplies. The average transfer prices per acre-foot at the treatment plant in the Base Transfer Scenario and Supplemental Analysis 4a are about $450 and $370, respectively.

Table III-24 also shows total costs of 4a relative to the Base Transfer Scenario. These results reflect numerous differences between 4a and the Base Transfer Scenario, including changes in M&I water supplies, changes in water prices due to Alternative 4 effects on agricultural water deliveries, and the transferability of CVP contract and exchange supplies. Attachment A to the Municipal Water Cost Technical Appendix describes in detail the assumptions and results of this analysis.

Cost Estimate for Water Acquisitions. Under Alternative 4, additional water (beyond Alternative 2) would be acquired from willing sellers on the Stanislaus, Tuolumne, and Merced rivers in order to increase the instream flows and attempt to meet targets identified for chinook salmon and steelhead. Additional water would be purchased on the Yuba, Calaveras, and Mokelumne rivers. The total amount of water acquired under Alternative 4 is estimated to be 765,000 acre-feet. The cost estimates for the acquired water are reported in Table III-25. The average cost is estimated to be about $100 per net acre-foot, with a total cost of $64 million. The specific plans for water acquisitions would be developed on a case-by-case basis, and the actual price and terms would vary within a region and across regions.

TABLE III-25

COST ESTIMATE OF ACQUIRED WATER IN ALTERNATIVE 4

Rivers	Long-term Average Water Acquisition (1,000 acre-feet/year) (1) (2)	Average Unit Cost of Applied Water ($/acre-foot) (3)	Long-term Average Water Cost ($ million/year)
Yuba River	92	$44.0	$3.8
Calaveras River	27	$63.0	$1.4
Mokelumne River	66	$63.0	$3.4
Stanislaus River	192	$134.0	$21.0
Tuolumne River	196	$113.4	$18.1
Merced River	192	$103.0	$16.2
Total Average	**765**	**$100.4**	**$64.0**

NOTES:
(1) The cost estimate does not include Level 4 incremental refuge water acquisitions.
(2) The numbers are estimated by SANJASM and PROSIM.
(3) Prices per acre-foot shown are for net water delivered to the field. Net water delivered is somewhat less than the purchased quantities shown in the second column because of conveyance losses between the point of diversion and field delivery.

These cost estimates are made in the context of Supplemental Analysis 4a, so the water prices reflect potential competition from other buyers. Prices per acre-foot shown in Table III-25 are for net water delivered to the field. Net water delivered is somewhat less than the purchased quantities shown in Table III-25 because of conveyance losses between the point of diversion and field delivery.

Potential Effect of Groundwater Substitution On the Transfer Market. The changes in Supplemental Analysis 4a if groundwater substitution is allowed are similar to those described for Supplemental Analysis 1e.

CHAPTER IV

BIBLIOGRAPHY

Chapter IV

BIBLIOGRAPHY

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CENTRAL VALLEY PROJECT IMPROVEMENT ACT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

DRAFT TECHNICAL APPENDIX

Municipal and Industrial Land Use and Demographics

September 1997

C-082942

C-082942

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LIST OF ABBREVIATIONS AND ACRONYMS

af	acre-feet
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DAU	detailed analysis unit
DOF	Department of Finance
DWR	Department of Water Resources
EIR	environmental impact report
M&I	municipal and industrial
PEIS	Programmatic Environmental Impact Statement
SWP	State Water Project

CHAPTER I

INTRODUCTION

Chapter I

INTRODUCTION

The Draft Programmatic Environmental Impact Statement (PEIS) summarizes the evaluation of the direct and indirect impacts of implementing a wide range of actions identified in the Central Valley Project Improvement Act (CVPIA). Details of the information used in the definition of the affected environment and analysis of the environmental consequences are presented in the technical appendices of the Draft PEIS.

This technical appendix presents a summary of municipal land use background information that was used during the PEIS preparation, and the results of the impact analyses for conditions that occurred throughout the study area, shown in Figure I-1.

The municipal land use analysis was primarily based upon land use presented in the California Department of Water Resources Bulletin 160-93 and land uses projected in county general plans, as available.

The assumptions and results of the analyses for Alternatives 1, 2, 3, and 4 are presented in this technical appendix and summarized in the Draft PEIS. The assumptions and results of Supplemental Analyses 1a through 1i, 2a through 2d, 3a, and 4a are summarized only in the Draft PEIS. The assumptions related to the municipal land use analyses for Alternatives 1, 2, 3, and 4 are presented in Table I-1. The results of the analyses are presented in Table I-2.

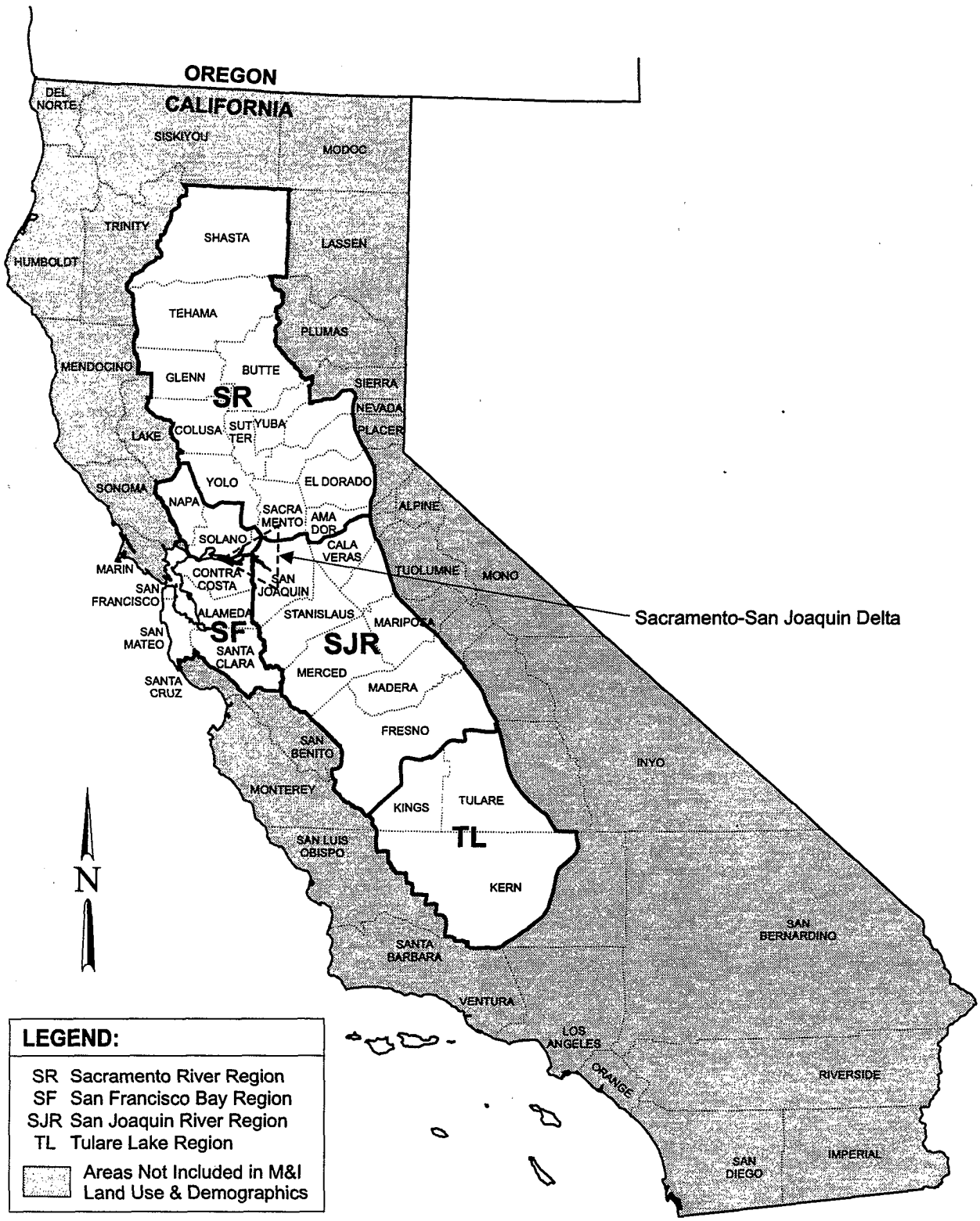

FIGURE I-1
STUDY AREA

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TABLE I-1

SUMMARY OF ASSUMPTIONS FOR M&I LAND USE AND DEMOGRAPHICS ANALYSES

Alternative or Supplemental Analysis	Assumption
No-Action Alternative	Urban growth would occur as presented in the California Department of Water Resources Bulletin 160-93 for year 2020.
1	Additional shortage eliminated by additional developed supplies and price-induced conservation.
2	Same as Alternative 1.
3	Same as Alternative 1.
4	Same as Alternative 1.

TABLE I-2

SUMMARY OF IMPACT ASSESSMENT OF M&I LAND USE AND DEMOGRAPHICS

Affected Factors	No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
		Change from No-Action Alternative			
M&I Land Use and Demographics	Based on DWR Bulletin 160-93	No change from No-Action Alternative	No change from No-Action Alternative	No change from No-Action Alternative	No change from No-Action Alternative

CHAPTER II

AFFECTED ENVIRONMENT

Chapter II

AFFECTED ENVIRONMENT

INTRODUCTION

This chapter provides an historical perspective and describes recent conditions of municipal and industrial (M&I) land use and demographics in the study area for the PEIS. M&I land use and demographics are related to the Municipal Water Costs, Agricultural Economics and Land Use, Regional Economics, Social Analysis, and Water Facilities and Supplies technical appendices.

For the purposes of this technical appendix, M&I land is defined as land used for residential, industrial, commercial, construction, institutional, public administrative purposes, railroad yards, cemeteries, airports, golf courses, sanitary landfills, sewage treatment plants, water control structures, and other development purposes. Highways, railroads, and other transportation facilities are also included as M&I land use if they are part of a surrounding M&I area.

Demographics is the science of human population statistics, and provides one component of the data used in the analysis of social conditions. Generally, demographics studies address characteristics of populations, including ethnicity, gender, and age. This technical appendix focuses on these and other characteristics of historic and projected demographic data in the PEIS study area. Other data associated with social characteristics include employment and income statistics. A summary of these economic indicators for the PEIS study is described in the Regional Economics Technical Appendix.

The study area for the M&I land use and demographics analysis in the PEIS includes the Sacramento River Region, San Joaquin River Region, Tulare Lake Region and the San Francisco Bay Region. Historic M&I land use and demographics data are summarized for the period from 1920 through 1990.

DATA SOURCES

Data for historic and recent M&I land use areas in the Sacramento River, San Joaquin River, and Tulare Lake regions were obtained from DWR annual estimates of land use. These data were reported as total urban land area within each detailed analysis unit (DAU). A DAU is the smallest study area used by the DWR for analysis of water demand and supply, and is generally defined by hydrologic features or boundaries of organized water service areas. In the major agricultural areas, a DAU typically is 100,000 to 300,000 acres.

DWR compiles and updates land use information for the Central Valley on a continual basis. Because of the extensive size of the Central Valley, the DWR has established a rotational update process, where each area within the Valley is updated approximately every seven years. As a

result, land use data are collected in some portion of the Central Valley each year. Each year, the collected data are used to update portions of the land use estimates for the entire Central Valley.

Annual land use data for DAUs in the Central Valley from the years 1920 to 1990 were obtained from DWR. Data for all DAUs within each study area were aggregated to obtain regional estimates of M&I land use areas. M&I land use areas in the three Central Valley regions are provided at 10-year intervals in this technical appendix to correspond with population data obtained from census reports. Land use estimates presented in this technical appendix are rounded to the nearest thousand acres. Historical M&I land use data from the San Francisco Bay Region were obtained from various publications of the California Water Plan (DWR Bulletin 160). These periodic publications provide current and projected land use estimates for geographic regions throughout California.

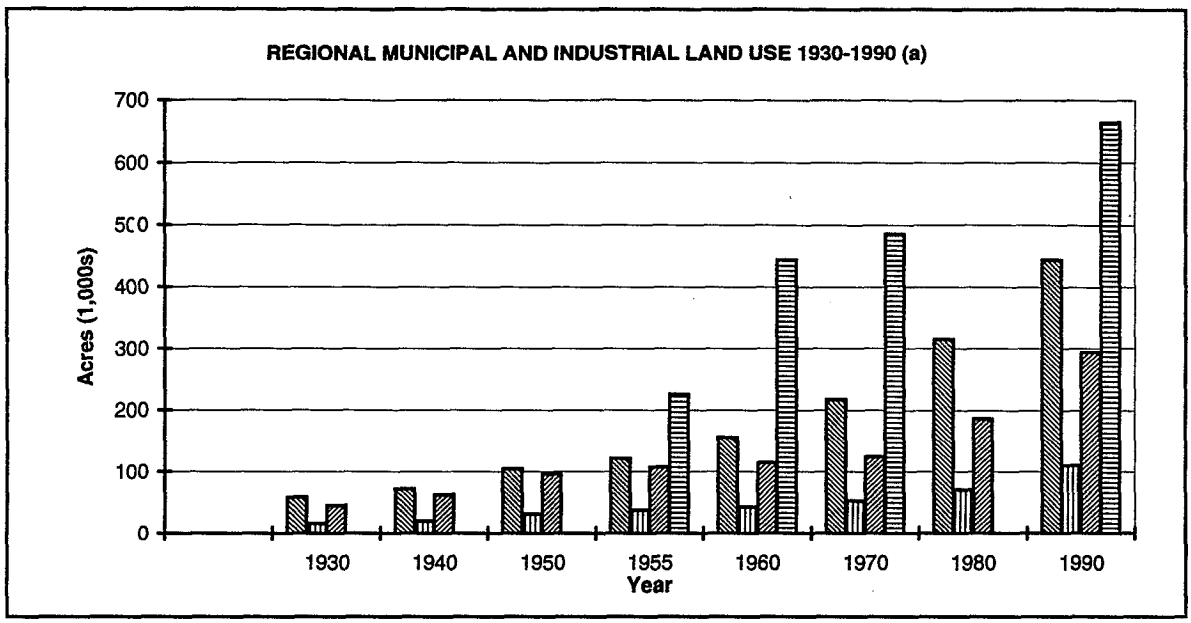
Historic demographic data were obtained from U.S. Department of Commerce census reports. Data were colleted at the county level and aggregated to the regional summaries presented in this technical appendix. The Sacramento River Region has been estimated by summing data for Amador, Butte, Colusa, El Dorado, Glenn, Napa, Nevada, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo, and Yuba counties. The San Joaquin River Region has been estimated by summing data for Calaveras, Fresno, Madera, Mariposa, Merced, San Joaquin, Stanislaus, and Tuolumne counties. The Tulare Lake Region has been estimated by summing data for Kern, Kings, and Tulare counties. The San Francisco Bay Region has been estimated by summing data for Alameda, Contra Costa, Marin, San Francisco, San Mateo, and Santa Clara counties. These regions are not necessarily the same as the DWR Bulletin 160 hydrologic regions. The ethnic distribution of historic and projected populations were obtained from the California Department of Finance (DOF, 1993). Population numbers presented in this technical appendix are rounded to the nearest thousand.

HISTORICAL PERSPECTIVE

This section provides a brief overview of the changes in total M&I land area and population that occurred within each of the four regions considered in this technical appendix.

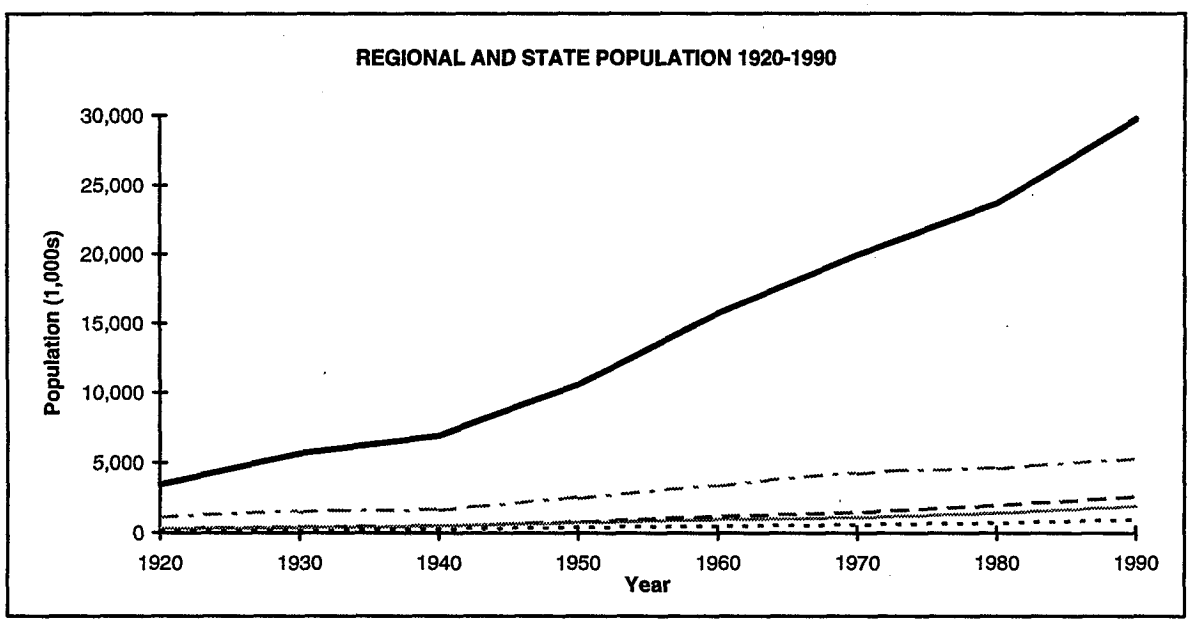
Figure II-1 presents a summary of M&I land use areas from 1930 through 1990 for each of the four regions. Data for the M&I land use areas in the San Francisco Bay Area for the period from 1930 through 1950 were not readily available from the data sources used for this analysis.

As indicated on Figure II-1, M&I land use increased within all four regions for which data was available between 1930 and 1950. Between 1950 and 1980, M&I land use areas approximately doubled in the three regions in the Central Valley. M&I growth during this period was partially supported by the development of several major water supply projects, including the CVP, the SWP, and several local projects in the Central Valley and throughout California. The use of groundwater resources to support M&I land uses also increased in the four regions during this period. In many areas the expansion of metropolitan areas within the four regions coincided with a conversion of land from agricultural to M&I use. In some cases, water supply facilities associated with agricultural lands were adapted for M&I water supply purposes.



NOTE: (a) San Francisco Bay Region data not readily available. Source: Department of Water Resources.

Sacramento River Region | San Joaquin River Region | Tulare Lake Region | San Francisco Region



California | Sacramento River Region | San Joaquin River Region | Tulare Lake Region | San Francisco Bay Region

FIGURE II-1

HISTORICAL MUNICIPAL AND INDUSTRIAL LAND USE AND POPULATION

Between 1920 and 1990 the population of California steadily increased. As shown in Figure II-1 this trend occurred statewide as well as within each of the four regions considered in this technical appendix. Although the population of the state continued to increase throughout this period, factors contributing to this increase have changed over time.

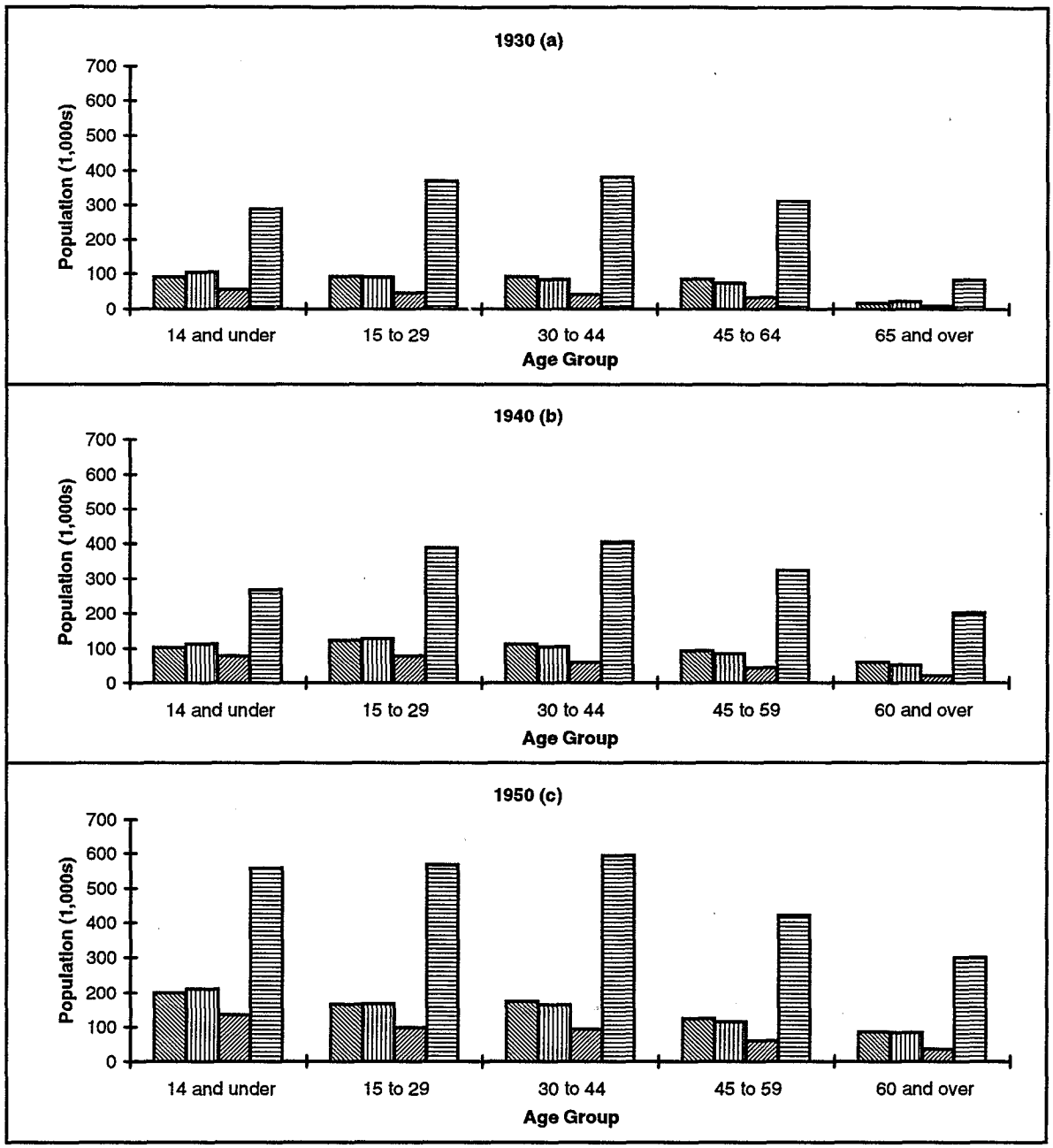
During the 1930s, the poor economic conditions associated with the Great Depression caused many people to migrate to California from other areas of the country. In the 1940s, migration from domestic sources was also associated with intensive military support functions during World War II. During the 1950s and 1960s, the post World War II "baby boom," combined with continued migration from domestic and foreign sources, contributed to the statewide population increase. Between 1970 and 1980, migration to California from foreign sources began to rise, as compared to migration from domestic sources. Between 1950 and 1980 California's growth rate was similar to the growth rate of the nation. During this time period, the people who moved to the state from outside the country accounted for approximately one-half of the total growth in California's population (Ong et al., 1986). Between 1980 and 1990, approximately 30 percent of the net-migration has been from other states, and 70 percent was from outside the county (DOF, 1993). Since 1970 migration to California has fluctuated widely. This wide fluctuation is mostly attributable to domestic migration since undocumented migration from other countries has remained fairly constant and documented migration from other countries has slowly increased (DOF, 1993).

Until recently, most of the M&I land use in California was concentrated in or near the coastal areas. During the last decade, this trend has begun to shift, as the rate of new development in coastal areas has declined as the availability of developable land has decreased and prices of remaining available land have risen. This trend is evident in the relationship between the San Francisco Bay Region and the areas of Sacramento and San Joaquin counties. During the 1980s, communities in the Sacramento, Tracy, and Stockton areas have grown partially with residents who commute to Livermore, Walnut Creek, and other areas of the San Francisco Bay Region.

As shown in Figure II-1, California had an estimated population of 29,760,000 in 1990 and approximately 36 percent, or 10,604,000, of these people are located within the four PEIS regions. The fast-growing cities of the Central Valley have raised the existing population of the Sacramento River, San Joaquin River, and Tulare Lake Regions to approximately 5,420,000 people. Most of the population in these regions is concentrated in relatively small portions, including the greater metropolitan areas of Redding, Sacramento, Vallejo, Fairfield/Vacaville, Stockton, Modesto, Fresno, and Bakersfield.

Figures II-2 through II-4 list age characteristics of historic population estimates based on U.S. Census data from 1930 through 1990.

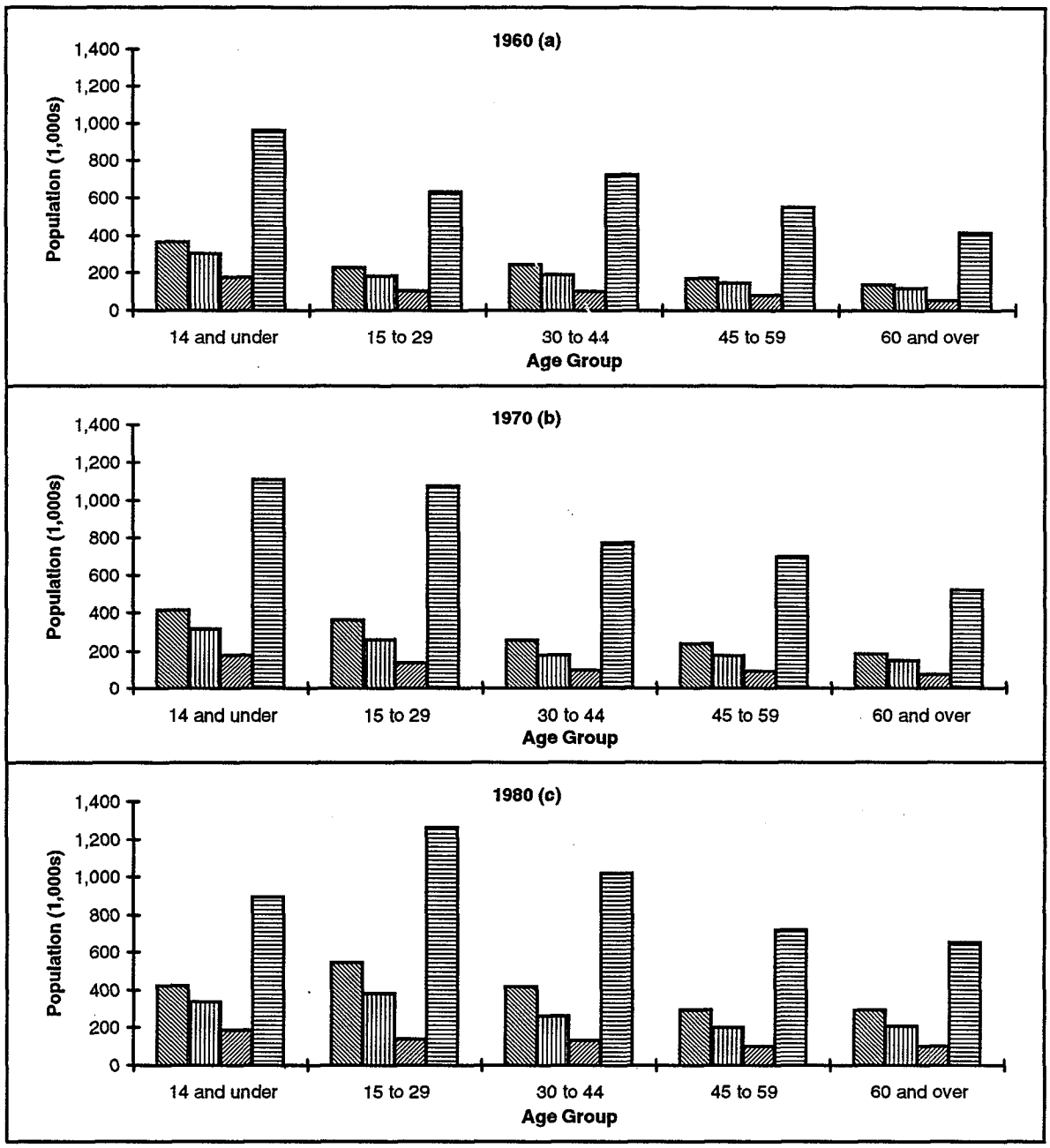
The following discussions provide an overview of historical M&I land use and demographics between 1930 and 1990 in each of the four regions. Because the rates of growth in California prior to and following World War II vary considerably, these discussions are generally divided into two parts: 1930 through 1950 and 1950 through 1990. The 1930 through 1950 time frame also precedes construction of the CVP, SWP and other local water supply projects throughout the Central Valley and California.



SOURCE: (a) U.S. Department of Commerce, 1930 Census Report.
(b) U.S. Department of Commerce, 1940 Census Report.
(c) U.S. Department of Commerce, 1950 Census Report.

FIGURE II-2

REGIONAL POPULATION BY AGE - 1930, 1940, 1950

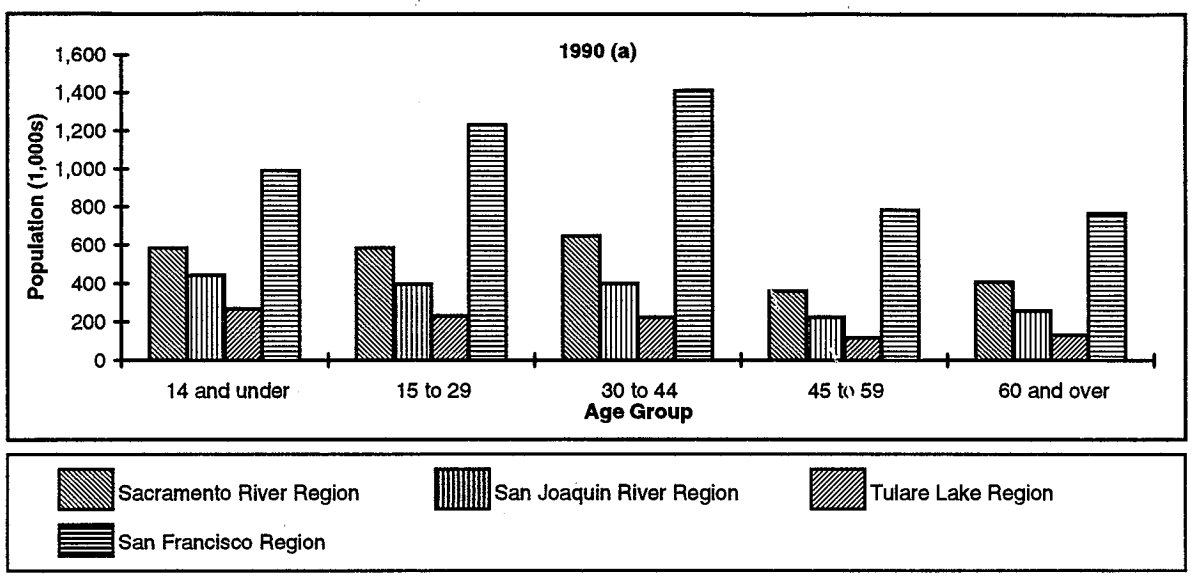


Sacramento River Region
San Joaquin River Region
Tulare Lake Region
San Francisco Region

SOURCE: (a) U.S. Department of Commerce, 1960 Census Report.
(b) U.S. Department of Commerce, 1970 Census Report.
(c) U.S. Department of Commerce, 1980 Census Report.

FIGURE II-3

REGIONAL POPULATION BY AGE - 1960, 1970, 1980



SOURCE: (a) U.S. Department of Commerce, 1990 Census Report.

FIGURE II-4

REGIONAL POPULATION BY AGE - 1990

SACRAMENTO RIVER REGION

M&I Land Use

M&I land use data for the Sacramento River Region were not collected for the period prior to 1922. Therefore, the data on M&I land use are presented beginning in 1930. Between 1930 and 1950, M&I land use in the Sacramento River Region increased from approximately 58,000 acres to 104,000 acres (Figure II-1). Much of the M&I land increases were associated with the growth of the city of Sacramento. Developed land within the remainder of the region was used primarily for agriculture and associated activities.

M&I land use in the Sacramento River Region increased after 1950, in part as a result of the post-World War II "baby boom" and strong economic conditions. Between 1950 and 1980, M&I corridors developed along Interstate 80 from Fairfield to Auburn and along Highway 50. During this time, development in the region included growth in Sacramento, which expanded the area from a regional transportation center for agriculture and the state capital, to an area that also supported aerospace, electronics, computer and other high technology industries.

Between 1980 and 1990, M&I land acreage within the Sacramento River Region increased from approximately 316,000 acres to 444,000 acres (Figure II-1). M&I land use within the region is concentrated in and around the City of Sacramento along the major highway corridors leading out of the city and in the Solano County area. As the state capital, Sacramento provides a base for many state and federal government offices. Its location in proximity to major transportation corridors, combined with its central location within the state, make it the largest M&I land use area within the Central Valley.

Rapid growth in single and multi-family housing has had a major impact on the Sacramento County area, as well as surrounding areas including Placer, El Dorado, Butte, Yolo, Solano, and Sutter counties. Suburban "ranchette" homes on relatively large parcels often surround M&I areas in this region. During the 1980s, the Auburn and Sacramento areas were among the fastest growing areas in California. Irrigated agricultural acreage in the region peaked during the 1980s and has since declined due to the conversion of these lands to M&I land uses.

Demographics

Between 1920 and 1950, the population of the Sacramento River Region more than doubled (Figure II-1). Population growth was relatively constant between 1920 and 1940, however, it increased dramatically between 1940 and 1950. During this decade, the Sacramento River Region experienced its greatest rate of population growth, increasing from approximately 488,000 to 754,000 people. This increase coincided with the movement of armed services people to the state during World War II and the beginning of the "baby boom." During this time intensive activity associated with Mather and McClellan air force bases near Sacramento influenced regional growth. Between 1950 and 1990, the population of the region increased from approximately 754,000 to more than 2.6 million. This increase was the second largest among all four regions.

For the entire period between 1920 and 1990, the population in the Sacramento River Region increased by approximately 2.2 million people. This increase represented the largest percent change of the four regions and was similar to the rate of population growth for the state. The total population increase was accompanied by changes in the composition of the population. Changes occurred in the age distribution, ethnicity, and education levels of the population.

Since 1920, age distributions of the population within the Sacramento River Region have changed. Between 1920 and 1950, the most dramatic increases occurred in the number of children and elderly. Specifically, the greatest increases occurred in the age group 14 years and younger and 60 years and older. These changes in age distributions coincided with the beginning of the post war "baby boom" and advances in medical technology that increased life expectancy. The changes in age distribution between 1950 and 1990 reflect the influence of the "baby boomer" generation, combined with changes in migration patterns. In 1960, people 14 years and younger comprised the greatest proportion of the population (Figure II-3). In 1980, people 29 years and younger comprised the greatest proportion of the population (Figure II-3). And in 1990, people 44 years and younger comprised the greatest proportion of the population (Figure II-4). Between 1980 and 1990 the population of all age groups increased. The greatest increases occurred in the age groups 14 years and younger and the 30 to 44 years old age group.

Data on the ethnic composition of the region's population are limited to the population of whites, blacks, and Hispanics, with all other ethnic groups combined to a single "other" category (Table II-1). Data on the proportion of Hispanics in the region between 1920 and 1950 were not readily available for this analysis. All ethnic groups, for which data are available, increased within the region between 1920 and 1950, a trend that has continued through 1990. Between 1920 and 1990, whites comprised the largest proportion of the population, although the relative proportion of all other ethnic groups have increased.

Data on the educational attainment of the region's population from 1950 to 1990 are shown in Table II-2. Data on the education level achieved by the population before 1950 were not readily available. The table shows the educational attainment for all persons in each region that are 25 years and older. The number of high school and college degrees in the region have steadily increased since 1950.

SAN JOAQUIN RIVER REGION

M&I Land Use

M&I land use data for the San Joaquin River Region are not available for the period between 1920 and 1930. Therefore, the data on M&I land use are presented beginning in 1930. Between 1930 and 1950, M&I lands within the San Joaquin River region were located primarily in valley towns such as Stockton, Madera, and Modesto. During this time, M&I acreage within this region doubled, increasing from approximately 16,000 acres in 1930 to 32,000 acres in 1950 (Figure II-1).

TABLE II-1

POPULATION BY ETHNICITY, 1920-1990

Year	Sacramento River Region				San Joaquin River Region				Tulare Lake Region				San Francisco Bay Region			
	White	Black	Hispanic	Other	White	Black	Hispanic	Other	White	Black	Hispanic	Other	White	Black	Hispanic	Other
1920	290	2	N/R	16	288	2	N/R	16	130	1	N/R	5	1,029	10	N/R	31
1930	346	3	N/R	40	333	3	N/R	40	159	3	N/R	6	1,363	16	N/R	74
1940	462	4	N/R	21	456	6	N/R	21	267	5	N/R	5	1,520	20	N/R	48
1950	717	17	N/R	23	691	25	N/R	23	402	17	N/R	6	2,215	142	N/R	69
1960	1,081	37	N/R	28	868	38	N/R	28	480	22	N/R	8	2,940	230	N/R	120
1970	1,343	60	N/R	48	991	46	N/R	48	537	25	N/R	12	3,579	348	N/R	247
1980	1,571	94	170	66	959	55	311	66	488	28	180	21	3,063	428	578	476
1990	1,933	152	292	206	1,116	74	525	165	566	41	307	43	3,034	466	821	863

NOTES:
All population data shown in thousands.
N/R - Data not reported in census.
SOURCE:
Total population estimates from the U.S. Department of Commerce, 1920-1990 Census Data. Ethnicity data for 1920-1980 from the U.S. Department of Commerce Census Data. Ethnicity data for 1990 from the California Department of Finance.

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TABLE II-2

REGIONAL EDUCATIONAL ATTAINMENT, 1950-1990

Year	Sacramento River Region		San Joaquin River Region		Tulare Lake Region		San Francisco Bay Region	
	High school and over	Bachelor degree and over	High school and over	Bachelor degree and over	High school and over	Bachelor degree and over	High school and over	Bachelor degree and over
1950	38%	6%	34%	6%	32%	6%	48%	10%
1960	46%	8%	39%	6%	40%	8%	55%	13%
1970	63%	12%	51%	9%	49%	8%	67%	17%
1980	76%	17%	63%	13%	60%	11%	79%	26%
1990	81%	21%	68%	31%	65%	12%	83%	32%

NOTES:
Data presented is for all persons 25 years and older.
SOURCE:
U.S. Department of Commerce Census of Population, Characteristics of Population.

Between 1950 and 1990, M&I acreage throughout California increased in response to the state's rapid population growth. Increases in M&I land use in the San Joaquin River Region occurred primarily in Fresno, Merced, Stanislaus, and San Joaquin Counties. During the 1980s, towns in the Sierra Nevada foothills, including Jackson, Angels Camp, San Andreas, Sonora, and Oakhurst experienced dramatic growth rates. Between 1980 and 1990, M&I land acreage within the San Joaquin River Region increased from approximately 71,000 acres to 110,000 acres (Figure II-1). This M&I acreage represented the smallest amount of M&I land of the four regions during this period. Major M&I centers include the cities of Fresno, Stockton, Tracy, Modesto, and Merced. These cities are industrial hubs for food and grain processing. The cities of Tracy and Stockton have grown recently, fed by the San Francisco Bay Region growth trends. The City of Fresno is the major M&I center for the San Joaquin Valley.

Demographics

As shown on Figure II-1, the population of the San Joaquin River Region more than doubled between 1920 and 1950. The majority of this change occurred from 1940 to 1950, as the population increased from approximately 483,000 to approximately 739,000. Between 1950 and 1990, the population of the region increased from approximately 739,000 to 1.9 million people. For the entire period between 1920 and 1990, the population of the San Joaquin River Region increased by approximately 1.6 million people. This increase exceeded the state's population growth rate for that period and was the largest increase of the four regions. The total population increase during this time was accompanied by changes in composition of the population. Changes occurred in the age distribution, ethnicity, and education levels of the population.

Since 1920, age distributions of the population in the San Joaquin River Region have also changed. Between 1930 and 1950 the most dramatic increase occurred in the numbers of children and the elderly. Specifically, the greatest increases occurred in the age group 14 years and younger and the age group 60 years and older. These changes in age distribution coincided with the beginning of the post war "baby boom" and advances in medical technology that increased life expectancy. Similar to the Sacramento River Region, the changes in age distribution between 1950 and 1990 reflect the influence of the "baby boomer" generation combined with changes in migration patterns.

Figure II-2 shows that the age distribution for the region in 1950 was concentrated in the age group 14 years and younger. Figure II-3 shows that the age distribution in the region in 1970 was concentrated in the age groups 29 years and younger. Figure II-4 shows that the age distribution in the region in 1990 was concentrated in the age groups 44 years and younger.

Data on the ethnic composition of the region's population are limited to the population of whites, blacks, and Hispanics, with all other ethnic groups combined to a single "other" category (Table II-1). Data on the proportion of Hispanics in the region between 1920 and 1950 were not readily available for this analysis. All ethnic groups for which data were available increased within the region between 1920 and 1950. This trend continued through 1990 for all ethnic groups except whites. Between 1920 and 1990, whites comprised the greatest proportion of the population, although the relative proportion of all other ethnic groups increased.

Data on the educational attainment of the region's population from 1950 to 1990 are shown in Table II-2. Data on the education level achieved by the population before 1950 were not readily available. The table shows the educational attainment for all persons in each region that are 25 years and older. The number of high school and college degrees in the region have steadily increased since 1950.

TULARE LAKE REGION

M&I Land Use

M&I land use data for the Tulare Lake Region are not available for the period between 1920 and 1930. Therefore, the data on M&I land use are presented beginning in 1930. Between 1930 and 1950, M&I land use more than doubled (Figure II-1). The rate of increase in M&I land use during this time period was fairly constant.

Between 1950 and 1990, M&I acreage in the Tulare Lake Region approximately tripled from 96,000 acres to 294,000 acres (Figure II-1). During the period between 1920 and 1990, M&I land use in the region increased by more than 6 times from approximately 45,000 acres to 294,000 acres. Much of the increase in growth in this region was related to the expansion of the city of Bakersfield. The City of Bakersfield is the largest M&I center within the region. Other municipal areas include the cities of Tulare, Hanford, and Visalia.

Demographics

Between 1920 and 1950, the population of the Tulare Lake Region more than tripled (Figure II-1). Population growth increased dramatically from 1930 to 1950. During this period, the Tulare Lake Region experienced its greatest population growth for the period addressed in this technical appendix, increasing from approximately 185,000 to 424,000 people. Between 1950 and 1990, the population of the region increased from approximately 424,000 to 957,000 people.

For the entire period between 1920 and 1990, the population in the Tulare Lake Region increased by approximately 821,000 people. The total population increase between 1920 and 1990 in the region was accompanied by changes in the composition of the population. Changes occurred in the age distribution, ethnicity, and education levels of the population.

Since 1920, age distributions of the population of the Tulare Lake Region have also changed. Between 1930 and 1950, the most dramatic changes occurred in the numbers of children and elderly people (Figure II-2). These changes in age distributions coincided with the beginning of the post war "baby boom" and advances in medical technology that increased life expectancy. Similar to other regions, the changes in age distribution between 1950 and 1990 also reflect the combined influence of the "baby boomer" generation and changes in migration patterns (Figures II-2 through II-4).

Data on the ethnic composition of the region's population contain information on white, black, Hispanic and other ethnic groups (Table II-1). No data on the proportion of Hispanics in the region between 1920 and 1950 were available for this analysis. Between 1920 and 1950, the total number of blacks and whites within the region consistently increased. Between 1950 and 1990, all ethnic groups increased within the region. Between 1920 and 1990, whites comprised the greatest proportion of the population, although the relative proportion of all other ethnic groups increased.

Data on the educational attainment of the region's population from 1950 to 1990 are shown in Table II-2. Data on the education level achieved by the population before 1950 were not readily available. The table shows the educational attainment for all persons in each region that are 25 years and older. The number of high school and college degrees in the region have steadily increased since 1950.

SAN FRANCISCO BAY REGION

M&I Land Use

Explicit M&I land use data for the San Francisco Bay Region were not collected for the period between 1920 and 1950 and the year 1980 (Figure II-1). Therefore, the historic data on M&I land use represent the years 1955, 1960, 1970 and 1990 only. Between 1955 and 1970, M&I land use in the San Francisco Bay Region increased from approximately 225,000 acres to 485,000 acres, which is the largest increase of M&I land uses of the four regions considered in this technical appendix. The Santa Clara Valley developed rapidly in the 1960s and 1970s.

By the 1980s few undeveloped areas remained in this region. Extensive development occurred during this period along the Highway 680 corridor. M&I land use for 1990 was 655,000 acres, a substantial increase in development for the 20-year period between 1970 and 1990. Although land development between 1950 and 1970 more than doubled, adding approximately 260,000 acres, the change from 1970 to 1990 was associated with "in-fill" developments, and has resulted in greater regional population density than in previous periods. This region is extensively urbanized and includes the San Francisco, Oakland, and San Jose metropolitan areas.

Demographics

Between 1920 and 1950, the population of the San Francisco Bay Region more than doubled from approximately 1 million to 2.5 million people (Figure II-1). Population growth in this region was greatest between 1940 and 1950. During this period, population in the San Francisco Bay Region increased from approximately 1.6 million to approximately 2.5 million. Between 1950 and 1990, the population of the region of the region increased from approximately 2.5 million to 5.2 million people.

For the entire period between 1920 and 1990, the growth rate was the smallest increase of the four regions, but was associated with increases in urban density. For the entire period the population increased by approximately 4 million. The total population increase during this time period was accompanied by changes in the composition of the population. Changes occurred in the age distribution, ethnicity, and education levels of the population.

Since 1920, age distributions of the population in the San Francisco Bay Region have also changed. Between 1930 and 1950, the age group composed of individuals 60 and older steadily increased while other age groups fluctuated (Figure II-2). Between 1940 and 1950, the greatest increases occurred in the age groups 14 years and younger. Between 1950 and 1990, increases occurred in different age groups. Between 1950 and 1960, the age group composed of individuals 14 and younger increased. Between 1960 and 1970, the age group composed of individuals 15 to 29 increased dramatically. Between 1970 and 1980, the age group composed of individuals 30 to 44 also increased dramatically. As shown in Figure II-3 decreases were associated with the age groups representing individuals 14 years old.

Data on the ethnic composition of the region's population contain information on white, black, Hispanic and other ethnic groups (Table II-1). No data on the proportion of Hispanics in the region between 1920 and 1950 were available for this analysis. Between 1920 and 1950, the total number of blacks and whites within the region consistently increased. Between 1950 and 1990, all ethnic groups increased within the region, except whites. Between 1920 and 1990, whites composed the greatest proportion of the population, although the relative proportion of all other ethnic groups increased.

Data on the educational attainment of the region's population from 1950 to 1990 are shown in Table II-2. Data on the education level achieved by the population before 1950 were not readily available. The table shows the educational attainment for all persons in each region that are 25 years and older. The number of high school and college degrees in the region have steadily increased since 1950.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

Chapter III

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter compares the impacts of Alternatives 1 through 4 to the No-Action Alternative with respect to M&I land use and demographics.

IMPACT ASSESSMENT METHODOLOGY

Potential impacts to M&I land uses and demographics depend on potential reductions in water available for M&I use. Other technical appendices related to this technical appendix include Municipal Water Costs, Agricultural Economics and Land Use, Surface Water Supplies and Facility Operations, Groundwater, Social Analysis, and Regional Economics.

NO-ACTION ALTERNATIVE

The No-Action Alternative is the base condition for the PEIS alternatives analyses and represents conditions in the future assuming a projected 2022 level of development without implementation of the CVPIA. The No-Action Alternative assumes the operation of existing facilities and future facilities that are certain to be constructed by 2022. The No-Action Alternative assumes that these water resource facilities will be operated in accordance with operating rules and criteria that were in effect or being developed as of October 1992 when the CVPIA was adopted.

Under the No-Action Alternative, surface water availability is reduced to CVP and SWP contractors as compared to historical conditions. Land use projections presented in the DWR Bulletin 160-93 indicate that some water rights holders would increase irrigated acreage. Most of the reduction in the use of surface water is projected to be replaced by groundwater. In addition, up to 25 percent deficiencies in deliveries of CVP water supplies to M&I users in the Central Valley and San Francisco Bay regions would periodically occur, as presented in the Surface Water Supplies and Facility Operations Technical Appendix. There would be 25 percent deficiencies, 15 percent of the time north of the Delta and 16 percent of the time south of the Delta.

Projected M&I land use areas for 1990 and 2020, based on DWR projections, are shown on Table III-1 (DWR, 1994). DWR Bulletin 160-93 land use projections were compared to land availability presented in the Department of Conservation 1990 to 1992 Farmland Conservation Report and County General Plans in order to confirm the current availability of projected changes. For example, Bulletin 160-93 projects a 65,100-acre decrease in irrigated land and 101,500-acre increase in urban land for the County of Fresno. The Farmland Conservation Report shows that 653,488 acres of irrigated land, 81,409 acres of urban land, and 384,022 acres of "other land" are available to potentially accommodate the Bulletin 160-93 projected land use changes. As

of "other land" are available to potentially accommodate the Bulletin 160-93 projected land use changes. As indicated on this table, M&I land use areas are projected to increase between 25 percent in the San Francisco Bay Region, and 48 percent in the Tulare Lake Region. The overall projected increase in M&I land use throughout the four regions is approximately 34 percent.

TABLE III-1

PROJECTED REGIONAL CHANGE IN M&I LAND USE IN THE NO-ACTION ALTERNATIVE

Year	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Francisco Bay Region
Total Area	17,254	10,208	10,573	2,816
M&I Area - 1990	396	138	229	656
M&I Area - 2020	616	234	440	871
Percent Increase	36	41	48	25
Percent of Total Area - 1990	2.3	1.4	2.2	23.3
Percent of Total Area - 2020	3.6	2.3	4.2	30.1

NOTES:
All areas in 1,000s of acres.
SOURCE:
DWR Bulletin 160-93.

As discussed in the Surface Water Supplies and Facility Operations and the Groundwater technical appendices, the projected water supplies to M&I areas would generally be provided from surface water sources, pursuant to existing water rights, or from additional groundwater pumping. The effects of these additional water supplies on surface water and groundwater resources are incorporated into the No-Action Alternative conditions.

Projected changes in regional population from 1990 to 2020 are shown in Table III-2. The 1990 population estimates were obtained from the 1990 Census, published by the Department of Commerce. The 2020 projected population estimates were obtained from State of California official population projections, published in April 1993 (California DOF, 1993). These estimates were projected from a baseline developed from the 1990 Census. The 1990 level data presented in that report are adjusted for a census population in mid-year, rather than on April 1, as reported by the Department of Commerce. Therefore, the baseline used to develop 2020 projections was slightly different from the 1990 populations shown on Table II-2.

TABLE III-2

PROJECTED REGIONAL POPULATION CHANGE

Year	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Francisco Bay Region
1990	2,583	1,880	957	5,184
2020	4,803	4,232	2,162	6,679

NOTES:
All population data shown in thousands.
Projections reflect the No-Action Alternative.

SOURCE:
U.S. Department of Commerce, 1990 Census Report. California Department of Finance, 2020 Population Projections.

Table III-3 provides a comparison of population estimates for 1990 and 2020, and associated 2020 M&I water demands for each county in the four regions. This table also displays the maximum amount of water delivered by the CVP to each county at the projected 2020 level of development. These estimates are based on the assumed contract amount for M&I water users in the No-Action Alternative, as presented in the Surface Water Supplies and Facility Operations Technical Appendix. As shown on this table, the total projected 2020 water use requirements exceed the maximum CVP delivery of water for M&I users in all counties. The CVP is a supplemental water supply and other local water supplies will be provided to meet full M&I demands, as discussed in the general plan and environmental impact report (EIR) for each of the counties. M&I users may substitute other supplies for CVP supplies if necessary. Therefore, the delivery of water by the CVP would not induce growth in excess of current projections.

ALTERNATIVE 1

Under Alternative 1, up to 25 percent deficiencies in deliveries of CVP water supplies to M&I users in the Central Valley and San Francisco Bay regions would periodically occur, as presented in the Surface Water Supplies and Facility Operations Technical Appendix. The extent of the deficiencies would not be greater than historically encountered. However, for residential users, the frequency of the deficiencies may increase. There would be 25 percent deficiencies, 15 percent of the time north of the Delta and 16 percent of the time south of the Delta.

Changes in municipal water use caused by Alternative 1 are discussed in the Municipal Water Costs Technical Appendix. The assumptions in the municipal water costs analysis allow M&I users to eliminate any long-run average shortage with other supplies and price-induced conservation. The other supplies may include groundwater, reclamation, and more intensive management. In dry water years, mandatory end-user conservation is required, but the percent savings from conservation is the same as in the No-Action Alternative, and it is assumed that M&I users develop other supplies to eliminate any remaining shortage.

TABLE III-3

CVP M&I WATER DELIVERY CONTRACT vs PROJECTED M&I WATER USE

Region/County	Population 1990 (1)	Population 2020 (1)	2020 No-Action Alternative Assumed CVP M&I Water Contract (taf)	2020 Projected M&I Water Use (taf) (2)	Regional Average Water Demand (gpcd) (3)
Sacramento River Region					248
Sacramento	1,041	1,840	374	511	
El Dorado	125	264	10	73	
Placer	173	369	38	102	
Yolo	141	286	24	79	
Shasta	147	267	36	74	
Glenn	25	47	>1	13	
San Joaquin River Region					309
San Joaquin	481	957	10	331	
Fresno	667	1,590	74	550	
Merced	178	402	>1	139	
Madera	88	214	0.02	74	
Tulare Lake Region					301
Kings	101	208	3	72	
Tulare	312	644	4	217	
San Francisco Bay Region					193
Santa Clara	1,498	1,959	152	423	
Contra Costa	804	1,213	168	262	

NOTES:
(1) All population data shown in thousands.
(2) Projected 2020 population x regional average per capita daily water use (DWR Bulletin 160) x 365 days per year ÷ 326,000 gallons/af.
(3) Gallons per capita per day.

SOURCE:
U.S. Department of Commerce, 1990 Census Report. California Department of Finance, 2020 Population Projections.

For regions with some CVP contract supplies, the municipal water cost analyses shows that the retail water price could increase from 1 to 5 percent, and water demand may be decreased by roughly 1 percent relative to the No-Action Alternative. Due to these small changes, the municipal water costs analysis did not identify any changes in municipal land use caused by changes in water supply or cost. Therefore, M&I land uses and population conditions under Alternative 1 would not change as compared to the No-Action Alternative.

Under Alternative 1, the frequency of deficiencies of SWP M&I water deliveries could be reduced, thereby increasing the frequency of full contract deliveries. The municipal water costs analysis estimates that water price in the Central and South Coasts could be reduced by about 1 percent relative to the No-Action Alternative because the development of other, more expensive supplies is avoided. The lower price increases water use by less than 1 percent relative to the No-Action Alternative. Due to these small changes, the municipal water costs analysis did not identify any changes in municipal land use caused by changes in water supply or cost. Therefore, the changes in deliveries to the SWP in Alternative 1 would not result in increased growth of M&I areas, or increases in populations, as compared to the No-Action Alternative.

ALTERNATIVE 2

The deliveries of water to CVP and SWP M&I water users under Alternative 2 would be similar to those described under Alternative 1. The acquisition of water from willing sellers on the Stanislaus, Tuolumne, and Merced rivers would be acquired from non-M&I sellers. Therefore, the total changes to M&I water supplies and effects on land use and demographics in Alternative 2 would be the same as those described under Alternative 1.

ALTERNATIVE 3

The deliveries of water to CVP M&I water users under Alternative 3 would be similar to those described under Alternative 1. Under Alternative 3, SWP M&I users receive more water delivery, on average, than under Alternative 1. Water price in the Central and South Coast could be reduced by about 4 percent, and quantity of demand could be increased by about 1 percent. This increase occurs because price-induced conservation is decreased. The acquisition of water from willing sellers in the Central Valley rivers would be acquired from non-M&I sellers. Therefore, the total changes to M&I water supplies and effects on land use and demographics in Alternative 3 would be the same as those described under Alternative 1.

ALTERNATIVE 4

The deliveries of water to CVP M&I water users under Alternative 4 would be similar to those described under Alternative 1. The frequency of SWP M&I deliveries would be about the same as in the No-Action Alternative. The acquisition of water from willing sellers in the Central Valley would be acquired from non-M&I sellers. Therefore, the total changes to CVP M&I

water supplies and effects on land use and demographics in Alternative 4 would be the same as those described under Alternative 1, and there is no effect on land use and demographics in SWP service areas.

SUMMARY

It is anticipated that the frequency of CVP M&I contract deficiencies would increase under Alternatives 1 through 4. Changes in municipal water use caused by Alternatives 1 through 4 are discussed in the Municipal Water Costs Technical Appendix. Most of the additional shortage is eliminated by additional developed supplies or by price-induced conservation. The municipal water costs analysis did not identify any changes in municipal land use caused by changes in water supply or cost. Therefore, M&I land uses and population conditions under Alternatives 1 through 4 would not change as compared to the No-Action Alternative.

Also under Alternatives 1 through 4, the frequency of deficiencies on SWP M&I water deliveries would be reduced, thereby increasing the frequency of full contract deliveries. However, the additional SWP supplies are mostly used to replace other, more expensive supplies. Cost savings are passed onto retail customers in the form of lower water prices, but the small water price change should not induce economic growth or urbanization. Therefore, the changes in deliveries to the SWP in Alternatives 1 through 4 would not result in increased growth of M&I areas, or increases in populations, as compared to the No-Action Alternative.

CHAPTER IV

BIBLIOGRAPHY

Chapter IV

BIBLIOGRAPHY

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CENTRAL VALLEY PROJECT IMPROVEMENT ACT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

DRAFT TECHNICAL APPENDIX

Municipal Water Costs

September 1997

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LIST OF ABBREVIATIONS AND ACRONYMS

af	acre-foot (feet)
CCWD	Contra Costa Water District
CEQA	California Environmental Quality Act
ft^3	cubic feet
CUWA	California Urban Water Agency
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPTM	Central Valley Production and Transfer Model
DWR	Department of Water Resources (California)
EBMUD	East Bay Municipal Utility District
IID	Imperial Irrigation District
KCWA	Kern County Water Agency
M&I	municipal and industrial
MWD	Municipal Water District of Southern California
PEIS	Programmatic Environmental Impact Statement
Reclamation	U.S. Bureau of Reclamation
RGO	resident, government, and other demands
SBA	South Bay Aqueduct
SCVWD	Santa Clara Valley Water District
SCWA	Sacramento County Water District
SF	San Felipe
SFWD	San Francisco Water District
SMUD	Sacramento Municipal Water District
SWP	State Water Project
SWRCB	State Water Resources Control Board
taf	thousand acre-feet

CHAPTER I

INTRODUCTION

Chapter I

INTRODUCTION

The Draft Programmatic Environmental Impact Statement (PEIS) summarizes the evaluation of the direct and indirect impacts of implementing a wide range of actions identified in the Central Valley Project Improvement Act (CVPIA). Details of the information used in the definition of the affected environment and analysis of the environmental consequences are presented in the technical appendices of the Draft PEIS.

This technical appendix presents a summary of municipal and industrial (M&I) water use and cost, background information that was used during the PEIS preparation, and the results of the impact analyses for conditions that occurred throughout the PEIS study area, shown in Figure I-1.

The municipal water cost analysis was primarily based upon water demands, local supplies and cost presented in the California Department of Water Resources Bulletin 160-93, water deliveries from PROSIM and SANJASM, water price data obtained from individual providers, and water resource economics literature, all augmented by planning documents of individual providers where available. This information was used to construct a M&I water use and costs analytical tool which estimates effects of water supply and cost changes on total costs, water price, water demand, and economic value.

The assumptions and results of the analyses for Alternatives 1, 2, 3, and 4 are presented in this technical appendix and summarized in the Draft PEIS. The assumptions and results of the Supplemental Analyses 1e, 2b, 3a, and 4a, which show municipal water costs with CVPIA water transfers, are also summarized here. The assumptions related to the municipal water cost analyses for Alternatives 1, 2, 3, and 4 are presented in Table I-1. The results of the analyses are presented in Table I-2.

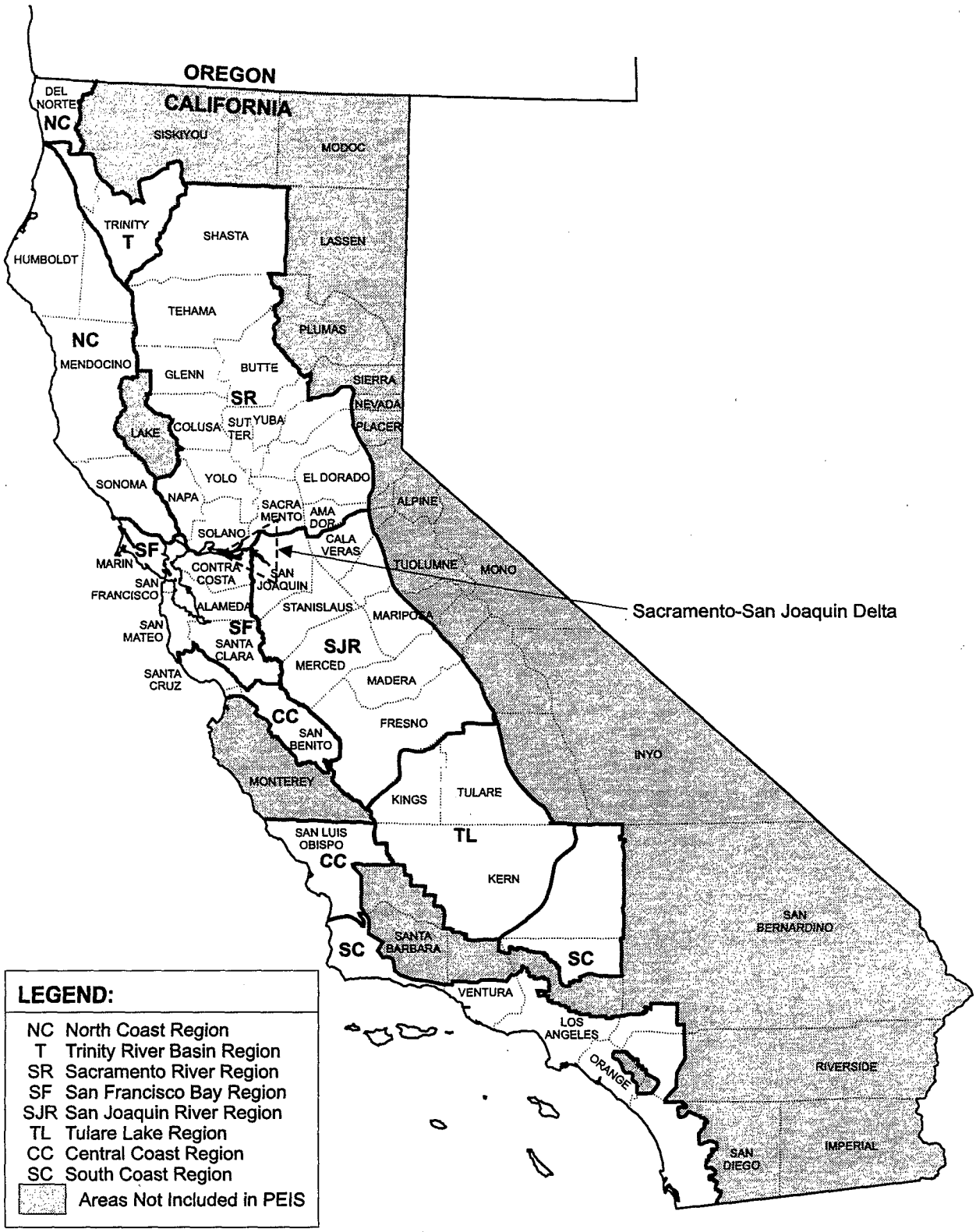

FIGURE I-1
STUDY AREA

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TABLE I-1

SUMMARY OF ASSUMPTIONS FOR MUNICIPAL WATER COSTS ANALYSES

Alternative or Supplemental Analysis	Assumption
No-Action Alternative	Imported supplies from PROSIM and SANJASM. Urban water demand levels are similar to those presented in the California Department of Water Resources Bulletin 160-93 for year 2020 with level 1 conservation, except that additional conservation may be induced by increased price if supplies must be developed to balance demand and supply. Mandatory conservation in dry years considers demand hardening due to level 1 conservation, and providers develop supplies to eliminate any remaining shortage.
Baseline Water Transfer Analysis	Same as No-Action Alternative except water transfers allowed to replace new developed supplies. Transfers of CVP service and exchange contract water are not allowed. Water transfers to South Coast constrained to less than 100,000 AF in average years and 400,000 AF in dry years.
1	Changes in M&I water supplies from PROSIM and SANJASM. M&I providers develop supplies to eliminate shortage, but water supply costs, restoration payments and conservation costs affect retail water price and demand. In the long run, demand equals supply and revenue equals cost. In dry years, additional shortage eliminated with more conservation up to maximum, then additional supplies are developed.
1e	Same as Alternative 1 except water transfers allowed to replace new developed supplies. Transfers of CVP service and exchange contract water are allowed. Water transfers to South Coast constrained to less than 100,000 AF in average years and 400,000 AF in dry years.
2	Same as Alternative 1. PROSIM and SANJASM Alternative 2 M&I water deliveries are the same as Alternative 1.
2b	Same as Alternative 2, except water transfers allowed to replace new developed supplies. Transfers of CVP service and exchange contract water are allowed. Water transfers to South Coast constrained to less than 100,000 AF in average years and 400,000 AF in dry years. Water transfer prices are affected by the level of water acquisition.
3	Same as Alternative 1 except PROSIM and SANJASM Alternative 3 M&I water deliveries are used.
3a	Same as Alternative 3, except water transfers allowed to replace new developed supplies. Transfers of CVP service and exchange contract water are allowed. Water transfers to South Coast constrained to less than 100,000 AF in average years and 400,000 AF in dry years. Water transfer prices are affected by the level of water acquisition.
4	Same as Alternative 1 except PROSIM and SANJASM Alternative 4 M&I water deliveries are used.
4a	Same as Alternative 4, except water transfers allowed to replace new developed supplies. Transfers of CVP service and exchange contract water are allowed. Water transfers to South Coast constrained to less than 100,000 AF in average years and 400,000 AF in dry years. Water transfer prices are affected by the level of water acquisition.

TABLE I-2

SUMMARY OF IMPACT ASSESSMENT OF MUNICIPAL WATER COSTS

Affected Factors	No-Action Alternative	Base Transfer Analysis	Alternative 1	Alternative 1e	Alternative 2
Change from No-Action Alternative					
Municipal Water Costs	Similar to DWR Bulletin 160-93, except South Coast must develop supplies and increase price to meet 2020 average demand. All groups must impose conservation and develop supplies in dry years.	Similar to No-Action Alternative except water transfers replace some new developed supplies, reduce costs and allow lower retail water prices.	CVP M&I water supplies reduced. Restoration payments and conservation costs increase price and reduce water use. CVP water service contractors with no other supplies affected the most. Increased SWP supplies reduce water costs and retail price. South Coast benefits the most.	Similar to Alternative 1 except water transfers replace some new developed supplies, reduce costs and allow slightly lower retail water prices. Water transfer prices are generally lower than in Base Transfer Scenario.	Same as Alternative 1.

Alternative 2b	Alternative 3	Supplemental Analysis 3a	Alternative 4	Supplemental Analysis 4a
Change from No-Action Alternative				
Similar to Alternative 1e except that average year water transfer prices are higher than in the Base Transfer Scenario.	Similar to Alternative 1, except SWP M&I supplies increased more than in Alternative 1.	Similar to Alternative 3 except water transfers replace some new developed supplies, reduce costs and allow slightly lower retail water prices. Water transfer prices are generally lower than in Base Transfer Scenario.	Similar to Alternative 1, except SWP supplies similar to No-Action Alternative.	Similar to Alternative 4 except water transfers replace some new developed supplies, reduce costs and allow slightly lower retail water prices. Highest water transfer prices among alternatives. Average year water transfer prices are higher than in the Base Transfer Scenario.

CHAPTER II

AFFECTED ENVIRONMENT

Chapter II

AFFECTED ENVIRONMENT

This chapter describes the municipal and industrial (M&I) water use and economics that may be affected by PEIS alternatives. First, major data sources are described. Then, historical patterns of M&I water use in the state are described. Factors that have affected recent M&I water use are discussed. Population, water use, and economic data are provided.

The affected environment for M&I water use includes any M&I providers who may be affected by CVPIA alternatives. Providers are considered to be potentially affected if they receive CVP contract water, if their water is delivered by CVP facilities, or if they might be affected by CVPIA water transfer provisions as a buyer of water.

DATA SOURCES

Data used in the descriptions of historical and recent conditions are primarily from three sources: the California Department of Water Resources (DWR), U.S. Bureau of Reclamation (Reclamation), and individual municipal providers. These sources are supplemented by a variety of publications from private and public sources.

DWR has provided data on urban water use through the California Water Plan (DWR, 1994a, 1983, 1970) and Urban Water Use in California (DWR, 1994b). Reclamation provided data on CVP water deliveries and water costs. The major providers were contacted by telephone, and data related to water balance, water transfer plans, and retail water costs were requested. Water planning documents were obtained where available.

HISTORICAL PERSPECTIVE

California's population is now about 20 times what it was in 1900, when it stood at approximately 1.5 million. The population as of 1990 was 30 million (DWR, 1994a). The increase in population over time has profoundly affected the use of the Central Valley land and water resource base. More people have meant greater urban water demand and more urbanization of agricultural and other lands. The growing population has also brought different attitudes about agriculture and the environment and has increased water-based recreation demands.

Until recently, most urbanization in California occurred near the coastal cities. In the last decade, there has been a relative shift in new development from the coast to the Central Valley and inland deserts. As urbanization has spread into the Central Valley and Southern California desert, the hotter summer climates of these regions have increased statewide average per capita use. On the other hand, urban water conservation measures have tended to reduce urban use.

Table II-1 demonstrates some of these trends. Since 1967, population in the coastal regions has grown most in absolute terms, but population in the Central Valley has recently been increasing faster on a percentage basis. Urban water demands have generally kept pace with these population increases except that urban use per capita has increased in some regions and declined in others. Increases in per capita use in the coastal regions reflect urbanization of the inland fringes of these regions, and per capita reductions in the Central Valley regions reflect water conserving features and smaller average lot and lawn size on new developments, among other factors.

RECENT CONDITIONS

The recent populations of some metropolitan statistical areas (MSAs) within the affected environment are provided in Table II-2, and some of the larger urban areas included in the affected environment are described below.

Urban water use in the Sacramento River Basin is concentrated within the City of Sacramento metropolitan area and near the City of Redding. Sacramento's location on major transportation corridors, including the Sacramento River shipping channel and Interstate 80, and a large and diverse economy make it the largest urban area in the Central Valley. Other areas of rapid urban growth in the region are located within Placer, El Dorado, Yolo, and Sutter counties. The City of Redding in Shasta County, with a 1990 population of 64,600, has also grown rapidly in recent years. Redding is an agricultural, transportation, and services center for the north Sacramento Valley.

Major urban centers in the San Joaquin River Basin include Fresno, Stockton, Modesto and Merced (1990 population 55,700). These cities are regional hubs for food transportation and processing. Growth in Tracy (1990 population 32,400) and Stockton has recently been fed by San Francisco Bay area growth trends. The City of Fresno is the largest urban center in the San Joaquin Valley. The City of Bakersfield is the main urban center within the Tulare Basin. Other municipal areas include Tulare, Hanford, and Visalia.

The San Francisco and Los Angeles metropolitan areas are two of the four largest urban areas in the United States. Both areas are largely built out, but continued population growth can occur by densification and in fringe areas. In the San Francisco Bay region, less than 10 percent of the undeveloped land base is considered developable, but the rate of population growth during the 1980s in the North Bay cities of Vallejo and Fairfield was comparable to that in Central Valley areas (Table II-2). The Los Angeles CMSA is second only to the New York CMSA in population. Population growth in the San Francisco and Los Angeles areas declined during the regional recession of the early 1990s. The California Department of Finance estimated that population of the City of Los Angeles actually fell during 1994 (CDF, 1996). Total population growth in San Francisco and Los Angeles counties from 1990 to 1995 was 4.85 and 3.67 percent, respectively.

TABLE II-1

POPULATION, URBAN APPLIED WATER, AND GALLONS PER CAPITA PER DAY, SELECTED YEARS

Year	Population by Hydrologic Study Area, Million Persons						
	San Francisco	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	State
2020	6.900	2.000	25.300	4.100	3.200	3.500	48.900
1990	5.500	1.300	16.300	2.200	1.400	1.500	30.000
1980	4.790	1.005	12.969	1.674	1.014	1.178	23.770
1972 (1)	4.475	0.833	11.291	1.311	0.805	0.989	20.593
1967	4.320	0.750	10.510	1.140	0.410	0.910	19.100
	Urban Applied Water Normalized Demands, 1,000 acre-feet						
	San Francisco	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	
1990	1,186	273	3,851	744	495	523	
1980 (1)	967	231	2,777	570	403	425	
1967 (2)	823	168	2,119	447	170	377	
	Gallons Per Capita Per Day, All Urban Uses						
	San Francisco	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	
1990	193	189	211	301	309	301	
1980 (3)	180	205	191	304	355	322	
1967	170	200	180	350	370	370	

NOTES:
(1) Some of increase in Sacramento and San Joaquin hydrologic study areas from 1967 is due to an increase in the geographic size of the regions.
(2) Derived from data on population and GPCD.
(3) Derived from data on population and applied water. The sizes of the Sacramento and San Joaquin River hydrologic study areas changed in 1980.

SOURCES:
DWR 1983, 1994a, 1970

TABLE II-2

POPULATION OF METROPOLITAN STATISTICAL AREAS AND CITIES WITHIN THE POTENTIALLY AFFECTED ENVIRONMENT

Region	Population, 1000s		Percent Increase
Metropolitan Statistical Area	1980	1990	
Sacramento Region			
Sacramento MSA	1,100	1,481	34.6
Central Valley Cities			
Fresno MSA	515	667	29.5
Stockton MSA	347	481	38.6
Bakersfield MSA	403	543	34.7
Bay Area			
Oakland PMSA	1,762	2,083	18.2
San Francisco PMSA	1,489	1,604	7.7
San Jose PMSA	1,295	1,498	15.7
Vallejo-Fairfield-Napa PMSA	334	451	35.0
Central and South Coast			
Santa Barbara-Santa Maria-Lompoc MSA	299	370	23.7
San Diego MSA	1,862	2,498	34.2
Los Angeles-Anaheim-Riverside CMSA	11,498	14,532	26.4

SOURCE:
U.S. Department of Commerce, 1992.
Legend:
CMSA=Consolidated Metropolitan Statistical Area, PMSA = Primary Metropolitan Statistical Area.

WATER USE AND ECONOMICS

Water use in recent years has been affected by changes in population patterns and the recent drought. Table II-3 gives data on the number of service connections, water use, and residential water costs for some major water providers included in the analysis.

Between 1988 and 1990, the number of active service connections apparently decreased in Los Angeles and increased in Fresno, reflecting short-run economic conditions in these two cities. Water use per connection generally fell with the drought, especially in Santa Barbara, which was under strict mandatory conservation.

Annual use and average water bills vary greatly among providers. Summer and winter residential water use are nearly identical in the northern coastal cities, reflecting climate and landscaping practices. In the Central Valley and inland South Coast, summer use per unit time is typically double winter use. Average annual use per residential account ranges from 0.17 acre-foot per year in San Francisco to 0.72 acre-foot in Sacramento. Lower use does not necessarily mean lower costs; Santa Barbara residents use almost the same amount of water per residence as San Franciscans, but they pay about three times as much for it.

TABLE II-3

SERVICE CONNECTIONS, AMOUNTS OF WATER INTO SYSTEMS, AND CHARACTERISTICS OF WATER USE FOR MAJOR PROVIDERS

Data for All Uses	San Francisco	San Jose	Santa Barbara	Los Angeles	Sacramento	Stockton	Fresno
1988 connections	163,746	197,493	24,100	693,563	109,305	62,524	77,093
1988 af water into system	97,793	151,473	16,525	676,780	117,947	53,508	101,090
1990 connections	164,892	201,150	24,146	635,698	111,785	64,179	99,049
1990 af water into system	97,253	126,317	9,451	671,605	114,048	52,578	118,818
1988 af per connection	0.60	0.77	0.69	0.98	1.08	0.86	1.31
1990 af per connection	0.59	0.63	0.39	1.06	1.02	0.82	1.20
Percent change, 1988 to 1990	-1.7	-18.2	-43.5	+8.2	-5.6	-4.6	-6.9
Data for Residential Uses							
Summer average monthly use (in 100 ft^3)	6	23	7	20	34	22	28
Winter average monthly use (in 100 ft^3)	6	18	6	10	18	13	12
Estimated annual use (af)	0.17	0.56	0.18	0.41	0.72	0.48	0.55
Average summer monthly bill, $	7	35	22	20	10	14	9
Average winter monthly bill, $	7	28	18	12	10	11	9

SOURCE:
DWR, 1994b.

Table II-4 shows 1990 normalized data for the M&I provider groups described in more detail in the Municipal Water Costs Methodology/Modeling Technical Appendix. Retail average cost data for a representative provider were obtained from DWR and price data were obtained from a survey of providers. Retail average cost includes service charges, while price is the charge per unit of water only. Data on 1990 water use and water supplies were generally developed from DWR (1994a). Demand during dry periods is greater than average because there is less recharge of urban landscape soil moisture (DWR 1994a).

Detailed information on M&I water demand and supply estimates is provided in the Municipal Water Costs Methodology/Modeling Technical Appendix.

CVP CONTRACTS AND WATER DELIVERIES

The CVP supplies M&I project water to more than 40 entities in the CVP service area. Table II-5 shows CVP M&I project water deliveries between 1983 and 1991.

In addition to those deliveries, the CVP must be operated to provide municipal water under state water rights and exchange contracts. Water rights of approximately 410,000 acre-feet and exchange contracts typically must be given priority over any other deliveries if requested. M&I exchange contract deliveries recently ranged from 43,000 to 55,000 acre-feet on the basis of rights of approximately 75,000 acre-feet.

TABLE II-4

1990 DATA FOR M&I PROVIDER GROUPS

Region	Retail Avg Cost $/af (1)	Retail Price $/af	Demand Served (taf)		CVP Contract and Water Rights and SWP Entitlement (taf)	Other Water Supplies (taf)	
			Avg	Dry		Avg	Dry
Sacramento River	254 to 311	0 to 205	566	613	361.7	204.8	251.4
Bay Area (2)	500 to 731	348 to 523	1,094	1,153	511.7	769.0	670.0
San Joaquin Cities	263 to 311	126 to 150	337	339	199.5	148.1	150.5
Central (3) and South Coast	461	383	3,784	3,916	2,332.7	2,499.4	2,321.2

NOTES:
(1) Includes service charges. The range provided is for subregions within the region.
(2) Includes the CVP San Felipe Service Area.
(3) Data are for South Coast only. The M&I Central Coast region includes only providers served by the SWP coastal aqueduct.

LEGEND:
taf = thousand acre-feet.

TABLE II-5

CVP M&I WATER DELIVERIES, ACRE-FEET FISCAL YEARS 1983-1991

Year	Contra Costa Canal	Folsom D&R	Folsom South Canal	San Felipe Unit	Friant Kern Canal	San Luis Canal	Other	Total
1983	131,079	41,424	20,902		51,532	11,437	20,653	277,027
1984	130,995	43,410	36,350		60,677	13,668	22,528	307,628
1985	132,291	44,360	28,698		62,735	13,322	22,189	303,595
1986	116,230	48,906	25,919		41,403	15,115	22,824	270,397
1987	142,267	52,893	23,912	20,784	63,954	14,060	24,909	342,779
1988	126,059	60,325	45,881	75,065	51,645	14,168	24,840	397,983
1989	164,612	46,694	38,950	94,615	60,262	15,320	24,128	444,581
1990	186,679	59,729	32,224	65,390	48,633	13,012	28,038	433,705
1991	153,363	42,441	38,060	53,352	66,305	10,528	24,336	388,385
Avg	142,619	48,909	32,322	61,841	56,350	13,403	23,827	351,787
Max	186,679	60,325	45,881	94,615	66,305	15,320	28,038	444,581
Min	116,230	41,424	20,902	20,784	41,403	10,528	20,653	270,397

SOURCE:
Reclamation, 1993, Schedule 12.

Use of CVP contract amounts by M&I contractors varies considerably. Some municipal users have used their full contract amounts in recent years; most are not expected to do so until sometime after the year 2000. Total use of CVP M&I contracts, water rights contracts, and exchange contracts could exceed 800,000 acre-feet as early as 2010.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

Chapter III

ENVIRONMENTAL CONSEQUENCES

This chapter describes the environmental consequences of changes in M&I water use and costs resulting from implementation of the CVPIA. The municipal water cost analysis does not allow water transfers from the Central Valley as a means to obtain replacement water supplies for M&I use. However, results of the analysis with transfers are presented as a supplemental analysis. Results are expressed as the difference between results with transfers and results without transfers. That is, the supplemental analysis shows the effects of all water transfers on M&I costs and water use. The Water Transfer Analysis Technical Appendix shows results of the water transfer analysis in terms of the difference between results for CVPIA alternatives with transfers and the No-Action Alternative with transfers, and these results are also provided in an attachment to this technical appendix.

SUMMARY

Results of the municipal water cost analysis are summarized in Table III-1. The analysis includes 10 groups of M&I providers aggregated into 4 regions: the Sacramento Valley, the San Joaquin Valley, the San Francisco Bay Area, and the Central and South Coast. Figure III-1 shows the four regions. The analysis excludes some M&I water use within each region that is not expected to be affected by the CVPIA. All of the regions except the Central and South Coast obtain some CVP contract supplies. All of the regions except the Sacramento Valley obtain some State Water Project (SWP) supplies, which can also be affected by CVPIA alternatives, and all regions have other supplies which will not be affected. The Central and South Coast region, which includes the Los Angeles and San Diego metropolitan areas, is approximately twice as large in terms of demand as the other three regions put together.

In summary, the estimated changes in water deliveries and costs are not large relative to the entire M&I water economy of each region. However, some providers within three of the regions (all but the Central and South Coast) are entirely dependent on CVP contract supplies, and only two CVP M&I contractors have been identified as having a need for water measurement retrofits under the CVPIA Section 3405(b) requirements. Water customers of these relatively affected providers could experience significant cost increases caused by CVPIA provisions.

ALTERNATIVES 1 AND 2

The Municipal Water Cost Analysis is identical for Alternatives 1 and 2 without transfers so results are combined here. The with-transfer supplemental analysis, explained below, has different results for these alternatives because of different water transfer prices.

TABLE III-1

MUNICIPAL WATER COSTS
SUMMARY COMPARISON OF CVPIA PEIS ALTERNATIVES (1)

Result	No-Action Alternative	Change from No-Action Alternative			
		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Average Condition (1922-1990) Supplies, taf (2)					
Sacramento Valley	933	-8	-8	-8	-8
Bay Area	1,025	-2	-2	-1	-2
San Joaquin Valley	708	-7	-7	-6	-8
Central and South Coast	5,797	20	20	64	-4
Average Condition Economic Costs, Million $ (3)					
Sacramento Valley		4.9	4.9	4.9	4.9
Bay Area		4.9	4.9	4.7	4.9
San Joaquin Valley		4.4	4.4	3.2	5.0
Central and South Coast		-32.9	-32.9	-105.6	6.1
Dry Condition (1928-1934) Supplies, taf (4)					
Sacramento Valley	992	-1.5	-1.5	-1.5	-1.5
Bay Area	886	1.6	1.6	21.7	-7.5
San Joaquin Valley	663	3.9	3.9	12.9	-1.1
Central and South Coast	4,890	89.9	89.9	215.7	0.0
Annual Cost of Dry Condition, Million $ (5)					
Sacramento Valley	3.1	2.8	2.8	2.8	2.8
Bay Area	177.7	0.3	0.3	-19.3	9.5
San Joaquin Valley	8.8	4.9	4.9	4.5	5.1
Central and South Coast	823.1	-67.3	-67.3	-119.9	-8.0

NOTES:
(1) Water transfers not allowed as replacement supplies.
(2) After purchase or development of non-transfer replacement supplies to make supply equal demand, i.e., these are not the change in imported supplies.
(3) Total costs include replacement supplies, restoration payments and metering. A negative is an economic benefit.
(4) Before acquisition of supplies to meet 2020 demand. A positive means the Alternative provides more water supply than the No-Action Alternative. Dry condition results do not include supply changes from the average condition.
(5) The annual cost of shortage following the average condition.

Without transfers, the Sacramento Valley region is affected only by the amount and cost of CVP contract supplies. These supplies are reduced by about 3,000 acre-feet on average and 1,500 acre-feet in the dry condition (1928-1934). Most of the cost of the alternatives is caused by restoration payments and metering, not water supply reduction. The annual cost of CVPIA provisions is $4.9 million in the average condition and $2.8 million in the dry condition.

The San Francisco Bay Area (Bay Area) receives CVP contract and SWP supplies. For both Alternatives 1 and 2, CVP contract supplies decrease and SWP supplies increase, for a net decrease of 6,000 acre-feet, but with simulated imported supplies and local supplies, most water users in the region have excess supplies in average year. Therefore, small changes for these relatively expensive supplies have no economic value. The Bay Area pays a cost associated with restoration payments

FIGURE III-1
MUNICIPAL AND INDUSTRIAL WATER USE REGIONS

and supply reductions to one water-short CVP contractor amounting to $4.9 million per year in the average condition. This cost increase is passed on to water customers in the form of higher retail water prices. Supply increases slightly in the dry condition (1,600 acre-feet), partially offsetting costs of restoration payments for a net annual dry condition cost of $0.3 million.

San Joaquin Valley M&I users also obtain both CVP and SWP supplies, so results also reflect a mixture of gains and losses. The region obtains about 1,000 acre-feet more supplies, on average, with Alternatives 1 and 2. These supplies are worth little compared to the cost of alternative supplies, which are groundwater, but CVP contractors pay more in the form of metering and restoration payments. CVPIA costs amount to $4.4 million annually, and costs during the dry condition amount to $4.9 million annually.

The Central and South Coast region is affected through SWP supplies only. PROSIM analysis, and operational assumptions that allow the SWP to export a share of increased Delta inflows, suggest that this region gains water supply in Alternatives 1 and 2. This region is expected to be in a substantial average condition supply deficit by 2020, so additional SWP supplies of 51,000 acre-feet are quite valuable in terms of cost avoided. The additional SWP supplies replace 31,000 acre-feet of other more expensive supplies, and cost and price reductions increase demand by 20,000 acre-feet. The result is an annual average benefit of $32.9 million. Even larger supply increases (89,900 acre-feet) are obtained in the dry condition, and annual economic benefits during the dry condition amount to $67.3 million.

A supplemental analysis of M&I water use and costs with water transfers allowed was conducted. M&I providers can buy evapotranspiration and non-recoverable losses from irrigated agriculture. The base transfer scenario does not allow transfers from CVP contract and exchange water that are allowed in the action alternatives. The analysis finds that M&I users in the Sacramento Valley and San Joaquin regions do not participate in water transfer markets because supplies are generally adequate to meet demands and groundwater is less expensive than water transfers as a replacement supply.

The Bay Area purchases little water in the average hydrologic condition, but 181,000 acre-feet are purchased in the dry condition. These transfers are worth roughly $30 million annually as compared to the base transfer scenario, largely because the region pays less for transfers ($139 and $124 less per acre-foot under Alternatives 1e and 2b, respectively) and most of $15.5 million of cost of other make-up supplies is avoided by substitution to less expensive transfers. A small part of the $15.5 million is avoided by the increase in dry condition supplies relative to the base transfer scenario. The measure of the value of CVPIA water transfer provisions is the cost savings on the amount of water transfers in the base transfer scenario, due to lower price, minus the cost of additional transfers which substitute for other make-up supplies, plus the share of make-up supply cost savings attributable to the water transfer provisions as opposed to more SWP supply in the alternative.

The South Coast is constrained by assumption to transfer no more than 100,000 acre-feet of Central Valley water in the average condition. Much of the average condition value of transfers is obtained in the base transfer scenario where cost savings of $55 million are obtained in comparison to the No-Action Alternative without transfers. Alternative 1e is worth another $1.0 million annually in cost

savings, but transfer price increases in Alternative 2b cost $1.8 million relative to the base transfer scenario average condition.

In the dry condition only half of the average-condition transfer is available, and the Central and South Coast Region purchases about 363,100 acre-feet of additional make-up supplies from Central Valley agriculture. The addition of CVPIA water transfer provisions in Alternatives 1e and 2b is worth $37 and $28 million, respectively, in cost savings during the dry condition, in comparison to the base transfer scenario. The difference between Alternatives 1e and 2b is due to water price increases as affected by water acquisition in Alternative 2.

ALTERNATIVE 3

Results for the Sacramento Valley are nearly identical to results for Alternatives 1 and 2, so they are not repeated here.

Under Alternative 3, the Bay Area obtains more water supplies (10,000 acre-feet) in the average condition relative to the No-Action Alternative, but the region is in a supply surplus, so these supplies have no economic value. The region pays a cost associated with restoration payments and supply reductions to one water-short CVP contractor amounting to $4.7 million per year in the average condition. The region obtains more water (21,700 acre-feet) in the Alternative 3 dry condition, which creates a benefit of $19.3 million annually during the drought.

Under this alternative, the San Joaquin Valley also obtains more water supplies on average, but these supplies are worth little in comparison to the cost of alternatives. The region pays a net cost of $3.2 million annually, which consists mostly of metering and restoration payments. Costs during the dry condition are estimated to be $4.5 million.

In the Central and South Coast, additional SWP supplies of 168,000 acre-feet in the average condition are quite valuable in terms of cost avoided. The result is an annual average benefit of $106 million. The supply increase in the average condition allows retail water price to be kept lower, which causes demand to be higher going into the drought, reducing the economic value of any supply increase in the dry condition. An even larger SWP supply increase (216,000 acre-feet) is obtained in the dry condition, but the effective supply increase is only 112,000 acre-feet because 104,000 acre-feet are needed to cover increased demand from the average condition. Annual economic benefits amount to $120 million in the dry condition.

A supplemental analysis of M&I water use and costs with water transfers allowed is included for Alternative 3. The analysis finds that M&I users in the Sacramento Valley and San Joaquin regions do not participate in water transfer markets. The Bay Area purchases little water in the average hydrologic condition, but 162,000 acre-feet are purchased in the dry condition. These transfers are worth about $18 million annually as compared to the base transfer scenario, in terms of net cost savings relative to other supplies, largely because the region pays less for transfers ($102 per acre-foot less).

In the Central and South Coast, 102,000 acre-feet are bought in the average condition. Alternative 3a is worth $0.2 million annually in cost savings, relative to the base transfer scenario average

condition. In the dry condition 360,000 acre-feet of transfers are worth $22 million in cost savings in comparison to the base transfer scenario.

ALTERNATIVE 4

Results for the Sacramento Valley are nearly identical to results for Alternatives 1 and 2, so they are not discussed further here.

In the Bay Area, 13,000 acre-feet less supply is obtained relative to the No-Action Alternative; however, the region is in a supply surplus so this supply reduction has no economic cost. The region pays a cost associated with restoration payments and supply reductions to one water-short CVP contractor amounting to $4.9 million per year in the average condition. The region obtains a reduced supply in the dry condition (7,500 acre-feet) which is associated with an annual cost of $9.5 million relative to the No-Action Alternative.

The San Joaquin Valley also obtains reduced water supplies on average, but these supplies are worth little in comparison to the cost of other supplies. The region pays a net cost of $5.0 million annually, which consists mostly of metering and restoration payments. Costs during the dry condition are estimated to be $5.1 million.

SWP supplies for the Central and South Coast in Alternative 4 are 9,000 acre-feet less than under the No-Action Alternative, and economic costs associated with this supply reduction are estimated to be $6.1 million in the average condition. In the dry condition, there is no effect on supplies, but demand reduction from the average condition is associated with a dry condition benefit of $8 million annually.

A supplemental analysis of M&I water use and costs with water transfers allowed is included for Alternative 4. Again, M&I users in the Sacramento Valley and San Joaquin regions do not participate in water transfer markets.

The Bay Area purchases little water in the average hydrologic condition, but 190,000 acre-feet are purchased in the dry condition. These transfers are worth about $20 million annually as compared to the base transfer scenario, largely because the region pays less for transfers ($82 per acre-foot less) and $15.5 million of costs of other make-up supplies are avoided.

In the Central and South Coast average condition, 105,000 acre-feet are bought. Average condition transfers in Alternative 4a cost $2.6 million more than in the base transfer scenario because price is about $25 per acre-foot higher. In the dry condition 363,000 acre-feet of transfers are worth $16 million in cost savings in comparison to the base transfer scenario.

BACKGROUND AND METHODS

The CVPIA may have a variety of effects on M&I water users (providers). CVP M&I water supplies may be affected directly, and the CVPIA will increase prices paid for CVP M&I water

through restoration payments and tiered pricing. SWP and local M&I supplies may be affected by the water acquisition program and changes in water availability in the Delta.

The purposes of the Municipal Water Costs analysis are to estimate:

- the costs and benefits of changes in M&I water supplies caused by CVPIA provisions;
- the costs to M&I providers and their customers associated with other CVPIA provisions; and
- M&I water transfer demand functions for use in the water transfer analysis and cost savings from water transfers.

The scope of the M&I analysis includes CVP M&I contractors, M&I water rights delivered by the CVP, and any non-CVP M&I providers who may be affected by the CVPIA. The potential impacts to CVP M&I contractors involve direct cost increases, changes in water supplies, and impacts of CVPIA water transfer provisions.

Under Section 3405(d), M&I providers must pay a higher price for the last 20 percent of their contract amount used. In addition, Section 3407(d) allows the U.S. Department of the Interior to charge up to $12.00, indexed to 1992 prices, for each acre-foot of CVP M&I contract water delivered, and a surcharge can be applied to water delivered in the Friant Division. These additional expenses will be paid into the restoration fund.

Section 3405(b) may require CVP M&I contractors to install meters on all existing service connections. Section 3405(e) requires that CVP M&I contractors develop and implement water conservation plans. The plans will require "the highest level of water use efficiency reasonably achievable by project contractors using best available cost effective technology and best management practices." These requirements may result in additional costs for CVP M&I contractors.

CVP contractors may obtain less CVP water in comparison to the No-Action Alternative. The dedication of CVP water supplies to fish and wildlife purposes under Section 3406 may reduce the average yield and reliability of CVP supplies. These direct effects, in terms of water delivery, are estimated by the hydrologic models.

IMPACT ASSESSMENT METHODOLOGY

The analysis procedure used for the quantitative analysis of M&I water economics is detailed in the Municipal Water Costs Methodology/Modeling Technical Appendix (M/M TA). The economic analysis of municipal water supply involves the cost of water and the cost of shortage. M&I providers faced with shortages can reduce or eliminate customer shortages with alternative water supplies, or they can reduce customer use. Generally, the approach to M&I shortage cost valuation and water transfer demands assumes that M&I providers will try to pick a least-cost mix of these two options. This mix is accomplished by accepting feasible water supply and shortage options in order of their marginal or incremental costs from least to most expensive.

The economic analysis for each alternative includes both a long-run and a short-run analysis. The differences between these analyses are as follows:

- The short-run condition analysis estimates economic impacts during the dry condition; the long-run analysis estimates impacts based on average supplies in the average condition. The dry condition is the period of 1928 through 1934. The average condition is the period of 1922 through 1990.

- Most water supply facilities are fixed going into a drought because they have a long planning and construction horizon. Therefore, there are fewer water supply options during the dry condition than in the long run. In general, additional supplies are more expensive during drought than in the long-run condition. Methods used to cost alternative supplies are described in the M/M TA.

- Retail customers are less willing and able to make adjustments in the short run than in the long run. This means the quantity of water demanded is less responsive to price during the dry condition than in the long run; demand is less elastic (more inelastic).

- In the short run during the dry condition, the financial resources of providers can be drawn down. In the long run, economic revenues must equal costs. Prices can be fixed in the short run, but they must respond to water sales and costs in the long run.

- For purposes of economic analysis, shortage is defined as a situation in which water customers cannot take the quantity of water they want at the existing price. Shortage is not allowed in the long-run analysis, but price changes affect the amount of water purchased at the retail level. Shortage is allowed in the dry condition analysis in the form of drought conservation. Drought water conservation is required before drought make-up supplies can be bought.

The form of economic costs differs considerably in the short run and long run. In the long-run analysis, the additional costs of make-up supplies are passed on to customers in the form of higher water prices. Therefore, rate increases needed to cover long-run average cost increases are estimated. These higher rates reduce customer use according to the long-run water demand function. Alternative supplies are acquired until water demand equals supply, given that the costs of new supplies increase the retail price of water and retail use is reduced. Economic costs to end users involve increases in the retail price of water.

In the short run, economic costs include net revenue losses, costs of drought conservation, costs of customer shortage, and costs of make-up supplies. Drought water conservation creates costs in the form of reduced net revenues to water providers. Net revenue losses are water sales losses less variable water cost savings. Costs of customer shortage are based on the concept of consumer surplus, which is the value of water to customers above what is actually paid for it. If drought conservation cannot accommodate the shortage, then more supplies are bought and their cost becomes part of the shortage cost.

Economic demand functions show the relationship between the price of a good and how much water customers want to buy. Water demand functions have several purposes in the analysis.

They define a maximum willingness to pay for alternative supplies, they calculate response to long-run price changes, and they determine costs of shortage in the drought condition. Retail water demand functions are obtained by using a baseline retail price and quantity of water to define a point, and an elasticity of demand defines the slope. The standard elasticity assumption for residential, government, and other unclassified demands (RGO) is -0.4 in the long run and -0.2 in the drought condition. For example, a permanent price increase of 10 percent results in a 4 percent decline in RGO quantity demanded. These assumptions are varied in sensitivity analyses.

Industrial and commercial demands are assumed to be insensitive to price, primarily because of a lack of data concerning price responsiveness. The result of the assumption is that overall demand elasticity is decreased by the percent of demand that is industrial and commercial. For example, if 50 percent of total M&I demand is industrial and commercial, the overall demand elasticity is reduced to -0.2 (.5*0.4).

The costs of alternative supplies vary by location as well as condition (long and short run). In the Central Valley groups, additional groundwater use is allowed. For the South Coast, an alternative cost function was estimated based on water supply options. In all other cases, the price of alternative supplies delivered is allowed to equal the marginal value of transfers from the water transfer demand function. The marginal value of transfers is equal to the marginal cost of other supplies avoided by having the transfer instead, so the marginal cost of the other supplies can be derived from the water transfer demand function.

Water transfers are not allowed in the main analysis. Results from the water transfer analysis are provided as a supplemental analysis following the M&I analysis for each alternative. The analysis with water transfers considers how voluntary transfers from Central Valley agriculture might affect M&I water use and costs. The water transfer analysis includes long-run and short-run analyses that incorporate the same long- and short-run principles as used in the M&I and agricultural analyses. Methods and data used in the water transfer analysis are provided in the CVPTM Methodology/Modeling Technical Appendix. The water transfer analysis assumes that M&I providers do not sell water and are water buyers only.

Secondary economic effects may result from shortage. Secondary effects involve economic linkages with directly affected water customers. Higher residential water costs leave less discretionary income for water customers to spend in the economy. These regional impacts are estimated in the regional analysis. All else equal, increased water costs and reduced supply reliability encourage people and businesses to locate elsewhere. Some relocation may involve movement from within CVP service areas to other regions of the state. Intra-state relocation has regional implications. There is no explicit quantitative analysis of impacts on population or growth. Increased water prices reduce water use without estimating the share of reduction attributable to use per user versus the number of users.

The steps of the Municipal Water Costs analysis are displayed generally in Figures III-2 and III-3. The impact assessment compares M&I results among the No-Action Alternative and PEIS action alternatives.

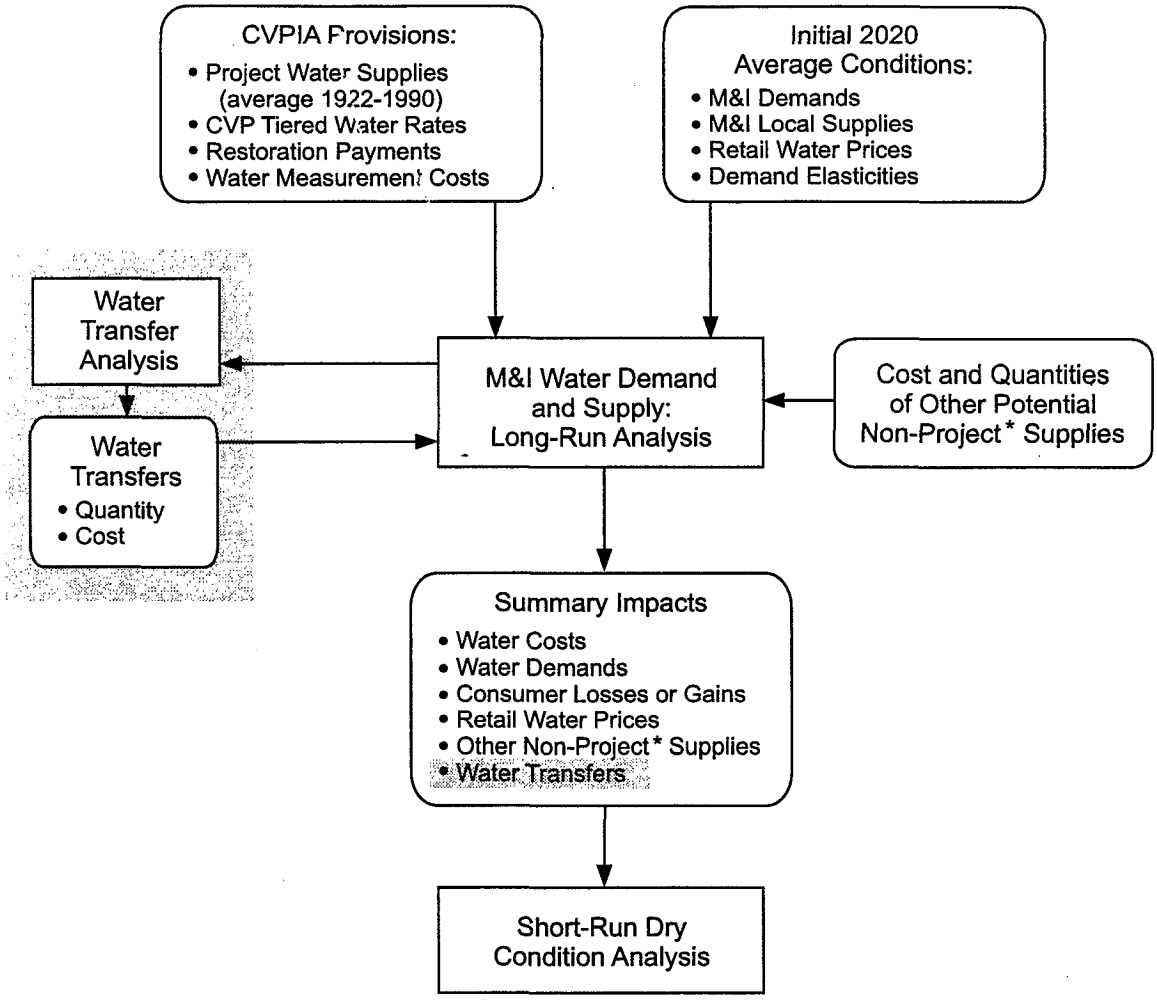
NO-ACTION ALTERNATIVE

The No-Action Alternative is the base condition for the PEIS alternatives analyses. The No-Action Alternative represents conditions in the future assuming a projected 2022 level of development without implementation of CVPIA. The No-Action Alternative assumes the operation of existing facilities and future facilities that are certain to be constructed by 2022. It further assumes that these water resource facilities will be operated in accordance with operating rules and criteria that were in effect or being developed as of October 1992 when the CVPIA was adopted. The major operations criteria affecting the CVP facilities include the following items:

- Coordinated Operations Agreement (COA);
- the Bay-Delta Plan Accord as defined in the State Water Resources Control Board (SWRCB) May 1995 Draft Water Quality Control Plan;
- the 1993 Winter Run Biological Opinion as amended in 1995 by National Marine Fisheries Service (NMFS);
- American River minimum streamflow requirements per modified SWRCB Decision 1400 (D-1400);
- Stanislaus River minimum streamflows of 155,700 acre-feet in non-critical years and 98,300 acre-feet in critical years per agreements with the Department of Fish and Game and the Service; and
- New Melones Reservoir operated to meet water quality standards per SWRCB Decision 1422 (D-1422), to the extent possible, on the Stanislaus River and on the San Joaquin River at Vernalis.

Other CVP system operations are consistent with the criteria defined in the Long-Term Central Valley Project Operations Criteria and Plan CVP-OCAP (October 1992).

Table III-2 shows results from the No-Action Alternative. The first two rows show the minimum and maximum retail price for each group. Demands and supplies are the initial 2020 levels before any adjustments for new supplies which are needed to balance demand and supply in the long run. For the two coastal groups, supplies must be developed to equate 2020 demand and supply. The Bay Area has a slight excess supply overall, but one provider shows a small shortage and develops 1,800 acre-feet of new supplies at a cost of $513 per acre-foot delivered.



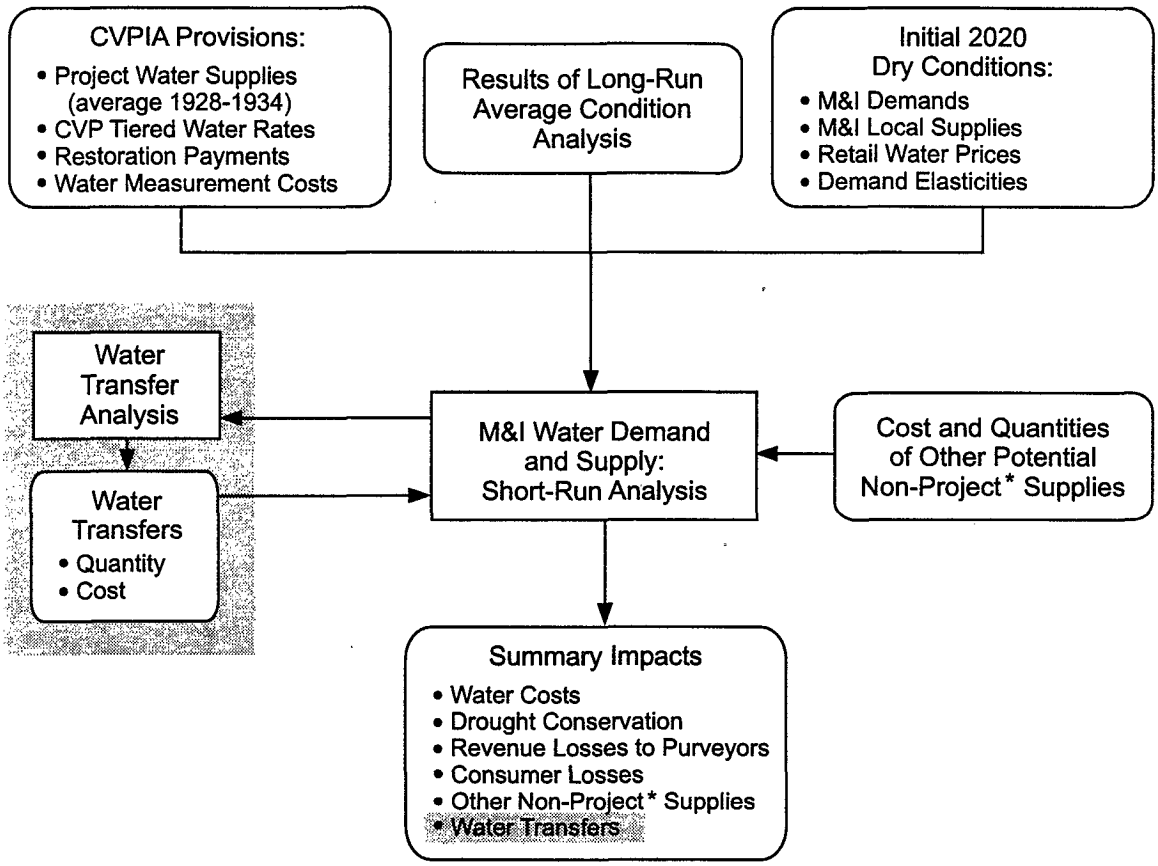
Notes:

* Non-Project refers to other potential sources of water supply not available through CVP or SWP or through water transfers. Sources could include local reclamation, desalination, and new local surface storage or conjunctive use projects.

Shaded areas indicate supplemental analysis with water transfers.

FIGURE III-2

MUNICIPAL WATER COSTS ANALYSIS LONG-RUN AVERAGE CONDITION



Notes:

* Non-Project refers to other potential sources of water supply not available through CVP or SWP or through water transfers. Sources could include local reclamation, desalination, and new local surface storage or conjunctive use projects.

Shaded areas indicate supplemental analysis with water transfers.

FIGURE III-3

MUNICIPAL WATER COSTS ANALYSIS SHORT-RUN DRY CONDITION

TABLE III-2

MUNICIPAL WATER COSTS
NO-ACTION ALTERNATIVE (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Min Retail Price, $/af (2)	136.0	401.0	133.0	418.0
Max Retail Price, $/af	222.0	591.0	158.0	1,347.0
Demand, taf	933.0	1,025.0	708.0	6,025.0
Supplies, taf	933.0	1,088.0	708.0	4,910.0
Shortage, taf (3)	0.0	-63.0	0.0	1,115.0
New Supplies, taf (4)	0.0	1.8	0.0	888.0
New Supply Cost, Mil $ (5)	0.0	1.0	0.0	634.0
New Supply Cost, $/af	0.0	513.0	0.0	714.0
% Retail Price Increase (6)	0.0%	0.2%	0.0%	14.0%
Demand Reduction, taf	0.0	0.5	0.0	228.0
New 2020 Demand, taf	933.0	1,025.0	708.0	5,797.0
DRY CONDITION (1928-1934 average hydrology)				
Demand before reduction, taf	1,011.0	1,134.0	717.0	6,240.0
Demand, taf	1,011.0	1,133.0	717.0	6,012.0
Supplies, taf	992.0	886.0	663.0	4,890.0
Shortage, taf	19.0	248.0	54.0	1,122.0
% RGO Shortage, Min (7)	2.1	5.9	4.3	11.1
% RGO Shortage, Max	8.0	5.9	14.5	13.5
Shortage Allocation, taf				
RGO Drought Cons	19.0	46.4	31.4	488.2
Comm/Ind Drt Cons (8)	0.0	17.6	5.9	81.1
Drought Supplies	0.0	183.7	17.1	552.8
Shortage Cost, Mil $ Following the Dry Condition				
Drought Supplies	0.0	175.1	3.4	679.6
Drought Conservation (9)	0.4	1.3	0.7	11.4
Comm/Ind Revenue (10)	0.0	8.9	0.9	39.2
Comm/Ind Surplus (11)	0.0	1.4	0.1	5.8
RGO Revenue (10)	3.3	23.6	4.7	237.3
RGO Surplus (11)	0.6	4.3	2.2	96.0
Water Cost Savings	-1.2	-36.8	-3.3	-246.1
TOTAL Cost/Yr, Mil $ (12)	**3.1**	**177.7**	**8.8**	**823.1**

NOTES:
(1) No M&I water transfers available. East Bay Municipal Utility District not included. Totals may not sum due to rounding.
(2) Retail price does not include service charges. Min and max are the minimum and maximum of providers in the group.
(3) The difference between demand and supplies. Does not consider that some regions have excess supplies, and does not consider effects of price changes on demand.
(4) In Bay Area, new supplies are needed for just one of four providers in group.
(5) Includes conveyance, treatment and delivery cost.
(6) Price increase relative to existing conditions. For Bay Area, the percent increase shown involves only 16% of demand.
(7) RGO shortage is associated with drought conservation programs. Min and max are the minimum and maximum of providers in the group.
(8) Commercial and industrial water savings from drought conservation is limited to 5% of demand.
(9) The cost of running the drought conservation program.
(10) Water revenue lost from lost sales.
(11) Consumer surplus lost from lost sales.
(12) Cost of drought relative to the average, long-run condition.

In the Central and South Coast group, a total 2020 supply deficit of 1.115 million acre-feet results in the development of 888 thousand acre-feet of average annual yield at a cost of $634 million or $714 per acre-foot on average delivered to retail customers. The incremental supply at this level of development costs $826 per acre-foot delivered to end users. The cost increase forces real price to increase an average of 14 percent, relative to current conditions, which reduces 2020 demand by 228,000 acre-feet or 3.8 percent. The overall elasticity of demand is -0.27 (3.8/14), as opposed to -0.4, because industrial and commercial demand is not affected by the price increase. Demand and supply are equal at the new equilibrium quantity of 5.797 million acre-feet. The demand reduction of 228,000 acre-feet is carried into the dry condition simulation—the Central and South Coast dry condition demand is reduced by 228,000 acre-feet to start the dry condition simulation at 6.012 million acre-feet.

During the 1928-1934 dry condition, all four groups of providers have shortages. The shortage is caused by lower dry-condition local supplies, less imported supplies, and more demand. Dry condition demand is larger than average because of less precipitation on urban landscapes, but demand in the coastal regions is reduced by the quantity of demand reduction caused by increased price in the average condition. The maximum drought conservation is sufficient to accommodate the shortage only in the Sacramento Valley group. Drought supplies must be developed by the other groups. The Bay Area group develops 183,700 acre-feet per year at an average cost of $953 per acre-foot delivered. The San Joaquin Valley group develops 17,100 acre-feet at a delivered cost of $200 per acre-foot, and the Central and South Coast group pays $1,229 per acre-foot for 553,000 acre-feet. Costs of shortage are mostly lost water revenue and economic surplus in the Central Valley groups, but most cost is for drought supplies in the coastal groups. This later cost is significantly higher than under recent conditions because demands are larger, and in the Central and South Coast Region 888 thousand acre-feet of less expensive supplies are already committed to meet long-run average demands. This increases the per unit cost of new supplies substantially in comparison to recent conditions.

Table III-3 shows results from the dry condition for the No-Action Alternative using an RGO demand elasticity of -0.1 instead of -0.2. In comparison to the bottom of Table III-2, costs of shortage are increased, but costs are not doubled because much of the cost of drought is lost revenue and alternative supplies, not RGO shortage.

BASE TRANSFER SCENARIO: NO-ACTION ALTERNATIVE WITH NON-CVPIA WATER TRANSFERS

Table III-4 shows results of the base transfer scenario. The underlying assumptions are identical to the No-Action Alternative except that water transfers of agricultural consumptive use to M&I providers are allowed subject to certain feasibility limitations, conveyance losses, and transfer prices and costs. M&I water transfer demands are created by a supply deficiency. In the base transfer scenario, transfers of CVP water service water and exchange water are not allowed. The Central Valley M&I regions do not participate in water markets because supplies are sufficient to accommodate demand.

TABLE III-3

MUNICIPAL WATER COSTS NO-ACTION ALTERNATIVE DRY-YEAR RESULTS WITH DEMAND ELASTICITY OF -0.1

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
Demand, taf	1,011.0	1,133.0	717.0	6,012.0
Supplies, taf	992.0	886.0	663.0	4,890.0
Shortage, taf	19.0	248.0	54.0	1,122.0
% RGO Shortage, Min	2.1	5.9	4.3	11.1
% RGO Shortage, Max	7.9	5.9	14.5	13.5
Shortage Allocation, taf				
RGO Drought Conservation, taf	19.0	46.4	31.4	488.2
Comm/Ind Drought Conservation	0.0	17.6	5.9	81.1
Drought Supplies	0.0	183.7	17.1	552.8
Shortage Cost, Mil $				
Drought Supplies	0.0	241.4	3.4	739.2
Drought Conservation	0.4	1.3	0.7	11.4
Comm/Ind Revenue	0.0	8.9	0.9	39.2
Comm/Ind Surplus	0.0	3.1	0.3	12.8
RGO Revenue	3.3	23.6	4.7	237.3
RGO Surplus	1.5	10.2	6.7	265.0
Water Cost Savings	-1.2	-36.8	-3.3	-246.1
TOTAL Cost/Yr, Mil $	**4.0**	**251.4**	**13.7**	**1,058.8**

In the average hydrologic condition, the Bay Area has excess supply overall, but one provider shows a small shortage and buys 2,100 acre-feet of transfers. In the Central and South Coast group, a total 2020 supply deficit of 1.115 million acre-feet results in the purchase of 105 thousand acre-feet of transfers plus the development of 814 thousand acre-feet of other supplies at a total cost of $597 million or $650 per acre-foot on average delivered to retail customers. The South Coast is constrained by assumption to buy no more than 100,000 acre-feet of transfers, and the remaining 5,100 acre-feet is purchased by the Central Coast. The coastal regions (Bay Area, Central and South Coast) must increase retail water prices to pay for these supplies, and increased water prices reduce demand. In the Central and South Coast, the cost increase forces price to increase an average of 11.8 percent which reduces demand by 196,100 acre-feet (note that, without transfers, cost increases were more, price was increased 14 percent and demand was reduced more). Demand and supply are equal at the new equilibrium quantity of 5.829 million acre-feet. The demand reduction of 196,100 acre-feet is carried into the dry condition simulation—the Central and South Coast dry condition demand is reduced by 196,100 acre-feet to start the No-Action Alternative dry condition simulation at 6.044 million acre-feet.

TABLE III-4

MUNICIPAL WATER COSTS
NO-ACTION ALTERNATIVE WITH NON-CVPIA TRANSFERS (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Min Retail Price, $/af (2)	136.0	401.0	133.0	418.0
Max Retail Price, $/af	222.0	591.0	158.0	1,347.0
Demand, taf	933.0	1,025.0	708.0	6,025.0
Supplies, taf	933.0	1,088.0	708.0	4,910.0
Shortage, taf (3)	0.0	-63.0	0.0	1,115.0
New Supplies, taf (4)	0.0	2.1	0.0	919.0
Water Transfers	0.0	2.1	0.0	105.0
New Supply Cost, Mil $ (5)	0.0	0.5	0.0	597.0
New Supply Cost $/af		219.0		650.0
% Retail Price Increase (6)	0.0	0.1	0.0	11.8
Demand Reduction, taf	0.0	0.2	0.0	196.0
New 2020 Demand, taf	933.0	1,025.0	708.0	5,829.0
DRY CONDITION (1928-1934 average hydrology)				
Demand, taf	1,011.0	1,134.0	717.0	6,044.0
Supplies, taf	992.0	885.0	663.0	4,869.0
Shortage, taf	19.0	249.0	54.0	1,175.0
% RGO Shortage, Min (7)	2.1	5.9	4.3	11.1
% RGO Shortage, Max	8.0	5.9	14.5	13.5
Shortage Allocation, taf				
RGO Drought Cons	19.0	46.5	31.4	491.7
Comm/Ind Drought Cons (8)	0.0	17.6	5.9	81.1
Drought Supplies	0.0	20.6	17.1	238.8
Additional Transfers (9)	0.0	164.2	0.0	363.1
Shortage Cost, Mil $				
Drought Supplies	0.0	15.5	3.4	260.4
Water Transfers	0.0	90.3	0.0	209.1
Drought Conservation (10)	0.4	1.3	0.7	11.5
Comm/Ind Revenue (11)	0.0	8.9	0.9	38.5
Comm/Ind Surplus (12)	0.0	1.3	0.1	5.6
RGO Revenue (11)	3.3	23.6	4.7	234.4
RGO Surplus (12)	0.7	4.2	2.2	94.7
Water Cost Savings	-1.2	-36.9	-3.3	-257.6
TOTAL Cost/Yr, Mil $ (13)	**3.1**	**108.3**	**8.8**	**596.5**

NOTES:
(1) Totals may not sum due to rounding.
(2) Retail price does not include service charges. Min and max are the minimum and maximum of providers in the group.
(3) A negative shortage is a supply surplus over all providers in the group.
(4) In Bay Area, new supplies are needed for just one of four providers in group.
(5) Includes conveyance, treatment and delivery cost.
(6) Price increase relative to existing conditions. For Bay Area, the percent increase shown involves only 16% of demand.
(7) Residential, Government and Other (RGO) shortage is associated with drought conservation programs. Min and max are the minimum and maximum of providers in the group.
(8) Commercial and industrial water savings from drought conservation is limited to 5% of demand.
(9) One-half of the transfers acquired in the long-run condition are available in the dry condition.
(10) The cost of running the drought conservation program.
(11) Water revenue lost from lost sales.
(12) Consumer surplus lost from lost sales.
(13) Cost of drought relative to the average, long-run condition.

During the 1928-1934 dry condition, all groups of providers have shortages. The shortage is caused by lower dry-condition local supplies, less imported supplies, and more demand. Dry condition demand is larger than average because of less precipitation on urban landscapes, but demand is reduced by the quantity of demand reduction caused by increased price in the average condition.

The Central Valley regions find that drought conservation can accommodate the shortage, or groundwater is less expensive than water transfers, so these regions do not participate in water transfer markets. Therefore, results are identical to the No-Action Alternative as reported in Table III-2.

In the coastal regions, the maximum drought conservation is not sufficient to accommodate the shortage, so drought supplies must be acquired. The Bay Area group acquires 164,200 acre-feet of transfers and develops 20,600 acre-feet of other make-up supplies, and the Central and South Coast acquires 363,100 acre-feet of transfers, in addition to 52,500 acre-feet of the 105,000 acre-feet average-year transfer, and 238,800 acre-feet of other make-up supplies are developed. Costs of drought include lost revenues, costs of transfers and other make-up supplies, costs of drought conservation programs, and lost economic surplus of end-users. Total annual shortage costs in the No-Action Alternative are $596.5 and $108.3 million in the Central and South Coast, and Bay Area, respectively.

Table III-5 shows the difference between the base transfer scenario and the No-Action Alternative. For the coastal regions, the availability of less expensive water transfers reduces the cost of new supplies, reduces the need for revenue to cover these costs, and allows the retail price of water to be kept lower in the long run. The Bay Area and Central and South Coast save $450,000 and $36 million, respectively, on costs of alternative supplies in the average condition.

Annual cost savings are more substantial in the dry condition. The Bay Area group eliminates about 90 percent of its shortage, after mandatory drought conservation, with transfers. These water transfers are estimated to be worth about $69 million (159.6-90.3) annually during the dry condition, in terms of net cost savings relative to other supplies. With very minor adjustments for revenue and economic surplus, total Bay Area annual cost savings from water transfers in the base transfer scenario dry condition are estimated to be $69.4 million.

In the Central and South Coast, base transfer scenario dry condition demand is larger than in the No-Action Alternative because retail water prices are lower. Also, only one-half of the 100,000 acre-feet of average condition transfer is available in the dry condition, but this increment of supply in the No-Action Alternative is considered perfectly reliable, so initial supplies in the base transfer scenario dry condition are less. Taken together, total dry condition shortage in the base transfer scenario is 53,000 acre-feet more than in the No-Action Alternative.

The transfer of 363,100 acre-feet costs $209.1 million, but $419.3 million of other water costs are avoided, so about $210 million of cost savings is obtained. The region could save more from transfers, but the South Coast is constrained to take no more than 350,000 acre-feet. Additional minor savings occur because retail water price is lower with transfers, so revenue and surplus losses are less. With minor adjustments for costs, revenue, and economic surplus, total Central

TABLE III-5

MUNICIPAL WATER COSTS
DIFFERENCE BETWEEN NO-ACTION ALTERNATIVE WITH TRANSFERS AND NO-ACTION ALTERNATIVE WITHOUT TRANSFERS (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
New Supplies, taf	0.0	0.3	0.0	31.0
New Supply Cost, Mil $(2)	0.0	-0.5	0.0	-36.0
New Supply Cost $/af	0.0	-$294.0	0.0	-$64.0
% Retail Price Increase (3)	0.0%	-0.1%	0.0%	-2.2%
Demand Reduction, taf	0.0	-0.3	0.0	-31.0
New 2020 Demand taf	0.0	0.0	0.0	31.0
DRY CONDITION (1928-1934 average hydrology)				
Demand, taf	0.0	0.0	0.0	31.0
Supplies, taf (4)	0.0	-1.0	0.0	-21.0
Shortage, taf	0.0	1.0	0.0	53.0
Shortage Allocation, taf				
RGO Drought Conservation	0.0	0.0	0.0	3.5
Comm/Ind Drought Cons	0.0	0.0	0.0	0.0
Drought Supplies	0.0	-163.2	0.0	-314.0
Additional Transfers	0.0	164.2	0.0	363.1
Shortage Cost, Mil $				
Drought Supplies	0.0	-159.6	0.0	-419.3
Water Transfers	0.0	90.3	0.0	209.1
Restoration Payment	0.0	0.0	0.0	0.0
Metering Cost	0.0	0.0	0.0	0.0
Drought Conservation	0.0	0.0	0.0	0.1
Comm/Ind Revenue	0.0	0.0	0.0	-0.8
Comm/Ind Surplus	0.0	0.0	0.0	-0.1
RGO Revenue	0.0	0.0	0.0	-2.9
RGO Surplus	0.0	0.0	0.0	-1.2
Water Cost Savings	0.0	-0.1	0.0	-11.5
TOTAL Cost/Yr, Mil $	**0.0**	**-69.4**	**0.0**	**-226.6**

NOTES:
(1) See Table III-2 for explanation of terms.
(2) A negative is a cost reduction or a benefit.
(3) A negative means cost increased less than in the No-Action Alternative.
(4) Without transfers, all new supplies are carried into the drought condition. With transfers, only 50 percent of average condition transfers are carried into the dry condition.

and South Coast annual savings from water transfers in the base transfer scenario dry condition are estimated to be $226.6 million.

ALTERNATIVE 1

Water management provisions in Alternative 1 were developed to utilize two of the tools provided by CVPIA, re-operation and (b)(2) water, toward meeting target flows in Central Valley streams. For the purposes of Alternative 1, it was assumed that no water would be acquired for fish and wildlife purposes. Alternative 1 assumes the implementation of several concurrent programs recognized or authorized under CVPIA. These programs include Trinity River flow requirements, provisions for a firm Level 2 water supply (historical average supply) for the refuges, and retirement of lands in accordance with the San Joaquin Valley Drainage Study. The water management actions under Alternative 1 primarily affect CVP-controlled streams. Other CVPIA provisions that affect M&I water providers include restoration payments and tiered water prices, water measurement and conservation requirements, and water transfer provisions.

Table III-6 provides results for Alternative 1. All regions except the San Joaquin Valley must develop new supplies to meet 2020 average condition demands. The San Joaquin Valley is able to reduce its use of supplies relative to the No-Action Alternative, but retail price must still be increased 4.7 percent to cover other CVPIA costs. In the other regions, the cost of new supplies and the costs of meters and restoration payments contribute to real retail price increases of 1.1 to 12.6 percent.

All regions experience shortage in the dry condition. The Sacramento Valley does not require all available drought conservation to get through the drought, so there is no need to purchase additional make-up supplies. Parts of the San Joaquin Valley require all available drought conservation, and all of the coastal regions do, so additional make-up supplies must be purchased. The annual cost of the drought to the Bay Area and Central and South Coast is $178 million and $756 million, respectively.

Table III-7 shows the difference between Alternative 1 and the No-Action Alternative. In the average condition, the Sacramento Valley group obtains about 3,400 acre-feet less CVP supply. The Bay Area receives a net of 6,100 acre-feet less but still has excess supplies in the average condition. The San Joaquin Valley and Central and South Coast groups receive more water delivery. The San Joaquin Valley receives about 1,000 acre-feet more, but demands are reduced by retail price increases caused by additional CVPIA costs. The Central and South Coast group receives 51,000 acre-feet more SWP M&I supply, and therefore pays less for new water supplies than under to the No-Action Alternative. These supplies are also less expensive on average because the acquisition of the most expensive incremental supplies is avoided.

Restoration payments by M&I providers are about $6.4 million, water metering costs for the Sacramento Valley group and the San Joaquin Valley group are $2.5 and $3.6 million, respectively, and total costs to the Bay Area and Central Valley are about $14 million annually in the average condition in comparison to the No-Action Alternative. Therefore, most costs associated with this alternative cover metering and restoration payments, not reductions in water

TABLE III-6

MUNICIPAL WATER COSTS
ALTERNATIVES 1 AND 2 (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Supplies, taf	930.0	1,082.0	709.0	4,961.0
Shortage, taf (2)	3.5	-56.9	-0.9	1,064.0
New Supplies, taf	0.5	2.5	-8.0	856.0
New Supply Cost, Mil $	0.1	1.0	-1.7	601.0
New Supply Cost $/af	115.0	523.0	207.0	702.0
% Retail Price Increase (3)	3.5%	1.1%	4.7%	12.6%
Demand Reduction, taf	7.8	2.1	7.1	208.0
New 2020 Demand, taf	925.0	1,023.0	701.0	5,817.0
Restoration Payment, Mil $	1.4	3.4	1.7	0.0
Metering Cost, Mil $ (4)	2.5	0.0	3.6	0.0
DRY CONDITION (1928-1934 average hydrology)				
Demand, taf	1,003.0	1,132.0	710.0	6,032.0
Supplies, taf	991.0	888.0	658.0	4,949.0
Shortage, taf	12.0	244.0	51.0	1,083.0
% RGO Shortage, Min	0.8	5.9	4.1	11.1
% RGO Shortage, Max	7.5	5.9	14.5	13.5
Shortage Allocation, taf				
RGO Drought Conservation	12.2	46.3	30.6	490.4
Comm/Ind Drought Conservation	0.0	17.6	5.4	81.1
Drought Supplies	0.0	179.9	15.5	511.6
Shortage Cost, Mil $				
Drought Supplies	0.0	171.7	3.1	606.7
Restoration Payment	1.1	3.0	1.6	0.0
Metering Cost	2.5	0.0	3.6	0.0
Drought Conservation	0.2	1.3	0.7	11.4
Comm/Ind Revenue	0.0	9.0	0.8	38.8
Comm/Ind Surplus	0.0	1.3	0.1	5.6
RGO Revenue	2.4	23.8	4.7	235.6
RGO Surplus	0.5	4.3	2.1	95.2
Water Cost Savings	-0.8	-36.3	-3.1	-237.6
TOTAL Cost/Yr, Mil $	**5.9**	**178.0**	**13.7**	**755.9**

NOTES:
(1) No M&I water transfers. East Bay Municipal Utility District not included. Totals may not sum due to rounding.
(2) A negative shortage is a supply.
(3) Price increase relative to existing conditions. Includes price increase caused by restoration payments.
(4) Metering cost is estimated based on $400 per meter and 5% O&M per year.

TABLE III-7

MUNICIPAL WATER COSTS
DIFFERENCE BETWEEN ALTERNATIVE 1 OR 2
AND NO-ACTION ALTERNATIVE (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Demand, taf	0.0	0.0	0.0	0.0
Supplies, taf	-3.0	-6.0	1.0	51.0
Shortage, taf	3.4	6.1	-0.9	-50.9
New Supplies, taf	0.5	0.7	-8.0	31.3
New Supply Cost, Mil $	0.1	0.4	1.7	-33.0
New Supply Cost $/af	115.0	11.0	207.0	-12.0
% Retail Price Increase	3.5	0.9	4.7	-1.3
Demand Reduction, taf	7.8	1.6	7.1	-19.6
New 2020 Demand, taf	-8.0	-1.6	-7.1	19.6
Restoration Payment, Mil $	1.4	3.4	1.7	0.0
Metering Cost, Mil $	2.5	0.0	3.6	0.0
Economic Cost by End User				
RGO Surplus Loss, Mil $	2.9	3.4	2.5	-24.1
Increased cost to Comm. & Ind., Mil $	2.0	1.5	2.0	-8.9
TOTAL Cost, Mil $	**4.9**	**4.9**	**4.4**	**-32.9**
DRY CONDITION (1928-1934 average hydrology)				
Demand, taf	-7.8	-1.6	-7.1	19.6
Supplies, taf	-1.1	2.3	-4.1	58.6
Shortage, taf	-6.8	-3.9	-3.0	-39.0
% RGO Shortage, Min	-1.3	0.0	-0.3	0.0
% RGO Shortage, Max	-0.5	0.0	0.0	0.0
Shortage Allocation, taf				
RGO Drought Conservation	-6.8	-0.1	-0.8	2.2
Comm/Ind Drt Cons	0.0	0.0	-0.6	0.0
Drought Supplies	0.0	-3.8	-1.6	-41.2
Shortage Cost, Mil $				
Drought Supplies	0.0	-3.4	-0.3	-72.9
Restoration Payment	1.1	3.0	1.6	0.0
Metering Cost	2.5	0.0	3.6	0.0
Drought Conservation	-0.1	0.0	0.0	0.0
Comm/Ind Revenue	0.0	0.1	-0.1	-0.5
Comm/Ind Surplus	0.0	0.0	0.0	-0.1
RGO Revenue	-0.9	0.2	0.0	-1.7
RGO Surplus	-0.1	0.0	-0.1	-0.7
Water Cost Savings	0.4	0.5	0.2	8.5
TOTAL Cost/Yr, Mil $	**2.8**	**0.3**	**4.9**	**-67.3**

NOTE:
(1) The difference between Tables III-6 and III-2. See explanatory notes for these tables. A positive is an increase relative to the No-Action Alternative, a negative is a decrease.

supply. In contrast, the Central and South Coast is estimated to benefit by $33 million in average years because of the additional deliveries of SWP supplies.

In the dry condition, all four groups have significant shortages. Restoration payments are reduced relative to the average condition ($5.7 million as compared to $6.5 million) primarily because payments under the CVPIA price tiers are reduced.

For all groups except the Central and South Coast, the additional average-condition costs of Alternative 1, which are mostly restoration payments and metering costs, increase price and reduce demand more than in the No-Action Alternative. Therefore, these groups enter the drought with a lower level of demand. This lower demand reduces the costs of drought relative to the No-Action Alternative. The Central and South Coast group enters the drought with a higher demand, which increases drought costs, but this group also obtains more water in the Alternative 1 dry condition than in the No-Action Alternative. In the dry condition, the Bay Area and San Joaquin Valley benefit from small imported supply increases relative to the No-Action Alternative. After accounting for all of these factors, all regions have less shortage during the dry condition than in the No-Action Alternative dry condition.

The Central Valley groups and the Bay Area must continue to pay the costs of metering and restoration payments during drought. Therefore, they are slightly worse off in a drought than they were in the No-Action Alternative, but the Central and South Coast is better off.

Table III-8 shows results from the dry condition for Alternative 1 using an RGO demand elasticity of -0.1 instead of -0.2. In comparison to Table III-6, costs of shortage are increased somewhat, but the effect is not large because much of the cost of drought is lost revenue and alternative supplies, not RGO shortage.

SUPPLEMENTAL ANALYSIS 1e: WATER TRANSFERS

Table III-9 shows results of the Alternative 1e analysis. Results are expressed as the difference between the with- and without-transfer alternatives. In comparison to Table III-5, results reflect the availability of CVP contract and exchange water for purchase. Therefore, cost savings from transfers can be larger than in the base transfer scenario. However, results can also reflect increased water transfer prices caused by dedicated water, and cost savings from water transfers can reflect the level of imported supplies because these supply levels affect the incremental cost of other supplies no longer needed because of transfers.

In the average condition, the Bay Area and Central and South Coast save about $740,000 and $35 million, respectively, in comparison to Alternative 1. The Bay Area saves more than in the base transfer scenario ($450,000, Table III-5) because there is more shortage to eliminate, so transfers are worth more, and the price of transfers is less ($116 per acre-foot at the treatment plant versus $144 in the base transfer scenario). The Central Coast must pay a significantly higher price for its water transfers under Alternative 1e than in the base transfer scenario ($229 per acre-foot as compared to $176 in the base transfer scenario). The South Coast pays a slightly lower price ($256 per acre-foot as compared to $268 in the base transfer scenario). Overall, the

TABLE III-8

MUNICIPAL WATER COSTS
ALTERNATIVES 1 AND 2 DRY-YEAR RESULTS
WITH DEMAND ELASTICITY OF -0.1

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
Demand, taf	1,003.0	1,132.0	710.0	6,032.0
Supplies, taf	991.0	888.0	658.0	4,949.0
Shortage, taf	12.0	244.0	51.0	1,083.0
% RGO Shortage, Min	0.8	5.9	4.1	11.1
% RGO Shortage, Max	7.5	5.9	14.5	13.5
Shortage Allocation, taf				
RGO Drought Cons	12.2	46.3	30.6	490.4
Comm/Ind Drt Cons	0.0	17.6	5.3	81.1
Drought Supplies	0.0	179.9	15.5	511.6
Shortage Cost, Mil $				
Drought Supplies	0.0	236.7	3.1	658.4
Restoration Payment	1.1	3.0	1.6	0.0
Metering Cost	2.5	0.0	3.6	0.0
Drought Conservation	0.2	1.3	0.7	11.4
Comm/Ind Revenue	0.0	9.0	0.8	38.8
Comm/Ind Surplus	0.0	3.0	0.2	13.0
RGO Revenue	2.4	23.8	4.7	235.6
RGO Surplus	1.1	10.0	6.7	267.6
Water Cost Savings	-0.8	-36.3	-3.1	-237.6
TOTAL Cost/Yr, Mil $	**6.6**	**250.5**	**18.3**	**987.2**

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TABLE III-9

MUNICIPAL WATER COSTS
DIFFERENCE BETWEEN ALTERNATIVE 1 WITH TRANSFERS AND ALTERNATIVE 1 WITHOUT TRANSFERS (1)

Variable	Bay Area	Central & South Coast
AVERAGE CONDITION		
New Supplies, taf	0.5	31.0
New Supply Cost, Mil $	-0.7	-35.0
New Supply Cost $/af	-$332.0	-$64.0
% Retail Price Increase	-0.2%	-2.1%
Demand Reduction, taf	-0.5	-31.0
New 2020 Demand taf	1.0	31.0
DRY CONDITION		
Demand, taf	1.0	31.0
Supplies, taf	-1.0	-21.0
Shortage, taf	2.0	52.0
Shortage Allocation, taf		
RGO Drought Conservation	0.0	3.5
Comm/Ind Drought Conservation	0.0	0.0
Drought Supplies	-179.9	-313.2
Additional Transfers	181.4	361.8
Shortage Cost, Mil $		
Drought Supplies	-171.7	-395.8
Water Transfers	74.8	171.1
Drought Conservation	0.0	0.1
Comm/Ind Revenue	0.0	-0.7
Comm/Ind Surplus	-0.1	-0.1
RGO Revenue	-0.1	-2.8
RGO Surplus	0.0	-1.1
Water Cost Savings	-0.2	-11.4
TOTAL Cost/Yr, Mil $	**-97.3**	**-240.7**

NOTE:
(1) See Notes from Tables III-4 and III-5.

benefits of average condition transfers for the Central and South Coast Region are about the same as the base transfer scenario.

In the dry condition, the Bay Area eliminates its entire shortage, after drought conservation, with water transfers. Net cost savings from all transfers (not just CVPIA transfers) are $97 million (171.7-74.8). These savings are substantially more than in the base transfer scenario ($69.3 million, Table III-5) primarily because Alternative 1e reduces the price the Bay Area must pay for transfers. With some minor adjustments for revenue and economic surplus, total Bay Area annual savings from water transfers in the dry condition under Alternative 1e are estimated to be $97.3 million, of which $28 million (97.3-69.4) can be attributed to Alternative 1e actions, especially CVPIA water transfer provisions.

The Central and South Coast Region also pays a lower price for its dry condition water transfers, but cost savings from water transfers are not as great as in the base transfer scenario because Alternative 1e results in additional SWP supplies, so transfers are worth less in terms of costs avoided. In net, the cost savings from transfers are estimated to be $225 million, little more than the $210 million estimated in the base transfer scenario. With some minor adjustments for revenue and economic surplus, total Central and South Coast annual savings from water transfers in the dry condition under Alternative 1e are estimated to be $240.7 million. The value of CVPIA water transfer provisions to the Central and South Coast, given the water prices as affected by water acquisition and other hydrologic factors in Alternative 1e, is estimated to be about $37 million, this being the difference between the cost of transfers in the base transfer scenario and Alternative 1.

ALTERNATIVE 2

Alternative 2 is the same as Alternative 1 except that acquired water is purchased for fish and wildlife habitat in accordance with Section 3406(b)(3) of the CVPIA. It is assumed that the water acquisition program would be limited by funding available in the Restoration Fund. Water is acquired in the Sacramento River basin, and from the Stanislaus, Tuolumne, and Merced rivers to attempt to meet flow targets, primarily in April through June. Water is also acquired to meet Level 4 refuge water supply deliveries which represent the water needs for the long-term development of the refuges as described in the Refuge Water Supply Study and the San Joaquin Basin Action Plan.

Alternative 1 and 2 have identical M&I water delivery amounts and costs. The M&I economics results for Alternative 2 are identical to results for Alternative 1. Therefore, Table III-6 provides M&I economics results for Alternative 2, Table III-7 shows the difference between Alternative 2 and the No-Action Alternative, and Table III-8 shows results from the dry condition for Alternative 2 using an RGO demand elasticity of -0.1 instead of -0.2.

SUPPLEMENTAL ANALYSIS 2b: WATER TRANSFERS

Alternative 2 M&I supplies are the same as Alternative 1 supplies. However, Alternative 2 includes a different water acquisition program than Alternative 1, so water transfer prices can be affected. Therefore, M&I economics results for Alternative 2b differ slightly from Alternative 1e. Table III-10 shows results of the Alternative 2b analysis. Results are expressed as the difference between Alternative 2 and Alternative 2b. In comparison to Table III-5, results reflect the availability of CVP contract and exchange water for purchase, differences in water transfer prices due to differences in dedicated water and water acquisition, and incremental costs of M&I supplies as affected by the level of imported supplies.

In the average condition, the Bay Area, and Central and South Coast save about $640,000 and $33 million, respectively, due to the availability of water transfers in comparison to Alternative 2. The Bay Area saves more than in the base transfer scenario ($450,000, Table III-5), because there is more shortage to eliminate, so transfers are worth more, but the price of transfers is more ($151.5 per acre-foot at the treatment plant versus $144 in the base transfer scenario). Alternative 2b has a higher transfer price than Alternative 1e ($151.5 versus $116) so cost savings are less than those in Alternative 1.

The Central Coast and the South Coast must pay a higher price for average condition water transfers under Alternative 2b than in the base transfer scenario. The two subregions pay $192 and $285 per acre-foot, respectively, as compared to $176 and $268 in the base transfer scenario. Therefore, savings from water transfers are less. Still, these prices are substantially less than the cost of other alternative supplies which are near $1,000 per acre-foot in both subregions.

In the dry condition, the Bay Area eliminates its entire shortage, after drought conservation, with water transfers. Net cost savings from transfers are $94.1 million (171.7-77.6). These savings are substantially more than in the base transfer scenario ($69.3 million, Table III-5) because Alternative 2b reduces the price the Bay Area must pay for transfers. With some minor adjustments for revenue and economic surplus, total Bay Area annual savings from water transfers in the dry condition under Alternative 2b are estimated to be $94.4 million of which $25 million (94.4-69.4) can be attributed to Alternative 2b actions, especially CVPIA water transfer provisions.

The Central and South Coast Region also pays a lower price for its dry condition water transfers, but cost savings from water transfers are not as great as in the base transfer scenario because Alternative 2b results in additional SWP supplies, so transfers are worth less in terms of costs avoided. In net, the net cost savings from transfers are estimated to be $216 million (395.8-179.7), just more than the $210 million estimated in the base transfer scenario. With some minor adjustments for revenue and economic surplus, total Central and South Coast annual savings from water transfers in the dry condition under Alternative 2b are estimated to be $232 million. The value of CVPIA water transfer provisions to the Central and South Coast, given the water transfer prices as affected by water acquisition and other hydrologic factors in Alternative 2b, is estimated to be about $29 million, this being the difference between the cost of transfers in the base transfer scenario and Alternative 2b.

TABLE III-10

MUNICIPAL WATER COSTS
DIFFERENCE BETWEEN ALTERNATIVE 2 WITH TRANSFERS AND ALTERNATIVE 2 WITHOUT TRANSFERS (1)

Variable	Bay Area	Central & South Coast
AVERAGE CONDITION		
New Supplies, taf	0.5	30.0
New Supply Cost, Mil $ (2)	-0.6	-33.0
New Supply Cost $/af	-$297.0	-$61.0
% Retail Price Increase (3)	-0.2%	-2.0%
Demand Reduction, taf	-0.5	-30.0
New 2020 Demand taf	0.0	30.0
DRY CONDITION		
Demand, taf	0.0	30.0
Supplies, taf	-1.0	-22.0
Shortage, taf	1.0	52.0
Shortage Allocation, taf		
RGO Drought Conservation	0.0	3.3
Comm/Ind Drought Conservation	0.0	0.0
Drought Supplies	-179.9	-313.0
Transfers	181.4	361.8
Shortage Cost, Mil $		
Drought Supplies	-171.7	-395.8
Water Transfers	77.6	179.7
Drought Conservation	0.0	0.1
Comm/Ind Revenue	0.0	-0.7
Comm/Ind Surplus	0.1	-0.1
RGO Revenue	-0.1	-2.7
RGO Surplus	0.0	-1.1
Water Cost Savings	-0.2	-11.4
TOTAL Cost/Yr, Mil $	**-94.4**	**-232.0**

NOTE:
(1) See notes from Tables III-4 and III-5.

ALTERNATIVE 3

Alternative 3 includes the same assumptions for the M&I analysis as Alternative 2, with additional water acquisition for instream flow needs on the eastside Sacramento and San Joaquin River tributaries. Under Alternative 3, water acquired and released for instream flow can be diverted from the Delta for export to the San Joaquin Valley and Southern California, if consistent with other existing water quality and environmental restrictions.

Table III-11 shows results for Alternative 3. All regions except the San Joaquin Valley must develop new water supplies to meet 2020 average demands, and CVPIA costs also contribute to small percent retail price increases (1.1 percent to 9.7 percent) which reduce demand by an even smaller percentage. Under Alternative 3, the San Joaquin Valley obtains more imported supplies than under the No-Action Alternative, so the cost of supplies needed to meet 2020 demands is reduced.

All regions experience shortage in the dry condition. Most of the Central Valley regions do not require all available drought conservation to get through the drought, but the coastal groups do. The Bay Area and Central and South Coast groups develop 160,400 and 497,800 acre-feet of alternative supplies per year, respectively, to get through the dry condition.

Table III-12 shows the difference between Alternative 3 and the No-Action Alternative. In the average condition, all of the regions except the Sacramento Valley obtain more water supplies than in the No-Action Alternative. The Bay Area and San Joaquin Valley obtain both SWP and CVP supplies, and the increase in SWP supplies is greater than the decrease in CVP supplies.

The Sacramento Valley obtains about 3,000 acre-feet less CVP supply. In the Bay Area, the contractors who receive more water also have plentiful supplies, but the one contractor who receives less CVP water is water-short, creating a demand for about 300 more acre-feet of new developed supplies relative to the No-Action Alternative. The Central and South Coast obtains 168,000 acre-feet more SWP delivery than in the No-Action Alternative.

All regions except the Central and South Coast experience a net cost in the average condition relative to the No-Action Alternative, and most of these costs consist of metering and restoration payments. The Central and South Coast obtains an annual benefit of about $106 million in comparison to the No-Action Alternative which results entirely from the increase in water supplies.

In the dry condition, all of the regions except the Sacramento Valley obtain more water supplies than in the No-Action Alternative, and all four regions have less drought shortage as compared to the No-Action Alternative. The reduced drought shortage in the Sacramento Valley is caused by the increased retail price and reduced demand from the long-run condition, not by more supplies. In the San Joaquin Valley, about 13,000 acre-feet more of SWP supplies are obtained, but 13,700 acre-feet less are carried in from the average condition analysis. All regions are able to reduce their drought conservation programs and/or acquire less drought make-up water. The additional quantity of drought conservation in the Central and South Coast region occurs because the level of demand from the long-run analysis is larger, and the drought conservation as a fixed percent of this demand is larger.

Alternative 3 results in a net dry condition cost for Central Valley groups even though the amount of drought shortage is reduced. This is because the costs of restoration payments and meters exceed the benefits of increased water supply. The Bay Area experiences a net benefit from Alternative 3 in the dry condition because cost savings from reduced make-up water costs are far in excess of CVPIA restoration payment and metering costs, and the Central and South Coast benefits from increased supplies without any offsetting CVPIA costs.

TABLE III-11

MUNICIPAL WATER COSTS
ALTERNATIVE 3 RESULTS (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Supplies, taf (2)	930.0	1,098.0	716.0	5,078.0
Shortage, taf	-3.1	-72.7	-8.2	947.0
New Supplies, taf	0.4	2.1	-13.7	784.0
New Supply Cost, Mil$	0.1	1.1	-2.7	528.0
New Supply Cost $/af	115.0	520.0	196.0	674.0
% Retail Price Increase (3)	3.5	1.1	3.6	9.7
Demand Reduction, taf	7.9	1.9	5.5	164.0
New 2020 Demand taf	925.0	1,023.0	703.0	5,861.0
Restoration Payment, Mil$	1.4	3.4	1.7	0.0
Metering Cost, Mil $ (4)	2.5	0.0	3.6	0.0
DRY CONDITION (1928-1934 average hydrology)				
Demand, taf	1,003.0	1,132.0	711.0	6,076.0
Supplies, taf	991.0	908.0	662.0	5,002.0
Shortage, taf	12.0	224.0	50.0	1,074.0
% RGO Shortage, Min	0.8	5.9	3.6	11.1
% RGO Shortage, Max	7.6	5.9	14.5	13.5
Shortage Allocation, taf				
RGO Drought Conservation	12.2	46.3	29.8	495.3
Comm/Ind Drought Cons	0.0	17.6	5.1	81.1
Drought Supplies	0.0	160.4	14.8	497.8
Shortage Cost, Mil $				
Drought Supplies	0.0	149.2	3.0	558.5
Restoration Payment	1.1	3.1	1.6	0.0
Metering Cost	2.5	0.0	3.6	0.0
Drought Conservation	0.2	1.3	0.7	11.5
Comm/Ind Revenue	0.0	9.0	0.8	37.8
Comm/Ind Surplus	0.0	1.3	0.1	5.5
RGO Revenue	2.4	23.8	4.5	231.8
RGO Surplus	0.5	4.3	2.1	93.7
Water Cost Savings	-0.8	-33.4	-3.0	-235.6
TOTAL Cost/Yr, Mil $	**5.9**	**158.4**	**13.3**	**703.2**

NOTES:
(1) No M&I water transfers.
(2) A negative shortage is a supply surplus.
(3) Includes price increase caused by restoration payments and meters.
(4) Metering cost is based on $400 per meter and 5% O&M per year.
(5) A negative implies a benefit in comparison to the No-Action Alternative.

TABLE III-12

MUNICIPAL WATER COSTS DIFFERENCE BETWEEN ALTERNATIVE 3 AND NO-ACTION ALTERNATIVE (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Supplies, taf	-3.0	10.0	8.0	168.0
Shortage, taf	3.0	-9.7	-8.2	-168.0
New Supplies, taf	0.4	0.3	-13.7	-104.0
New Supply Cost, Mil $	0.1	0.2	-2.7	-106.0
New Supply Cost $/af	115.0	8.0	196.0	-40.0
% Retail Price Increase	3.5	0.9	3.6	-4.2
Demand Reduction, taf	7.9	1.4	5.5	-64.0
New 2020 Demand taf	-8.0	-1.0	-6.0	64.0
Restoration Payment, Mil $	1.4	3.4	1.7	0.0
Metering Cost, Mil $	2.5	0.0	3.6	0.0
Cost by End User				
Consumer Surplus Loss, Mil $	2.9	3.3	1.8	-77.3
Increased Cost to Comm & Ind, Mil $	2.0	1.5	1.4	-28.3
TOTAL Cost as Compared to No-Action Alternative, Mil $	4.90	4.72	3.23	-105.6
DRY CONDITION (1928-1934 average hydrology)				
Demand, taf	-8.0	-1.0	-6.0	64.0
Supplies, taf	-1.0	22.0	-1.0	112.0
Shortage, taf	-7.0	-23.0	-5.0	-48.0
% RGO Shortage, Min	-1.3	0.0	-0.7	0.0
% RGO Shortage, Max	-0.4	0.0	0.0	0.0
Shortage Allocation, taf				
RGO Drought Cons	6.8	-0.1	-1.6	7.1
Comm/Ind Drought Cons	0.0	0.0	-0.8	0.0
Drought Supplies	0.0	-23.3	-2.3	-55.0
Shortage Cost, Mil $				
Drought Supplies	0.0	-25.9	0.5	-121.1
Restoration Payment	1.1	3.1	1.6	0.0
Meters	2.5	0.0	3.6	0.0
Drought Conservation	-0.1	0.0	0.0	0.1
Comm/Ind Revenue	0.0	0.1	-0.2	-1.5
Comm/Ind Surplus	0.0	0.0	0.0	-0.2
RGO Revenue	-0.9	0.2	-0.2	-5.5
RGO Surplus	-0.1	0.0	-0.1	-2.2
Water Cost Savings	0.4	3.4	0.3	10.5
TOTAL Cost/Yr, Mil $	**2.8**	**-19.2**	**4.5**	**-119.9**

NOTE:
(1) The difference between Tables III-11 and III-2. See explanatory notes for these tables. A positive is an increase relative to the No-Action Alternative, a negative is a decrease.

SUPPLEMENTAL ANALYSIS 3a: WATER TRANSFERS

Table III-13 shows results of the Alternative 3a analysis. Results are expressed as the difference between the with- and without-transfer scenarios. In comparison to Table III-5, results reflect the availability of CVP contract and exchange water for purchase, differences in water transfer prices due to differences in agricultural water supply levels, and incremental costs of M&I supplies as affected by the level of imported supplies.

In the average condition, the Bay Area and Central and South Coast save about $590,000 and $30 million in comparison to Alternative 3. The Bay Area saves more than in the base transfer scenario ($450,000, Table III-5) because there is more shortage to eliminate, so transfers are worth more, and the price of transfers is less ($120.4 per acre-foot at the treatment plant versus $144 in the base transfer scenario).

The Central Coast must pay a higher price for average condition water transfers ($233.5 per acre-foot) under Alternative 3a than in the base transfer scenario ($176.2 per acre-foot). The South Coast pays about the same price. In either case, these prices are substantially less than the cost of other alternative supplies which are near $1,000 per acre-foot in both regions. The value of water transfers in the Central and South Coast in Alternative 3a ($30 million) is less than in the base transfer scenario ($36 million) primarily because, with more SWP supplies, the transfers are worth less in terms of cost avoided.

In the dry condition, the Bay Area eliminates its entire shortage, after drought conservation, with water transfers. The total amount of shortage in Alternative 3a is somewhat less than in the other Action Alternatives, so net savings from transfers are also less. Net cost savings from transfers are $76.6 million (149.2-72.6). These savings are more than in the base transfer scenario ($69.3 million) because Alternative 3a reduces the price the Bay Area must pay for transfers. With some minor adjustments for revenue and economic surplus, total Bay Area annual savings from water transfers in the dry condition under Alternative 3a are estimated to be $76.9 million of which $7.5 million (76.9-69.4) can be attributed to Alternative 3a actions, especially CVPIA water transfer provisions.

The Central and South Coast region also pays a lower price for its dry condition water transfers, but cost savings from water transfers are not as great as in the base transfer scenario because Alternative 3a results in additional SWP supplies, so transfers are worth less in terms of costs avoided. The net cost savings from transfers are estimated to be $188 million (373.1-184.9), less than the $210 million estimated in the base transfer scenario. With some minor adjustments for revenue and economic surplus, total Central and South Coast annual savings from water transfers in the dry condition under Alternative 3a are estimated to be $203.4 million. The value of CVPIA water transfer provisions to the Central and South Coast, given the water transfer prices as affected by water acquisition and other hydrologic factors in Alternative 3a, is estimated to be about $24 million, this being the difference between the cost of transfers in the base transfer scenario and Alternative 3a.

TABLE III-13

MUNICIPAL WATER COSTS
DIFFERENCE BETWEEN ALTERNATIVE 3 WITH TRANSFERS AND ALTERNATIVE 3 WITHOUT TRANSFERS (1)

Variable	Bay Area	Central & South Coast
AVERAGE CONDITION		
New Supplies, taf	0.4	29.0
New Supply Cost, Mil $	-0.6	-30.0
New Supply Cost $/af	-$325.0	-$61.0
% Retail Price Increase	-0.2%	-1.8%
Demand Reduction, taf	-0.4	-29.0
New 2020 Demand, taf	0.0	29.0
DRY CONDITION		
Demand, taf	0.0	29.0
Supplies, taf	-1.0	-22.0
Shortage, taf	1.0	51.0
Shortage Allocation, taf		
RGO Drought Conservation	0.0	3.2
Comm/Ind Drought Conservation	0.0	0.0
Drought Supplies	-160.4	-312.6
Transfers	161.7	360.4
Shortage Cost, Mil $		
Drought Supplies	-149.2	-373.1
Water Transfers	72.6	184.9
Drought Conservation	0.0	0.1
Comm/Ind Revenue	0.0	-0.6
Comm/Ind Surplus	-0.1	-0.1
RGO Revenue	-0.1	-2.4
RGO Surplus	0.0	-1.0
Water Cost Savings	-0.1	-11.2
TOTAL Cost/Yr, Mil $	**-76.9**	**-203.4**

NOTE:
(1) See notes from Tables III-4 and III-5.

ALTERNATIVE 4

Alternative 4 includes the same assumptions for the M&I analysis as Alternative 3, except that both dedicated water and acquired water are prescribed for in-Delta purposes, thereby reducing the ability of the CVP and SWP to export that water.

Table III-14 shows results for Alternative 4. All regions except the San Joaquin Valley must develop new water supplies to meet 2020 average demands, and CVPIA metering and restoration costs also contribute to small percent retail price increases which reduce demand by a small percentage.

All regions experience shortage in the dry condition. In general, the Central Valley regions do not require all available drought conservation to get through the drought, but the Coastal groups do. The Bay Area and Central and South Coast groups develop 189,000 and 544,000 acre-feet of make-up supplies per year, respectively, to get through the drought.

In comparison to the No-Action Alternative, all of the regions except the San Joaquin Valley must develop more long-run water supplies (Table III-15), ranging from hundreds of acre feet in the Sacramento Valley regions to 6,000 acre-feet in the Central and South Coast.

These amounts are generally quite small, being about one-tenth of one percent of demands. In the San Joaquin Valley, CVPIA cost increases reduce demand and therefore, the use of supplies. All of the regions must increase retail prices more than in the No-Action Alternative to cover costs of make-up water and other CVPIA costs, but the increase is less than 1 percent in the coastal regions. All regions experience a net cost in the average condition relative to the No-Action Alternative, and almost half of these costs consist of metering and restoration payments. Demands are reduced slightly in comparison to the No-Action Alternative.

This demand reduction carries into the dry condition, and all of the regions obtain about the same amount of water supplies in the dry condition as in the No-Action Alternative. Taken together, the need for drought conservation is reduced slightly in all regions. The Bay Area shows a small increase in its use of drought make-up supplies, but the Central and South Coast uses less.

Alternative 4 results in a small net dry condition cost, relative to the No-Action Alternative, for Central Valley groups and the Bay Area. In the Central Valley groups, the costs of restoration payments and meters exceed a small benefit from reduced shortage. The Bay Area shows a small net cost, consisting of increased water and restoration costs, and the Central and South Coast shows a small net benefit in the form of reduced make-up supply costs.

SUPPLEMENTAL ANALYSIS 4a: WATER TRANSFERS

Table III-16 shows results of the Alternative 4a. Results are expressed as the difference between the with- and without-transfer scenarios. In comparison to Table III-5, results reflect the availability of CVP contract and exchange water for purchase, differences in water transfer prices

TABLE III-14

MUNICIPAL WATER COSTS
ALTERNATIVE 4 RESULTS (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Supplies, taf (2)	930.0	1,075.0	706.0	4,901.0
Shortage, taf	3.5	-50.3	2.7	1,124.0
New Supplies, taf	0.5	2.5	-5.2	893.0
New Supply Cost, Mil $	0.1	1.3	-1.2	640.0
New Supply Cost $/af	115.0	523.0	224.0	716.0
% Retail Price Increase (3)	3.5	1.1	5.3	14.2
Demand Reduction, taf	7.9	2.1	7.8	231.0
New 2020 Demand taf	925.0	1,023.0	700.0	5,794.0
Restoration Payment, Mil $	1.4	3.6	1.7	0.0
Metering Cost, Mil $ (4)	2.5	0.0	3.6	0.0
DRY CONDITION				
(1928-1934 average hydrology)				
Demand, taf	1,003.0	1,132.0	709.0	6,009.0
Supplies, taf	991.0	879.0	656.0	4,896.0
Shortage, taf	12.0	253.0	53.0	1,113.0
% RGO Shortage, Min	0.8	5.9	4.1	11.1
% RGO Shortage, Max	7.5	5.9	14.5	13.5
Shortage Allocation, taf				
RGO Drought Cons	12.2	46.3	30.4	487.8
Comm/Ind Drought Cons	0.0	17.6	5.8	81.1
Drought Supplies	0.0	189.0	16.7	544.0
Shortage Cost, Mil $				
Drought Supplies	0.0	182.2	3.3	669.1
Restoration Payment	1.1	3.0	1.6	0.0
Meters	2.5	0.0	3.6	0.0
Drought Conservation	0.2	1.3	0.7	11.4
Comm/Ind Revenue	0.0	9.0	0.9	39.3
Comm/Ind Surplus	0.0	1.3	0.1	5.7
RGO Revenue	2.4	23.8	4.7	237.7
RGO Surplus	0.5	4.3	2.1	96.0
Water Cost Savings	-0.8	-37.6	-3.2	244.1
TOTAL Cost/Yr, Mil $	**5.9**	**187.2**	**14.0**	**815.1**

NOTES:
(1) No M&I water transfers.
(2) A negative shortage is a supply surplus.
(3) Price increase relative to existing conditions. Includes price increase caused by restoration payments and meters.
(4) Metering cost is based on $400 per meter and 5% O&M per year.

TABLE III-15

MUNICIPAL WATER COSTS DIFFERENCE BETWEEN ALTERNATIVE 4 AND NO-ACTION ALTERNATIVE (1)

Variable	Sacramento Valley	Bay Area	San Joaquin Valley	Central & South Coast
AVERAGE CONDITION				
Supplies, taf	-3.0	-13.0	-3.0	-9.0
Shortage, taf	3.4	12.7	2.6	9.0
New Supplies, taf	0.5	0.7	-5.2	6.0
New Supply Cost, Mil $	0.1	0.4	-1.1	6.0
New Supply Cost, $/af	115.0	11.0	224.0	2.0
% Retail Price Increase	3.5	0.9	5.3	0.2
Demand Reduction, taf	7.9	1.6	7.8	4.0
New 2020 Demand, taf	-8.0	-2.0	-8.0	-4.0
Restoration Payment, Mil $	1.4	3.6	1.7	0.0
Metering Cost, Mil $	2.5	0.0	3.6	0.0
Cost by End User				
Consumer Surplus Loss, Mil $	2.9	3.4	2.7	4.4
Increased Cost to Comm & Ind., Mil $	2.0	1.5	2.3	1.6
TOTAL Cost as Compared to No-Action Alternative, Mil $	4.9	4.9	5.0	6.1
DRY CONDITION (1928-1934 average hydrology)				
Demand, taf	-8.0	-2.0	-8.0	-4.0
Supplies, taf	-1.0	-7.0	-6.0	6.0
Shortage, taf	-7.0	5.0	-2.0	-9.0
% RGO Shortage, Min	-1.3	0.0	-0.3	-0.0
% RGO Shortage, Max	-0.5	0.0	-0.0	-0.0
Shortage Allocation, taf				
RGO Drought Cons	6.8	-0.1	-1.0	-0.4
Comm/Ind Drought Cons	0.0	0.0	-0.1	0.0
Drought Supplies	0.0	5.3	-0.4	-8.8
Shortage Cost, Mil $				
Drought Supplies	0.0	7.1	-0.1	-10.5
Restoration Payment	1.1	3.0	1.6	0.0
Meters	2.5	0.0	3.6	0.0
Drought Conservation	-0.1	0.0	-0.0	0.0
Comm/Ind Revenue	0.0	0.1	0.0	0.1
Comm/Ind Surplus	0.0	0.0	0.0	0.0
RGO Revenue	-0.9	0.2	-0.0	0.3
RGO Surplus	-0.2	0.0	-0.0	0.1
Water Cost Savings	0.4	-0.8	0.1	2.0
TOTAL Cost/Yr, Mil $	**2.8**	**9.5**	**5.1**	**-8.0**

NOTE:
(1) The difference between Tables III-14 and III-2. See explanatory notes for these tables. A positive is an increase relative to The No-Action Alternative, a negative is a decrease.

TABLE III-16

MUNICIPAL WATER COSTS
DIFFERENCE BETWEEN ALTERNATIVE 4 WITH TRANSFERS AND ALTERNATIVE 4 WITHOUT TRANSFERS (1)

Variable	Bay Area	Central & South Coast
AVERAGE CONDITION		
New Supplies, taf	0.5	30.0
New Supply Cost, Mil $	-0.6	-35.0
New Supply Cost, $/af	-$300.0	-$62.0
% Retail Price Increase	-0.2%	-2.1%
Demand Reduction, taf	-0.5	-30.0
New 2020 Demand, taf	0.0	30.0
DRY CONDITION		
Demand, taf	0.0	30.0
Supplies, taf	-1.0	-22.0
Shortage, taf	1.0	53.0
Shortage Allocation, taf		
RGO Drought Conservation	0.0	3.4
Comm/Ind Drought Cons	0.0	0.0
Drought Supplies	-189.0	-313.7
Transfers	190.5	362.9
Shortage Cost, Mil $		
Drought Supplies	-182.2	-417.3
Water Transfers	89.4	193.1
Drought Conservation	0.0	0.1
Comm/Ind Revenue	0.0	-0.7
Comm/Ind Surplus	-0.1	-0.1
RGO Revenue	-0.1	-2.8
RGO Surplus	0.0	-1.2
Water Cost Savings	-0.2	-11.5
TOTAL Cost/Yr, Mil $	**-93.1**	**-240.4**

NOTE:
(1) See notes from Tables III-4 and III-5.

due to differences in agricultural water supply levels, and incremental costs of M&I supplies as affected by the level of imported supplies.

In the average condition, the Bay Area and Central and South Coast save about $650,000 and $35 million due to the availability of water transfers in comparison to Alternative 4. The Bay Area saves more than in the base transfer scenario ($450,000, Table III-5) because there is more shortage to eliminate, so transfers are worth more. The price of transfers is about the same ($148.1 per acre-foot at the treatment plant) as in the base transfer scenario ($143.9).

The Central and South Coast must pay higher prices for average condition water transfers ($255.6 and $290.1 per acre-foot, respectively) under Alternative 4a than in the base transfer scenario ($176.2 and $267.8 per acre-foot). Still, these prices are substantially less than the cost of other alternative supplies which are near $1,000 per acre-foot in both regions.

In the dry condition, the Bay Area eliminates its entire shortage, after drought conservation, with water transfers. Net cost savings from transfers are $92.8 million (182.2-89.4). These savings are substantially more than in the base transfer scenario ($69.3 million, Table III-5) because Alternative 4a reduces the price the Bay Area must pay for transfers, and there is more shortage to eliminate. The dry condition price of transfers for the Bay Area in Alternative 4a is larger than in any other water transfer supplemental analysis Alternative. With some minor adjustments for revenue and economic surplus, total Bay Area annual savings from water transfers in the dry condition under Alternative 4a are estimated to be $93.1 million. of which $24 million (93.1-69.4) can be attributed to Alternative 4a actions, especially CVPIA water transfer provisions.

The Central and South Coast region pays a lower price for its dry condition water transfers, relative to the base transfer scenario, but cost savings from water transfers are about the same as in the base transfer scenario. The net cost savings from transfers are estimated to be $224.2 million (417.3-193.1), just more than the $210 million estimated in the base transfer scenario. With some minor adjustments for revenue and economic surplus, total Central and South Coast annual savings from water transfers in the dry condition under Alternative 4a are estimated to be $240.5 million. The value of CVPIA water transfer provisions to the Central and South Coast, given the water prices as affected by water acquisition and other hydrologic factors in Alternative 4a, is estimated to be about $16 million, this being the difference between the cost of transfers in the base transfer scenario and Alternative 4a.

CHAPTER IV

BIBLIOGRAPHY

Chapter IV

BIBLIOGRAPHY

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Attachment A

EXPLANATION OF MUNICIPAL WATER TRANSFER ANALYSIS AND COMPLETE DISPLAY OF MUNICIPAL WATER USE AND COSTS, WITH TRANSFERS, DIFFERENCE FROM BASE TRANSFER SCENARIO

Attachment A

EXPLANATION OF MUNICIPAL TRANSFER ANALYSIS AND COMPLETE DISPLAY OF SUPPLEMENTAL ANALYSIS MUNICIPAL WATER USE AND COSTS, DIFFERENCE FROM BASE TRANSFER SCENARIO

This attachment expands on information about municipal water transfers provided in the Water Transfers Technical Appendix. Especially, results of Alternatives 1e, 2b, 3a, and 4a are expressed as the difference from the base transfer scenario. Tables A-1 through A-4 show results of each alternative in terms of the difference from the base transfer scenario. Results of the base transfer scenario were discussed in the main body of this technical appendix.

The differences between the base transfer scenario and the four alternatives involve CVPIA-related costs of CVP water supplies, the price of water available for transfer, and the quantity of CVP and SWP water supplies. Water prices can be affected by the size of the water acquisition program and by the availability of CVP contract and exchange water in the action alternatives. In general, more water acquisition increases water prices. On the other hand, CVP water service contract water and exchange water may not be transferred in the base transfer scenario, but these supplies can be transferred in any supplemental action alternative. When these supplies are less expensive than those used in the base transfer scenario, transfer prices can be reduced. Finally, the value of transfers is affected by the cost avoided by buying them, and this cost is a function of the SWP supply levels which vary by alternative.

There is no difference between supplemental alternatives in initial M&I water price or demand, and initial supplies and shortage reflect results of the hydrologic models. Quantities of transfers taken are related to shortage in the Central Coast and Bay Area. Most of the difference in the cost of new supplies between the alternatives and the base transfer scenario is related to the amount of shortage eliminated, not the price of transfers.

The price of transfers affects the cost per acre-foot of new supplies. For the average condition, transfer price is generally reduced in Alternatives 1e and 3a, and increased in Alternatives 2b and 4a, relative to the base transfer scenario. In Table A-2 (Alternative 2b), the cost per acre-foot of new supplies in the Central and South Coast is reduced because the reduced cost of other supplies exceeds the increased cost of transfers. Overall, two of the factors in the alternatives that affect transfers – the availability of CVP contract and exchange supplies for transfer and the water acquisition program – have little net effect on average condition economics. In the Bay Area, much of the difference in economic costs between the base transfer scenario and the action alternatives involves restoration payments. In the Central and South Coast, much of the difference involves changes in SWP supplies.

CVPIA transfer provisions have a much larger effect in the dry condition. Transfer prices paid are lower than the base transfer scenario in every supplemental action alternative. In the Bay Area, 20,600 acre-feet of make-up supplies developed in the base transfer scenario are replaced with less expensive transfers in all four supplemental alternatives, saving $15.5 million. The cost of transfers declines by $15.6, $12.7, $17.7, and $0.9 million in Alternatives 1e, 2b, 3a, and 4a, respectively; and total costs decline by $14.2 million (Alternative 4a) to $27.5 million (Alternative 1e) annually. In the Central and South Coast, a combination of increased SWP supplies and reduced transfer prices generates benefits of $21.8 million (Alternative 4a) to $96.7 million (Alternative 3a) annually.

The share of these savings attributable to CVPIA water transfer provisions, given that water prices are affected by water supply levels, water acquisition, and water transfers in each alternative, can be roughly estimated. In the average condition, CVPIA water transfer provisions, in combination with these other factors, have no benefit in Alternative 2b because any price benefit of the water transfer provisions is more than offset by higher water prices caused by the other factors. In Alternative 1e, small benefits are obtained in the average condition. In the Central and South Coast, the benefit is about $1.0 million. The Bay Area obtains a small benefit in Alternative 3a because transfer price is reduced ($120 instead of $144 in the base transfer scenario), but the Central and South Coast pays about the same price as in the base transfer scenario. CVPIA water transfer provisions have no benefit in Alternative 4a because water transfer prices are higher than in the base transfer scenario average condition.

In the dry condition, lower water prices caused by CVPIA water transfer provisions have more substantial benefits. In the Bay Area, cost savings are estimated as the cost savings on the base transfer scenario level of transfers from reduced transfer prices, plus cost savings on other make-up supplies avoided by substitution to transfers, minus the cost of the transfers that substitute for the other make-up supplies. For Alternatives 1e, 2b, 3a, and 4a, these values are $30, $28, $18, and $20 million, respectively. In the Central and South Coast, there is no substitution effect and the amount of dry-condition transfers is nearly the same regardless of alternative. Dry-condition cost savings in Alternatives 1e through 4a are estimated to be $37, $28, $22, and $16 million, respectively.

TABLE A-1

MUNICIPAL WATER COSTS SUPPLEMENTAL ANALYSIS 1e, ALTERNATIVE 1e, BASE TRANSFER SCENARIO AND DIFFERENCE

	Bay Area			Central and South Coast		
Variable	Alternative 1e	Base	Difference	Alternative 1e	Base	Difference
AVERAGE CONDITION						
Min Retail Price, $/af	$401	$401	$0	$418	$418	$0
Max Retail Price, $/af	$591	$591	$0	$1,347	$1,347	$0
Demand, taf	1,025	1,025	0	6,025	6,025	0
Supplies, taf (1)	1,082	1,088	(6)	4,961	4,910	51
Shortage, taf (2)	(57)	(63)	6	1,064	1,115	(51)
New Supplies, taf (3)	3.0	2.1	0.9	887	919	(32)
Transfers	3.0	2.1	0.9	104	105	(1)
New Supply Cost, Mil $ (4)	0.58	0.47	0.12	566	597	(31)
New Supply Cost, $/af	191	219	(28)	638	650	(12)
% Retail Price Increase	0.9%	0.1%	0.8%	10.5%	11.8%	-1.2%
Demand Reduction, taf (5)	1.5	0.2	1.4	176.8	196.1	(19.3)
New 2020 Demand, taf	1,024	1,025	(1)	5,848	5,829	19
Restoration Payment, Mil $	3.37	0.00	3.37	0.00	0.00	0.00
DRY CONDITION						
Demand, taf	1,132	1,134	(1)	6,063	6,044	19
Supplies, taf	887	885	2	4,928	4,869	59
Shortage, taf	245	249	(3)	1,135	1,175	(40)
% RGO Shortage, Min (6)	5.9%	5.9%	0.0%	11.1%	11.1%	0.0%
% RGO Shortage, Max	5.9%	5.9%	0.0%	13.5%	13.5%	0.0%
Shortage Allocation, taf						
RGO Drought Conservation	46.4	46.5	(0.1)	493.8	491.7	2.1
Comm/Ind Drought Cons (7)	17.6	17.6	0.0	81.1	81.1	0.0
Make-up Supplies (8)	0.0	20.6	(20.6)	198.4	238.8	(40.4)
Water Transfers	181.4	164.2	17.2	361.8	363.1	(1.3)
Shortage Cost, Mil $						
Make-up Supplies	0.0	15.5	(15.5)	211.0	260.4	(49.4)
Water Transfers (9)	74.8	90.3	(15.6)	171.1	209.1	(38.0)
Restoration Payment	3.0	0.0	3.0	0.0	0.0	0.0
Drought Conservation	1.3	1.3	0.0	11.5	11.5	0.0
RGO Revenue (10)	9.0	8.9	0.0	38.0	38.5	(0.4)
RGO Surplus	1.3	1.3	0.0	5.6	5.6	(0.1)
Comm//Ind Revenue	23.7	23.6	0.1	232.8	234.4	(1.6)
Comm/Ind Surplus	4.2	4.2	0.0	94.1	94.7	(0.6)
Water Cost Savings (11)	(36.5)	(36.9)	0.4	(248.9)	(257.6)	8.6
TOTAL Cost/Yr, Mil $	**80.7**	**108.3**	**(27.5)**	**515.1**	**596.5**	**(81.4)**

NOTES:
(1) Supplies from Bulletin 160-93 and hydrologic models.
(2) Supply minus demand. A negative means excess supply.
(3) In the Bay Area, one provider in the group has shortage.
(4) Includes transfers. Costs include treatment and distribution.
(5) Demand is reduced by the higher price needed to pay for new supplies.
(6) Percent drought conservation imposed on RG0 customers. Min and max is the minimum and maximum of providers in the group.
(7) Comm/Ind is commerce and industry.
(8) Make-up supplies do not include transfers.
(9) Cost delivered to end users includes treatment and delivery cost.
(10) Water sales revenue lost because of drought water conservation.
(11) Reduction in water costs due to original drought shortage.

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TABLE A-2

MUNICIPAL WATER COSTS SUPPLEMENTAL ANALYSIS 2b, ALTERNATIVE 2b, BASE TRANSFER SCENARIO AND DIFFERENCE (1)

	Bay Area			Central and South Coast		
Variable	Alternative 2b	Base	Difference	Alternative 2b	Base	Difference
AVERAGE CONDITION						
Min Retail Price, $/af	$401	$401	$0	$418	$418	$0
Max Retail Price, $/af	$591	$591	$0	$1,347	$1,347	$0
Demand, taf	1,025	1,025	0	6,025	6,025	0
Supplies, taf	1,082	1,088	(6)	4,961	4,910	51
Shortage, taf	(57)	(63)	6	1,064	1,115	(51)
New Supplies, taf	3.0	2.1	0.9	886	919	(33)
Transfers	3.0	2.1	0.9	104	105	(1)
New Supply Cost, Mil $	0.68	0.47	0.21	568	597	(30)
New Supply Cost, $/af	227	219	8	641	650	(9)
% Retail Price Increase	0.9%	0.1%	0.9%	10.6%	11.8%	-1.2%
Demand Reduction, taf	1.6	0.2	1.4	178.2	196.1	(17.9)
New 2020 Demand, taf	1,024	1,025	(1)	5,847	5,829	18
Restoration Payment, Mil $	3.37		3.37	0.00		0.00
DRY CONDITION						
Demand, taf	1,132	1,134	(1)	6,062	6,044	18
Supplies, taf	887	885	2	4,927	4,869	57
Shortage, taf	245	249	(3)	1,135	1,175	(39)
% RGO Shortage, Min	5.9%	5.9%	0.0%	11.1%	11.1%	0.0%
% RGO Shortage, Max	5.9%	5.9%	0.0%	13.5%	13.5%	0.0%
Shortage Allocation, taf						
RGO Drought Conservation	46.4	46.5	(0.1)	493.7	491.7	2.0
Comm/Ind Drought Cons	17.6	17.6	0.0	81.1	81.1	0.0
Make-up Supplies	0.0	20.6	(20.6)	198.6	238.8	(40.2)
Water Transfers	181.4	164.2	17.2	361.8	363.1	(1.3)
Shortage Cost, Mil $						
Make-up Supplies	0.0	15.5	(15.5)	210.9	260.4	(49.5)
Water Transfers	77.6	90.3	(12.7)	179.7	209.1	(29.4)
Restoration Payment	3.0	0.0	3.0	0.0	0.0	0.0
Drought Conservation	1.3	1.3	0.0	11.5	11.5	0.0
Comm/Ind Revenue	9.0	8.9	0.0	38.1	38.5	(0.4)
Comm/Ind Surplus	1.3	1.3	0.0	5.6	5.6	(0.1)
RGO Revenue	23.7	23.6	0.1	232.9	234.4	(1.5)
RGO Surplus	4.2	4.2	0.0	94.1	94.7	(0.6)
Water Cost Savings	(36.5)	(36.9)	0.4	(248.9)	(257.6)	8.6
TOTAL Cost/Yr, Mil $	**83.6**	**108.3**	**(24.7)**	**523.8**	**596.5**	**(72.7)**

NOTE:
(1) See notes from Table A-1.

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TABLE A-3

MUNICIPAL WATER COSTS SUPPLEMENTAL ANALYSIS 3a
ALTERNATIVE 3a, BASE TRANSFER SCENARIO AND DIFFERENCE (1)

	Bay Area			Central and South Coast		
Variable	Alternative 3a	Base	Difference	Alternative 3A	Base	Difference
AVERAGE CONDITION						
Min Retail Price, $/af	$401	$401	$0	$418	$418	$0
Max Retail Price, $/af	$591	$591	$0	$1,347	$1,347	$0
Demand, taf	1,025	1,025	0	6,025	6,025	0
Supplies, taf	1,098	1,088	10	5,078	4,910	168
Shortage, taf	(73)	(63)	(10)	947	1,115	(168)
New Supplies, taf	2.5	2.1	0.4	812	919	(107)
Transfers	2.5	2.1	0.4	102	105	(3)
New Supply Cost, Mil $	0.49	0.47	0.02	498	597	(100)
New Supply Cost, $/af	195	219	(24)	613	650	(37)
% Retail Price Increase	0.9%	0.1%	0.8%	7.9%	11.8%	-3.9%
Demand Reduction, taf	1.5	0.2	1.3	134.8	196.1	(61.2)
New 2020 Demand, taf	1,024	1,025	(1)	5,890	5,829	61
Restoration Payment, Mil $	3.44	0.00	3.44	0.00	0.00	0.00
DRY CONDITION						
Demand, taf	1,132	1,134	(1)	6,105	6,044	61
Supplies, taf	907	885	22	4,980	4,869	111
Shortage, taf	226	249	(23)	1,125	1,175	(50)
% RGO Shortage, Min	5.9%	5.9%	0.0%	11.1%	11.1%	0.0%
% RGO Shortage, Max	5.9%	5.9%	0.0%	13.5%	13.5%	0.0%
Shortage Allocation, taf						
RGO Drought Conservation	46.4	46.5	(0.1)	498.5	491.7	6.8
Comm/Ind Drought Cons	17.6	17.6	0.0	81.1	81.1	0.0
Make-up Supplies	0.0	20.6	(20.6)	185.2	238.8	(53.6)
Water Transfers	161.7	164.2	(2.5)	360.4	363.1	(2.7)
Shortage Cost, Mil $						
Make-up Supplies	0.0	15.5	(15.5)	185.4	260.4	(74.9)
Water Transfers	72.6	90.3	(17.7)	184.9	209.1	(24.2)
Restoration Payment	3.1	0.0	3.1	0.0	0.0	0.0
Drought Conservation	1.3	1.3	0.0	11.6	11.5	0.1
Comm/Ind Revenue	9.0	8.9	0.0	37.1	38.5	(1.3)
Comm/Ind Surplus	1.3	1.3	0.0	5.4	5.6	(0.2)
RGO Revenue	23.7	23.6	0.1	229.4	234.4	(5.0)
RGO Surplus	4.2	4.2	0.0	92.7	94.7	(2.0)
Water Cost Savings	(33.6)	(36.9)	3.4	(246.8)	(257.6)	10.8
TOTAL Cost/Yr, Mil $	**81.6**	**108.3**	**(26.6)**	**499.8**	**596.5**	**(96.7)**

NOTE:
(1) See notes from Table A-1.

TABLE A-4

MUNICIPAL WATER COSTS SUPPLEMENTAL ANALYSIS 4a, ALTERNATIVE 4a, BASE TRANSFER SCENARIO, AND DIFFERENCE (1)

	Bay Area			Central and South Coast		
Variable	Alternative 4A	Base	Difference	Alternative 4A	Base	Difference
AVERAGE CONDITION						
Min Retail Price, $/af	$401	$401	$0	$418	$418	$0
Max Retail Price, $/af	$591	$591	$0	$1,347	$1,347	$0
Demand, taf	1,025	1,025	0	6,025	6,025	0
Supplies, taf	1,075	1,088	(13)	4,901	4,910	(9)
Shortage, taf	(50)	(63)	13	1,124	1,115	9
New Supplies, taf	3.0	2.1	0.9	924	919	5
Transfers	3.0	2.1	0.9	105	105	0
New Supply Cost, Mil $	0.67	0.47	0.20	604	597	7
New Supply Cost, $/af	223	219	4	654	650	5
% Retail Price Increase	0.9%	0.1%	0.9%	12.1%	11.8%	0.3%
Demand Reduction, taf	1.6	0.2	1.4	200.7	196.1	4.6
New 2020 Demand, taf	1,024	1,025	(1)	5,824	5,829	(5)
Restoration Payment, Mil $	3.35		3.35	0.00		0.00
DRY CONDITION						
Demand, taf	1,132	1,134	(1)	6,039	6,044	(5)
Supplies, taf	878	885	(7)	4,874	4,869	5
Shortage, taf	254	249	6	1,165	1,175	(9)
% RGO Shortage, Min	5.9%	5.9%	0.0%	11.1%	11.1%	0.0%
% RGO Shortage, Max	5.9%	5.9%	0.0%	13.5%	13.5%	0.0%
Shortage Allocation, taf						
RGO Drought Conservation	46.4	46.5	(0.1)	491.2	491.7	(0.5)
Comm/Ind Drought Cons	17.6	17.6	0.0	81.1	81.1	0.0
Make-up Supplies	0.0	20.6	(20.6)	230.3	238.8	(8.4)
Water Transfers	190.5	164.2	26.3	362.9	363.1	(0.2)
Shortage Cost, Mil $						
Make-up Supplies	0.0	15.5	(15.5)	251.8	260.4	(8.5)
Water Transfers	89.4	90.3	(0.9)	193.1	209.1	(16.0)
Restoration Payment	3.0	0.0	3.0	0.0	0.0	0.0
Drought Conservation	1.3	1.3	0.0	11.4	11.5	0.0
Comm/Ind Revenue	9.0	8.9	0.0	38.6	38.5	0.1
Comm/Ind Surplus	1.3	1.3	0.0	5.6	5.6	0.0
RGO Revenue	23.7	23.6	0.1	234.8	234.4	0.4
RGO Surplus	4.2	4.2	0.0	94.9	94.7	0.2
Water Cost Savings	(37.8)	(36.9)	(0.8)	(255.6)	(257.6)	2.0
TOTAL Cost/Yr, Mil $	**94.1**	**108.3**	**(14.2)**	**574.7**	**596.5**	**(21.8)**

NOTE:
(1) See notes from Table A-1.

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CENTRAL VALLEY PROJECT IMPROVEMENT ACT PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

DRAFT TECHNICAL APPENDIX

Regional Economics

September 1997

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LIST OF ABBREVIATIONS AND ACRONYMS

Bay Region	San Francisco Bay Region
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CVPM	Central Valley Production Model
Delta	Sacramento-San Joaquin Delta
DWR	California Department of Water Resources
FIRE	finance, insurance and real estate
Interior	U.S. Department of the Interior
M&I	municipal and industrial
NEPA	National Environmental Policy Act
PEIS	Programmatic Environmental Impact Statement
POW	place of work
Reclamation	U.S. Bureau of Reclamation
Secretary	Secretary of the Department of Interior
Service	U.S. Fish and Wildlife Service
SIC	Standard Industrial Classification
SWP	State Water Project
SWRCB	State Water Resources Control Board
TCU	transportation, communications, and utilities
USGS	U.S. Geological Survey

CHAPTER I

INTRODUCTION

Chapter I

INTRODUCTION

The Draft Programmatic Environmental Impact Statement (PEIS) summarizes the evaluation of the direct and indirect impacts of implementing a wide range of actions identified in the Central Valley Project Improvement Act (CVPIA). Details of the information used in the definition of the affected environment and analysis of the environmental consequences are presented in the technical appendices of the Draft PEIS.

This technical appendix presents a summary of regional economics throughout California, including background information that was used during the PEIS preparation, and the results of the impact analyses for conditions that occurred throughout the study area, shown in Figure I-1.

The regional economics analysis was primarily based upon changes in agricultural economics, recreation economics, and the cost of water to agricultural and municipal users. Information from the Agricultural Economics and Land Use; Fish, Wildlife, and Recreation Economics; and Municipal Water Cost technical appendices was used in the development of this technical appendix.

The assumptions and results of the analyses for Alternatives 1, 2, 3, and 4 are presented in this technical appendix and summarized in the Draft PEIS. The assumptions related to the regional economics analyses for Alternatives 1, 2, 3, and 4 are presented in Table I-1. The results of the analyses are presented in Table I-2.

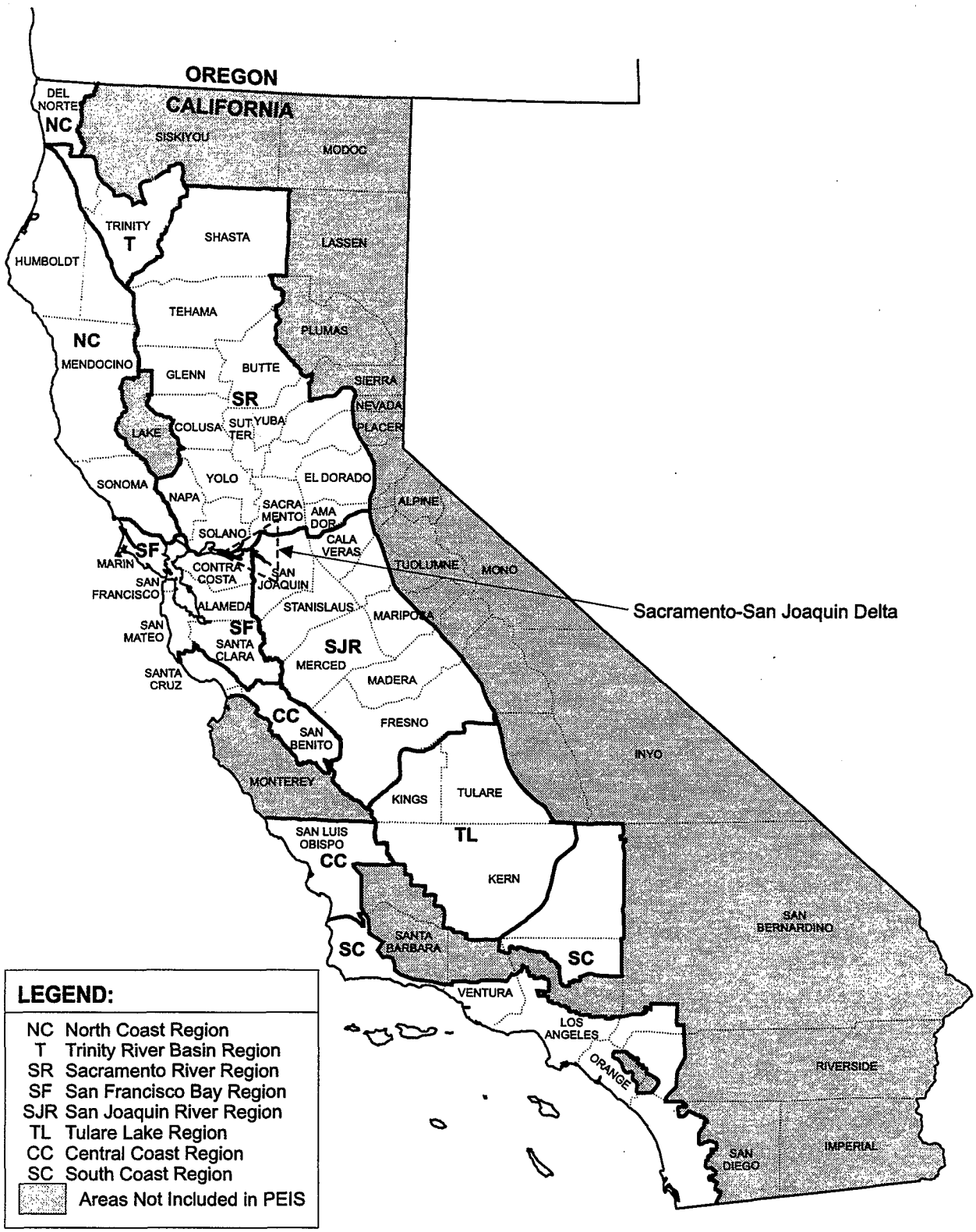

FIGURE I-1
STUDY AREA

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TABLE I-1

SUMMARY OF ASSUMPTIONS FOR REGIONAL ECONOMICS ANALYSES

Alternative or Supplemental Analyses	Assumptions
No-Action Alternative	For purposes of impact assessment, the structure of the No-Action Alternative regional economy is assumed to be similar to Recent Conditions.
1	Recent Conditions technology and trade patterns are assumed suitable for 2020 conditions. Direct impacts are reduced agricultural value of output from land fallow, reduced agricultural net income from increased water prices, increased agricultural net income from water sales, all from the Agricultural Economics and Land Use TA; increased recreation expenditures from Fish, Wildlife, and Recreation Economics TA, and change in disposable income of retail customers of municipal water users from Municipal Water Costs TA.
2	Same as Alternative 1, but using direct impacts estimated for Alternative 2.
3	Same as Alternative 1, but using direct impacts estimated for Alternative 3.
4	Same as Alternative 1, but using direct impacts estimated for Alternative 4.

TABLE I-2

SUMMARY OF IMPACT ASSESSMENT OF REGIONAL ECONOMICS

No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
	Change from No-Action Alternative			
1991 economic data provided as basis for comparison.	Annual statewide loss of $183 million output, $80 million personal income, and 2,790 jobs. Adverse impacts concentrated in the CVP water service areas, and some benefits to South Coast Region. Significant portions of the regional losses would be offset by positive but temporary impacts from construction of restoration structures and habitat.	Annual statewide loss of $241 million output, $100 million personal income, and 3,550 jobs. Adverse impacts concentrated in the CVP water service areas, and some benefits to South Coast Region. Significant portions of the regional losses would be offset by positive but temporary impacts from construction of restoration structures and habitat.	Annual statewide loss of $143 million output, $26 million personal income, and 2,060 jobs. Adverse impacts in CVP water service areas, and large benefits to South Coast Region. Significant portions of the regional losses would be offset by positive but temporary impacts from construction of restoration structures and habitat.	Annual loss of $457 million output, $194 million personal income, and 6,540 jobs. Adverse impacts concentrated in CVP water service areas. Significant portions of the regional losses would be offset by positive but temporary impacts from construction of restoration structures and habitat.

CHAPTER II

AFFECTED ENVIRONMENT

Chapter II

AFFECTED ENVIRONMENT

INTRODUCTION

This chapter reviews the economic environment that could be affected by implementation of the CVPIA. Implementation of the CVPIA is expected to have varied effects on water costs and water supplies, which in turn could cause direct impacts in sectors of regional economies that depend intensively upon water, including agriculture, commercial fishing, sport fishing, other recreation, power generation, and municipal and industrial growth and development. Each effect has economic dimensions, and the regional economic analysis combines these respective dimensions, for each alternative, into measures that allow for comparison among alternatives in Chapter III.

Following a brief discussion of the study area regions and the data sources used in this analysis is a historical perspective of economic development in California. The historical perspective sets the stage for the description of the regional economic baseline condition. The 1991 IMPLAN database was the most current database available at the time that the models were developed for the PEIS analysis. The baseline data summarizes the final demand, total industry output, and employment for the major industries in each of the study regions.

In the final section, a more detailed discussion of employment is provided by study region. Employment is broken down into the major industries in each region including but not limited to the agricultural, manufacturing, and services sectors.

STUDY AREA

The PEIS study area regions used for the analysis are those in which the CVPIA alternatives are expected to have economic effects, as shown in Figure I-1, with one exception. The assessment of regional effects of changes in municipal water costs uses a central coast region which consists of San Luis Obispo and Santa Barbara counties.

Each region is unique in terms of industrial, resource, demographic, and other characteristics. Each region is also unique in terms of its degree of economic integration within its boundaries and with other regions as well as its sensitivity to economic and demographic changes at the state and federal levels. Accordingly, as California has grown historically, regions have grown at different rates and in different ways.

In some cases, county boundaries do not match the PEIS study area boundaries. For example, some of the counties covering the Sierra foothills and the eastern edge of the Central Valley extend beyond the Sacramento River Region and San Joaquin River Region boundaries. However, data for these counties are not disaggregated for this analysis because most of the

population within these counties is in the PEIS study area and because little economic data at the sub-county level is available.

DATA SOURCES

This study utilizes regional economic models developed using IMPLAN software to estimate economic impacts. (See IMPLAN Methodology/Modeling Technical Appendix.) IMPLAN in turn is based on many secondary sources of data at the federal, state, and county levels. Some of these are identical to those utilized explicitly in the regional economic analysis, for example the Census of Agriculture. Others are taken from different sources. The IMPLAN database and other sources, e.g., California Employment Development Department for employment estimates, were compared and validated prior to usage of the models for regional analysis.

Data used in the regional economic analysis are taken from several government sources, both federal and state. The Census of Agriculture (U.S. Department of Commerce, Bureau of the Census, 1994) is used for information on land in farms and land in irrigated farms. Reports of the County Agricultural Commissioners (1993) are used for information on acreage and value of production by type of crop. Data from the California Employment Development Department (1994) are used to analyze changes in sectoral employment within regions.

HISTORICAL PERSPECTIVE

POPULATION

Between 1940 and 1992, the population of California grew at a 2.9 percent compound annual rate, while that of the U.S. grew at a 1.3 percent rate (California Department of Finance, 1995). Growth in California was stimulated by such factors as the "baby boom" following World War II, expanded job opportunities in electronics and defense-related sectors, and climate and other quality of life considerations in California.

AGRICULTURE

Agriculture in California has progressed through several distinct phases, and some of the earliest influences are still present today (Branch and Poremba, 1990 and the U.S. Bureau of Reclamation [Reclamation], 1949). The first phase was in the early to mid-1800s and was characterized by land-extensive cattle grazing and the beginning of grain farming. The second phase began in the 1860s with the further expansion of grain production and the first significant development of water supplies that allowed the irrigation of previously unirrigated areas. The third phase was in the late 1800s and early 1900s, a period during which irrigated agriculture expanded farther south in the Central Valley with the development of additional water supplies. The most recent phase included the development of both the CVP and the State Water Project (SWP). Also during this phase, much greater use was made of groundwater for irrigation because of advances in pump design and capacity.

Since 1920, California agriculture has been affected to varying degrees by external events, including water development. Several of these are shown in Table II-1. The post-World War I period was one of high inflation, escalating land prices, and increased amounts of land under tillage (Gist, 1952). During the Great Depression, California land prices fell because of low commodity prices, and thousands of acres of land were idled. California agriculture expanded rapidly in the 1940s and 1950s, however, because of the demands of World War II and the completion of several important water delivery projects.

TABLE II-1

KEY EVENTS AFFECTING CALIFORNIA AGRICULTURE, 1920-1992

Decade	Key Events Affecting California Agriculture
1920s	Commodity inflation Land speculation Expanded irrigation
1930s	Depression and deflation Immigration from other states Land price declines Planning for CVP
1940s	World War II demands for foods Completion of first CVP facilities Rapid population growth
1950s	Completion of other CVP facilities Korean War and inflation, then deflation of crop prices
1960s	Completion of other CVP facilities Completion of first SWP facilities Vietnam mobilization Increasing inflation rate
1970s	High inflation Farm programs Drought
1980s and 1990s	Disinflation Drought Immigration reform Farm programs Economic recession in California

Irrigated cropland increased in the 1960s and 1970s because of further water development, although the number of farms and farm population fell. Agriculture was also affected during this period by commodity shortages, high energy prices and interest rates, important changes in government farm programs, and drought. The environment during the 1980s and early 1990s was one of falling interest rates, major tax legislation, immigration reform, and further changes in government programs.

California agriculture suffered through an extended drought from 1987 to 1992. During that time, many thousands of acres of farmland were idled (Northwest Economic Associates, 1993). Water deliveries were curtailed from both the CVP and SWP, and those farmers able to do so pumped additional groundwater. Other farmers utilized the State Water Bank and other water transfers.

RECENT CONDITIONS AND SUMMARY OF REGIONAL ECONOMIC BASELINE CONDITION

Base year data for the IMPLAN models constructed for the Sacramento River, San Joaquin River, Tulare Lake, North Coast, and Central Coast regions are shown in Table II-2. Data are also shown for the San Francisco Bay Region (Bay Region), and the Central and South Coast Region. Counties included in each of these latter regions are shown in Table II-3. Input-output models have been estimated for these regions and are used only to estimate the impacts of the alternatives on municipal and industrial (M&I) water costs. Impacts of the alternatives on agriculture and recreation have not been estimated for these regions. The data in Table II-2 have been aggregated to one-digit Standard Industrial Classification (SIC) major groups for presentation purposes. The disaggregated models are used for the analysis of indirect and induced impacts associated with the alternatives.

All base year data for the regional analysis are in 1991 dollars or units. The 1991 IMPLAN database was the most current available at the time that models were estimated for this study. All direct impacts provided for agriculture, recreation, and other directly-impacted sectors were measured in 1992 dollars, but were converted to 1991 dollars for incorporation into the input-output models. The direct, indirect, induced, and total regional impacts are expressed relative to the 1991 baseline conditions underlying the models. Changes in overall price levels between 1991 and 1992 were modest, about 2.8 percent economy-wide. The estimates from the regional models are, therefore, considered to be representative of 1992 level impacts.

The final demand column is a sum of several components. It includes three personal consumption components (low, medium, and high income household consumption); two federal government consumption components (military and non-military spending); two state and local government components (education and non-education); capital investment; inventory investment; and two export components (domestic and foreign). The total industry output column shows the total value of output of each industry. The difference between final demand and total industrial output is interindustry trade, the quantity of domestic inputs used by industries for commodity production.

The next three columns summarize final payments to factors of production. Property-type income includes both proprietary income (owners' salaries) and other property type income (rents, royalties, and dividends). The difference between total Place of Work income and value added is indirect business taxes.

Employment is total employment, including wage and salary employees as well as the self employed. As discussed in the IMPLAN Methodology/Modeling Technical Appendix, these data differ from those reported by the California Employment Development Department, since the latter exclude the self employed. However, the IMPLAN employment data are consistent with the sum of the California Employment Development Department data and data on proprietor employment taken from Regional Economic Information System (U.S. Department of Commerce, Bureau of Economic Analysis, 1994).

TABLE II-2

BASELINE DATA FOR REGIONAL MODELS

Industry	Final Demand (MM$)	Total Industry Output (MM$)	Employee Compens. Income (MM$)	Property Income (MM$)	Total Place of Work Income (MM$)	Total Value Added (MM$)	Employ-ment (Number of Jobs)
Sacramento River Region							
Agriculture, Forestry, Fishing	1,848	2,704	316	620	936	987	57,630
Mining	746	834	62	516	578	644	1,770
Construction	8,794	9,763	2,548	797	3,346	3,399	104,600
Manufacturing	9,547	12,130	2,761	1,985	4,745	5,106	82,200
Transportation, Comm.,	3,047	5,714	1,539	1,479	3,018	3,251	45,010
Wholesale, Retail Trade	8,269	9,822	5,138	1,299	6,438	7,834	264,940
Finance, Insurance, Real	9,276	12,260	2,184	5,736	7,920	9,739	107,620
Services	11,585	15,148	6,718	2,830	9,548	9,748	327,240
Govt. Enterprise & Special	11,677	12,822	9,515	1,237	10,752	10,753	306,250
Total	64,787	81,196	30,782	16,499	47,281	51,461	1,297,260
Population	2,671,300						
San Joaquin River Region							
Agriculture, Forestry, Fishing	5,288	7,718	842	1,479	2,321	2,391	150,010
Mining	1,818	2,023	58	1,541	1,599	1,642	1,490
Construction	4,749	5,306	1,377	430	1,808	1,836	58,180
Manufacturing	12,888	15,511	2,809	2,100	4,909	5,311	91,090
Transportation, Comm.,	2,204	3,936	1,010	877	1,887	2,038	32,600
Wholesale, Retail Trade	4,885	6,292	3,335	851	4,186	5,112	169,740
Finance, Insurance, Real	4,892	6,970	1,157	3,420	4,577	5,605	59,590
Services	7,082	8,784	3,890	1,542	5,432	5,538	191,010
Govt. Enterprise & Special	4,172	4,462	3,829	235	4,065	4,065	136,520
Total	47,979	61,003	18,307	12,477	30,784	33,538	890,220
Population	1,944,100						
Tulare Lake Region							
Agriculture, Forestry, Fishing	4,181	5,316	614	1,036	1,649	1,698	108,270
Mining	2,332	2,513	180	880	1,060	1,591	3,830
Construction	2,676	3,382	832	211	1,043	1,057	34,980
Manufacturing	3,800	4,767	873	670	1,544	1,636	26,600
Transportation, Comm.,	1,432	2,281	626	598	1,224	1,318	22,770
Wholesale, Retail Trade	2,287	2,910	1,542	399	1,941	2,368	80,700
Finance, Insurance, Real	1,948	2,713	400	1,388	1,788	2,209	21,590
Services	2,864	3,917	1,635	744	2,379	2,430	85,400
Govt. Enterprise & Special	2,819	2,962	2,550	100	2,649	2,649	84,570
Total	24,340	30,761	9,253	6,024	15,277	16,955	468,710
Population	994,000						
North Coast Region							
Agriculture, Forestry, Fishing	474	785	103	165	268	276	15,070
Mining	296	318	29	96	125	202	710
Construction	2,221	2,453	642	201	843	856	26,150
Manufacturing	3,676	4,463	1,086	645	1,731	1,952	34,090
Transportation, Comm.,	1,051	1,573	354	355	710	776	10,900
Wholesale, Retail Trade	1,975	2,396	1,251	317	1,567	1,904	66,990
Finance, Insurance, Real	2,379	3,118	580	1,440	2,020	2,454	27,980
Services	2,841	3,713	1,647	683	2,330	2,386	87,030
Govt. Enterprise & Special	1,395	1,489	1,272	86	1,358	1,359	45,610
Total	16,309	20,308	6,964	3,988	10,952	12,163	314,520
Population	636,300						

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TABLE II-2 CONTINUED

Industry	Final Demand (MM$)	Total Industry Output (MM$)	Employee Compens. Income (MM$)	Property Income (MM$)	Total Place of Work Income (MM$)	Total Value Added (MM$)	Employ-ment (Number of Jobs)
Central Coast Region							
Agriculture, Forestry, Fishing	2,440	3,038	416	534	950	965	57,790
Mining	601	650	31	446	477	521	720
Construction	2,272	2,563	665	206	871	885	28,010
Manufacturing	4,118	4,814	1,109	836	1,944	2,034	32,750
Transportation, Comm., Utilities	1,682	2,275	506	467	973	1,070	15,880
Wholesale, Retail Trade	2,630	3,178	1,630	428	2,058	2,489	89,730
Finance, Insurance, Real Estate	2,261	3,147	456	1,617	2,072	2,555	27,950
Services	3,838	4,998	2,271	969	3,240	3,336	110,080
Govt. Enterprise & Special Ind.	2,840	3,042	2,327	102	2,429	2,429	82,960
Total	22,680	27,706	9,410	5,604	15,014	16,284	445,860
Population	848,600						
San Francisco Bay Region							
Agriculture, Forestry, Fishing	1,191	1,572	389	348	737	750	29,990
Mining	3,718	3,810	263	1,556	1,819	2,517	4,780
Construction	15,205	17,313	5,302	1,655	6,957	7,007	169,010
Manufacturing	67,753	81,877	21,099	14,585	35,683	36,791	449,000
Transportation, Comm., Utilities	14,297	21,422	6,052	5,085	11,137	11,839	153,780
Wholesale, Retail Trade	23,904	29,844	15,002	4,355	19,357	24,046	642,710
Finance, Insurance, Real Estate	25,561	35,289	7,224	16,963	24,187	28,036	269,060
Services	36,225	52,661	23,552	10,535	34,087	34,660	994,810
Govt. Enterprise & Special Ind.	15,537	17,045	14,076	576	14,323	14,325	416,410
Total	203,390	260,833	92,959	55,659	148,288	159,969	3,129,540
Population	5,007,200						
Central and South Coast							
Agriculture, Forestry, Fishing	4,998	6,980	1,487	1,487	2,975	3,011	143,950
Mining	6,644	7,007	560	2,294	2,854	4,427	12,520
Construction	46,384	53,027	14,479	5,135	19,615	19,775	550,140
Manufacturing	149,168	184,117	47,185	34,477	81,661	83,459	1,350,450
Transportation, Comm., Utilities	23,383	44,719	12,244	11,159	23,403	24,967	349,600
Wholesale, Retail Trade	66,710	82,545	39,839	11,742	51,581	65,577	1,955,030
Finance, Insurance, Real Estate	73,836	101,390	18,451	50,953	69,404	81,417	774,660
Services	102,574	148,797	64,569	29,026	93,595	95,398	2,774,150
Govt. Enterprise & Special Ind.	43,693	48,778	39,249	1,478	40,690	40,694	1,246,640
Total	517,391	677,360	238,063	147,752	385,779	418,725	9,157,150
Population	17,585,500						

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TABLE II-3

REGIONS AND COUNTIES FOR CVPIA REGIONAL ANALYSIS

Sacramento River Region
- Amador
- Butte
- Colusa
- El Dorado
- Glenn
- Napa
- Nevada
- Placer
- Sacramento
- Shasta
- Solano
- Sutter
- Tehama
- Yolo
- Yuba

San Joaquin River Region
- Calaveras
- Fresno
- Madera
- Mariposa
- Merced
- San Joaquin
- Stanislaus
- Tuolumne

Tulare Lake Region
- Kern
- Kings
- Tulare

North Coast Region
- Del Norte
- Humboldt
- Mendocino
- Sonoma
- Trinity

Central Coast Region (fisheries)
- Monterey
- San Benito
- San Luis Obispo
- Santa Cruz

San Francisco Bay Region
- Alameda
- Contra Costa
- Marin
- San Francisco
- San Mateo
- Santa Clara

Central and South Coast Region (M&I)
- Los Angeles
- Orange
- Riverside
- San Diego
- San Luis Obispo
- Santa Barbara
- Ventura

EMPLOYMENT BY STUDY REGION

SACRAMENTO RIVER REGION

In 1940, agriculture was the largest single employer in the Sacramento River Region. At that time, agricultural production provided 20.8 percent of total household employment in the region. As shown in Figure II-1, by 1992 agricultural production provided 3.7 percent of total wage and salary employment in the area or about 37,000 jobs (California Employment Development Department, 1994, and U.S. Department of Commerce, Bureau of the Census, 1942). (Data for 1992 are based on place of work. California Employment Development Department employment data for 1992 are not comparable with years prior to 1983 because of data revisions. Data for 1940 are taken from the decennial census [U.S. Department of Commerce, Bureau of the Census, 1942] and are based on place of residence. Although the data are not strictly comparable in unit terms, they are consistent when expressed in percent-of-total fashion.) Employment data for 1940 were used for comparison to 1992 data because 1940 is the earliest year for which comparable data, in terms of employment categories, are available.

From 1940 to 1992, the share of manufacturing employment fell from 12.2 percent to 7.8 percent. Transportation, communications, and utilities (TCU) fell from 9.1 percent to 4.5 percent. Conversely, during the same period wholesale and retail trade increased from 18.4 percent to 23.2 percent, services increased from 17.7 percent to 23.6 percent, and government increased from 8.2 percent to 26.9 percent. Currently, the largest proportions of wage and salary jobs in the region are in the government, services, and wholesale and retail trade sectors, respectively.

Patterns of employment growth in the Sacramento River Region reflect the changing rural and urban complexion of the region. While production agriculture provides less than 4 percent of wage and salary employment, the percentage varies widely among the counties. In 1992, production agriculture accounted for 33 percent of employment in Colusa County, 19 percent in Glenn County, and 16 percent in Yuba County. However, it accounted for less than 1 percent in Sacramento, Placer, and Nevada counties.

SAN JOAQUIN RIVER REGION

In 1940, agriculture was the largest single employer in the San Joaquin River Region. At that time, agricultural production provided 34.9 percent of total household employment in the region. As shown in Figure II-2, by 1992 agricultural production provided 8.3 percent of total wage and salary employment in the area, or about 56,000 jobs (California Employment Development Department, 1994, and U.S. Department of Commerce, Bureau of the Census, 1942). Over the same period, manufacturing increased from 9.4 percent to 12.9 percent of employment, wholesale and retail trade increased from 18.3 percent to 21.8 percent, services grew from 17.5 percent to 18.6 percent, and government expanded from 3.0 percent to 18.6 percent. Currently, the largest proportions of wage and salary jobs in the region are in the services, wholesale and retail trade, and government sectors, respectively.

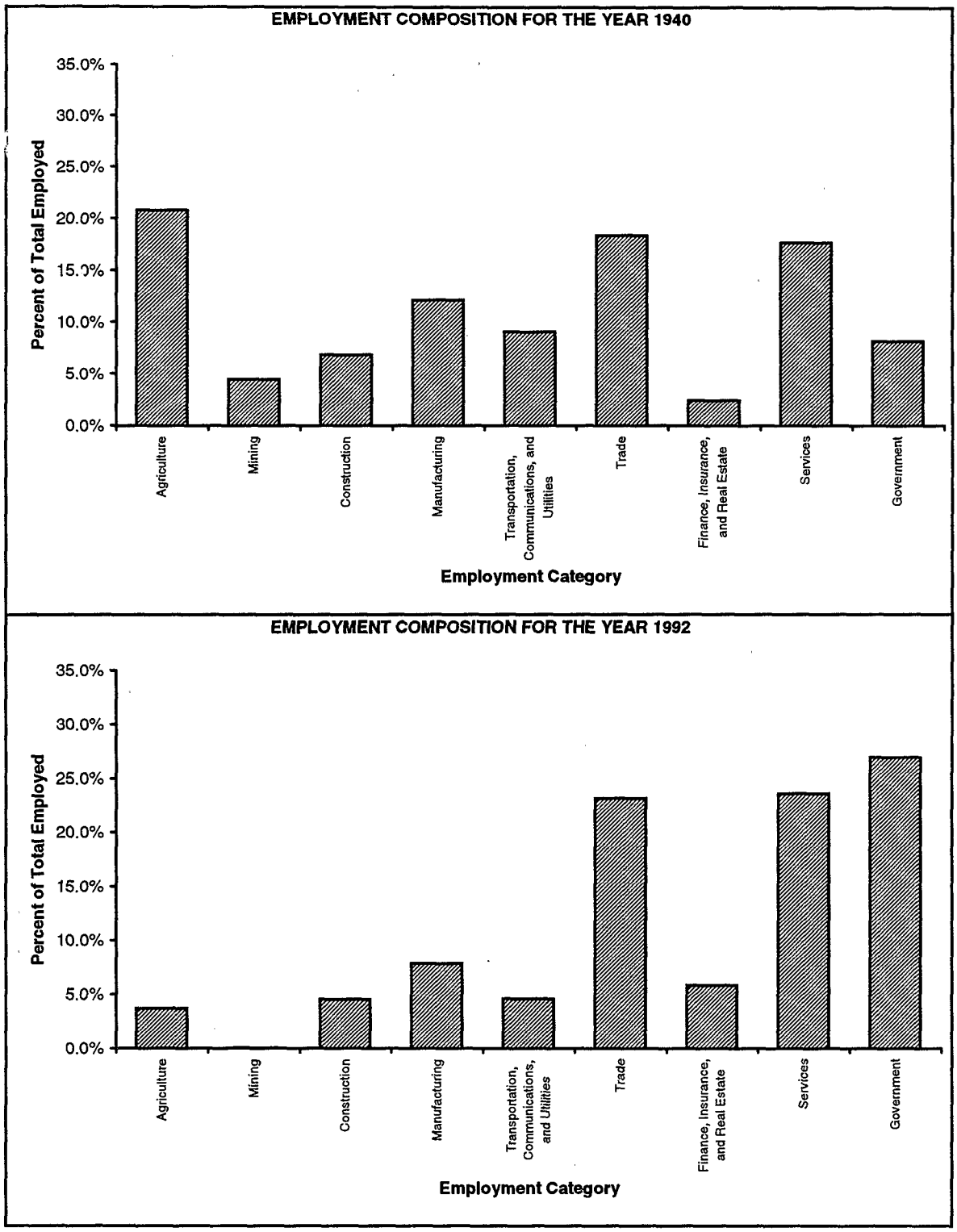

FIGURE II-1
EMPLOYMENT COMPOSITION
SACRAMENTO RIVER REGION

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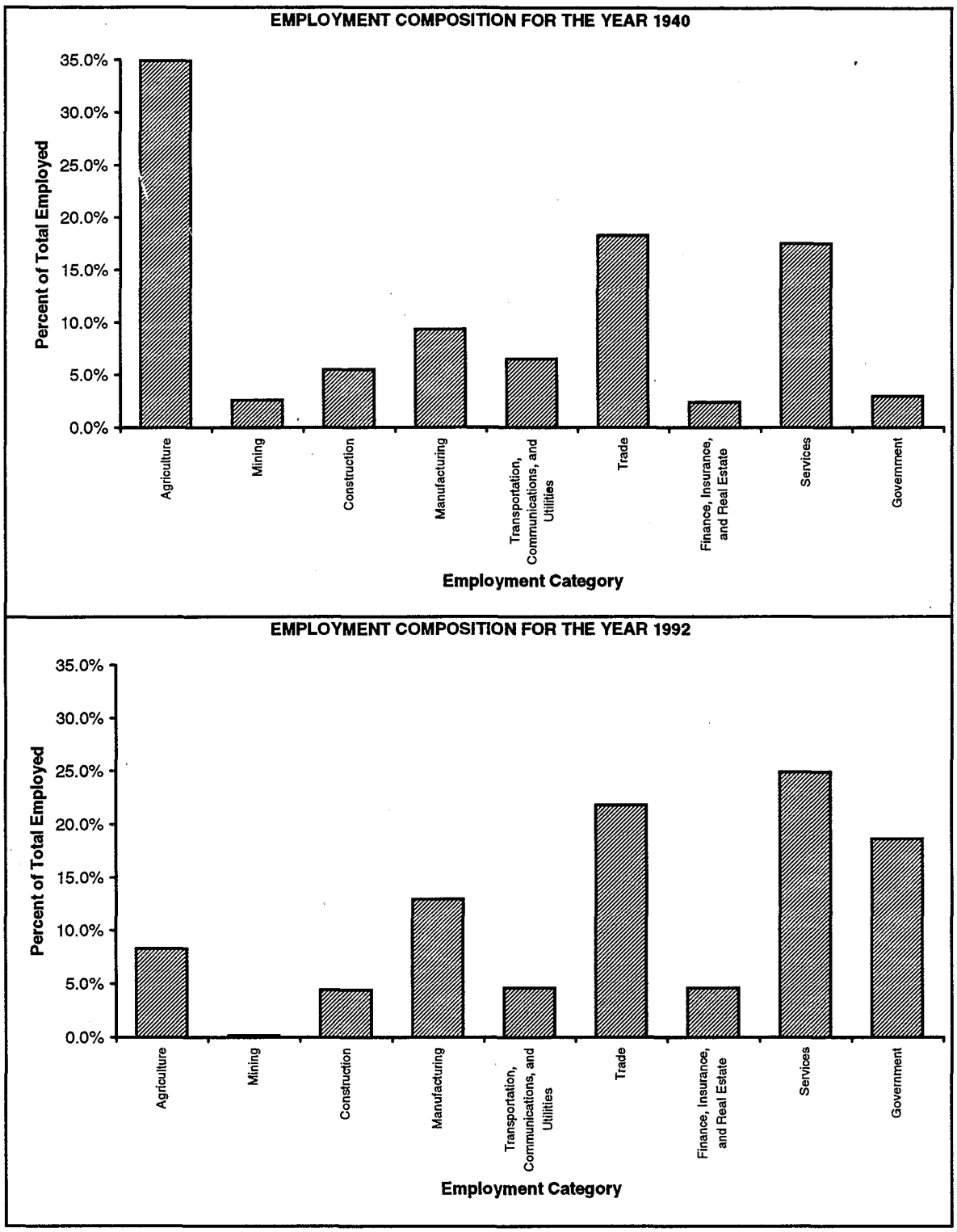

FIGURE II-2
EMPLOYMENT COMPOSITION
SAN JOAQUIN RIVER REGION

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TULARE LAKE REGION

In 1940, agriculture was the largest single employer in the Tulare Lake Region. At that time, agricultural production provided 31.7 percent of total household employment in the region. As shown in Figure II-3, by 1992 agricultural production provided 10.3 percent of total wage and salary employment in the area, or about 37,000 jobs (California Employment Development Department 1994, and U.S. Department of Commerce, Bureau of the Census 1940). Over the same period, the share of mining fell from 9.9 percent to 3.4 percent; TCU fell from 6.7 percent to 3.8 percent; services rose from 17.5 percent to 25.9 percent; and government increased from 3.1 percent to 22.2 percent.

Employment patterns in the Tulare Lake Region reflect both the continued importance of crop and livestock agriculture and the growth of the urban population. Dairies and the industries associated with them, such as hay and forage, are important parts of the agricultural sector in the region. In addition, however, as urban population has increased, retail, service, and finance-related businesses have followed and have reduced the overall dependence on agriculture. Hence, while production agriculture accounted for 10.3 percent of wage and salary employment in 1992, that varied from 7 percent in Kern County to 16 percent in Kings County. Currently, the largest proportions of wage and salary jobs in the region are in the services, government, and wholesale and retail trade sectors.

NORTH COAST REGION

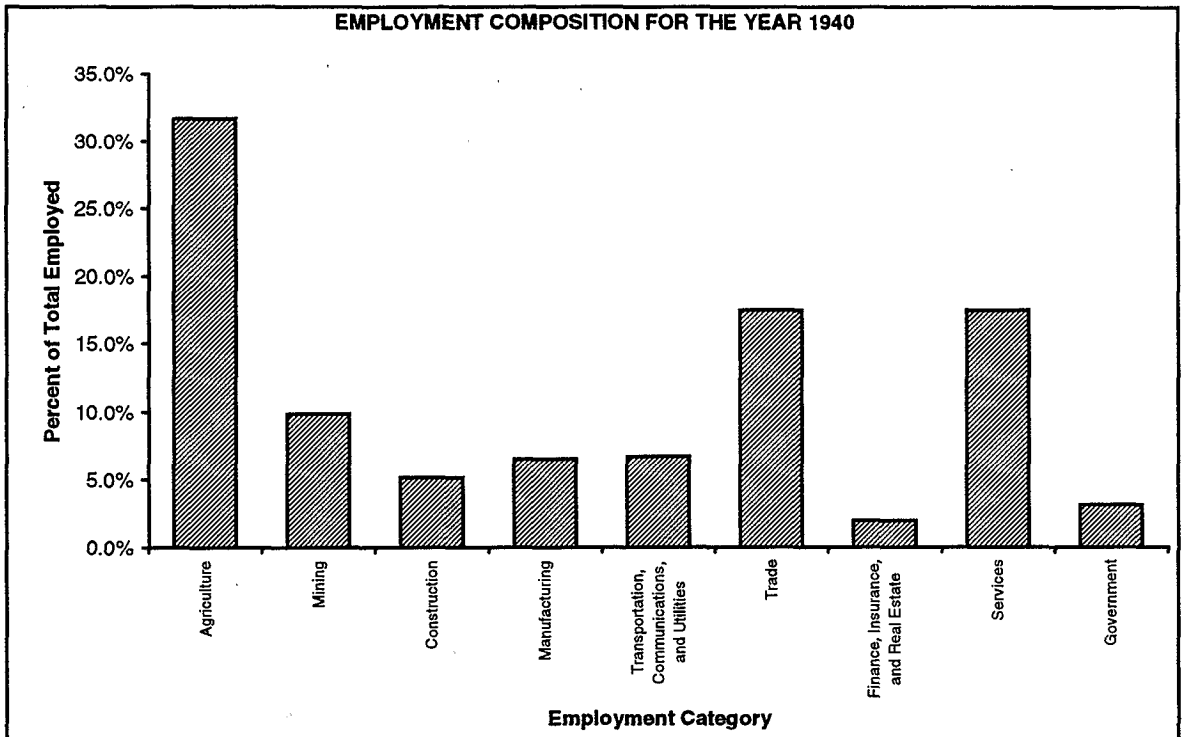
Forestry, fishing, and agriculture were the largest employers in the North Coast Region in 1940. At that time, production in this sector provided 26.4 percent of total household employment in the region (U.S. Department of Commerce, Bureau of the Census, 1942). By 1992, wage and salary employment in the forestry, fishing, and agriculture sector accounted for only 4.2 percent, or about 7,200 jobs (California Employment Development Department, 1994). Currently, the largest proportions of wage and salary jobs in the region are in the services, wholesale and retail trade, government, and manufacturing sectors.

CENTRAL COAST REGION

Agriculture, forestry, and fishing were the largest employers in the Central Coast region in 1940. At that time, production in this sector provided 26.8 percent of total household employment in the region (U.S. Department of Commerce, Bureau of the Census, 1942). By 1992, agriculture, forestry, and fishing sector accounted for 14.4 percent of total wage and salary employment, or about 47,500 jobs (California Employment Development Department, 1994). Currently, the largest proportions of wage and salary jobs in the regions are in the wholesale and retail trade, services, government, and agricultural sectors.

SAN FRANCISCO BAY REGION

The largest employers in the Bay Area region in 1940 were the services, wholesale and retail trade, and manufacturing sectors. Agriculture, forestry, and fishing accounted for 3.8 percent of total household employment in the region (U.S. Department of Commerce, Bureau of the Census, 1942). By 1992, agriculture, forestry, and fishing accounted for only 0.4 percent of wage



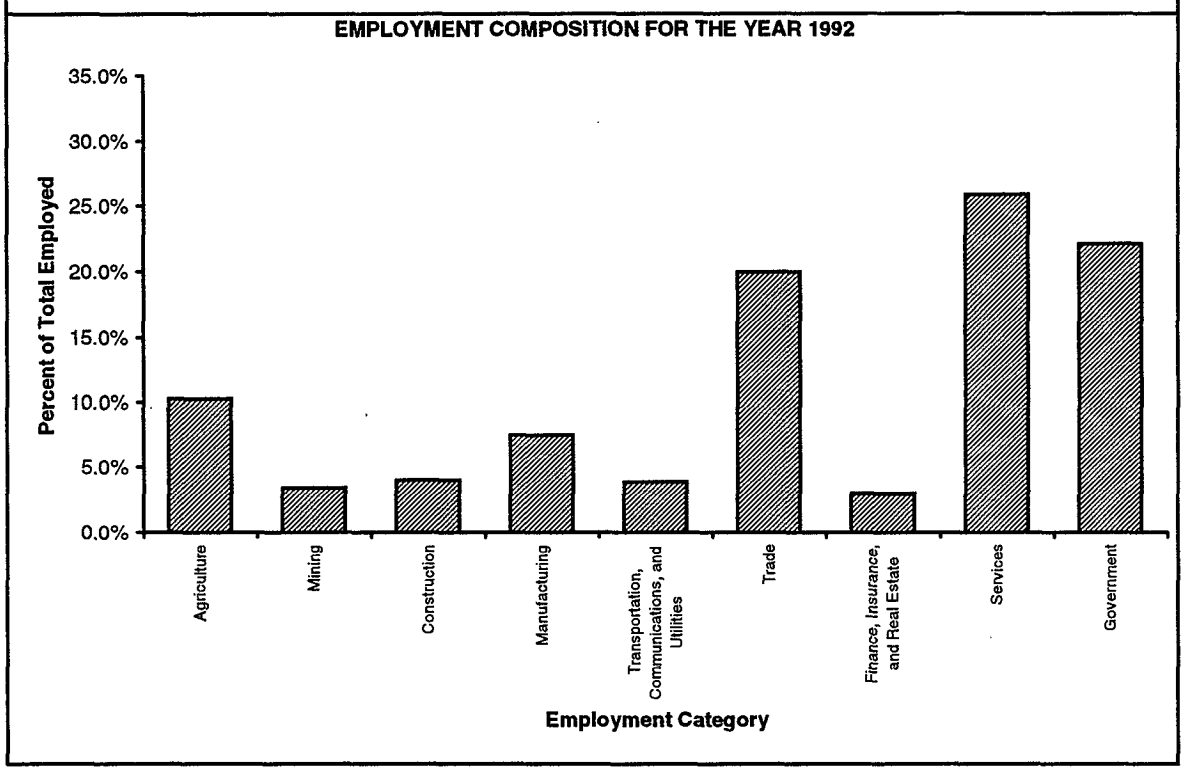


FIGURE II-3
EMPLOYMENT COMPOSITION
TULARE LAKE REGION

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and salary employment in the region (California Employment Development Department, 1994). Currently, the largest proportions of wage and salary jobs in the region are in the services, wholesale and retail trade, manufacturing, and government sectors.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

Chapter III

ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

Implementation of the CVPIA could cause changes in the uses, prices, and availability of water. These changes will affect production, consumption, and investment decisions in the agricultural, recreational, and other water-using sectors. As a result, outputs and final demands for the goods and services produced in these sectors will change. These changes in final demands are used to calculate direct impacts, measured as changes in employment, output, and income in the agricultural, recreational, and household sectors. Additionally, final demand changes will produce indirect and induced impacts in these three sectors and many other sectors of the economy because of the linkages and interdependencies among industries.

The regional economic impacts of the various alternatives are presented in this chapter. Each alternative is analyzed in terms of the three directly impacted sectors, agriculture, recreation, and municipal water use, within each region. The indirect and induced impacts associated with each of these are estimated using regional input-output models (see the IMPLAN Methodology/ Modeling Technical Appendix). The economic impacts are presented in terms of the incremental change from the No-Action Alternative. Some results are also presented, for reference purposes, as a percent of the baseline values presented in the Affected Environment discussion. The baseline data is used because it was not possible to conduct a 2020 IMPLAN No-Action simulation. The regional economic simulations are based on input of incremental changes between each alternative and the No-Action Alternative as estimated by the other economic analysis tools.

IMPACT ASSESSMENT METHODOLOGY

The regional economic analysis is conducted after the impacts of the CVPIA alternatives on the other issue areas have been analyzed in comparison to the No-Action Alternative. The three principal water-using categories of direct impacts analyzed are agricultural production, commercial fishing and recreation, and municipal and industrial (M&I) water use. The incremental impact results, estimated by the other economic analysis tools, are input into the regional economics analysis as the change caused by each alternative as compared to the No-Action Alternative. Figure III-1 shows each of the key issue areas incorporated into the regional economic analysis as well as the methodology used for each to estimate the direct impacts of the alternatives.

Direct economic impacts of the alternatives have been measured for activities occurring throughout California. Since the actual incidence of these direct impacts may be distributed across locations throughout the study area, secondary impacts related to the direct impacts may occur in some parts of the area and not others. To better reflect these differences, multi-county regions are identified, for which boundaries are determined in part by the expected incidence of

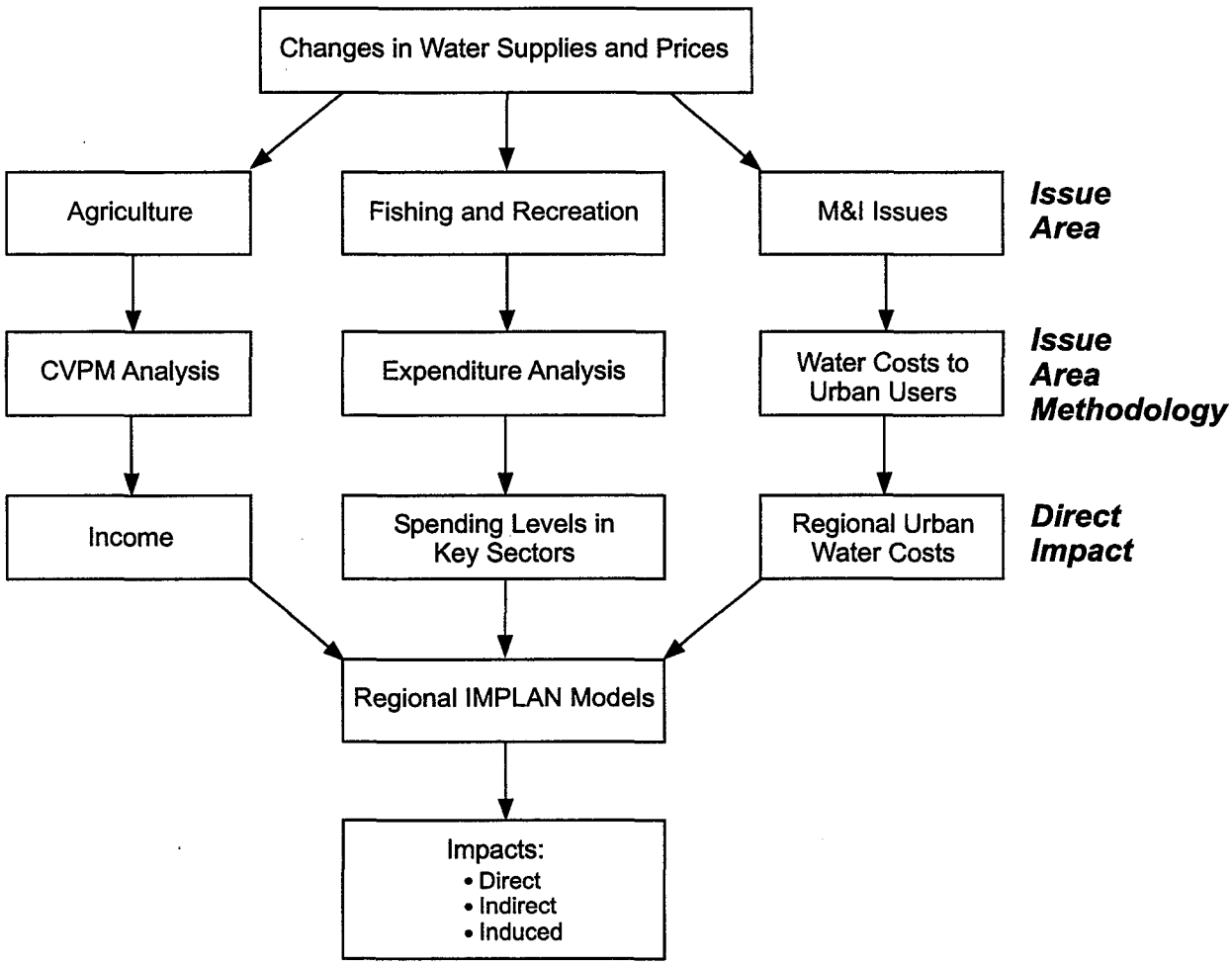

FIGURE III-1

REGIONAL ECONOMIC ANALYSIS FRAMEWORK

direct economic impacts. These models are used to measure impacts in terms of total changes in employment, income, and output.

Direct impacts, aside from employment, are expressed in dollar terms for all impacted sectors despite the initial measurement of some of those impacts in other units. For example, while some direct agricultural impacts are measured in terms of acreages (see Agricultural Economics and Land Use Technical Appendix), they have been incorporated into the input-output models in dollar terms as impacts to gross and net revenues. Similarly, the direct recreation-related impacts of the alternatives are estimated initially in terms of visitor days (see Fish, Wildlife, and Recreation Economics Technical Appendix), but have been converted to direct dollar measures of effects on the sectors likely to be impacted.

Regional input-output models have been utilized to measure the indirect impacts associated with estimated direct impacts. Models have been estimated for seven subregions in California. The development of these models is discussed in the IMPLAN Methodology/Modeling Technical Appendix. Each model follows county lines and incorporates, to the extent allowed by available data, the distinct sectoral characteristics of the region modeled. All changes are assumed to be average annual changes.

Two tables have been prepared for the analysis of each alternative. The first table illustrates the direct and total economic impacts of the alternative on the entire regional economy. These impacts are shown in relation to the sectors in which the initial direct impact occurs. For example, the table shows region-wide impacts due to changes in recreation; changes in M&I water costs; and direct agricultural impacts including land fallowing, reduced net income because of higher water costs, and, for some alternatives, increased income from water sales. The first table does not disaggregate among the sectors affected by the initial direct impact; rather, it shows the impacts of the initial change on the entire regional economy. The second table shown for each alternative displays the effects of the direct impacts of the alternative on individual (aggregated) sectors in the region. It shows the composite of changes caused by direct impacts in agriculture, recreation, and M&I water costs. The second table does not differentiate among the sectors from which the initial direct impact originated; rather, it shows the effects of those changes on various sectors in the economy. In some cases, there may be slight discrepancies between the two tables for a given alternative. The primary reason for these differences is rounding.

AGRICULTURAL IMPACTS

Implementation of CVPIA could directly affect crop acreages, the cost and supply of surface water, the cost of groundwater, investments by irrigators in different irrigation systems, and for some alternatives, sales of water by irrigators. The impacts vary by region, depending upon the mix of crops currently grown, the composition and cost of water supplies, and other factors. These factors and the methodology used to estimate the changes cited are discussed in the Agricultural Economics and Land Use Technical Appendix. Changes in crop acreages and price changes cause changes in the gross revenues to irrigators from crop production. Changes in surface water availability cause changes in groundwater pumping, where groundwater is available, and consequently affect the cost of pumping within each region. Higher CVP water charges increase the costs of surface water. Higher water costs stimulate increased investments

in water-conserving irrigation equipment. And, for some of the alternatives, water purchases result in movements of water from agriculture to other regions and uses. The Central Valley Production Model (CVPM), discussed in the CVPM Methodology/Modeling Technical Appendix, is used to provide all of these estimates.

Changes in gross revenues for various crops are taken from the CVPM. Those changes are then converted to categories that conform to the sectoring scheme within the IMPLAN database. For those crops assumed to have no forward linkages within a region, the converted figures are input directly into IMPLAN as changes in final demand for the respective crop sectors. For crops that do have forward linkages, the gross revenue change is broken into two separate final demand changes, as shown in Table III-1 of the IMPLAN Technical Appendix. In this latter case, the inputs into IMPLAN include a change in final demand for the crop in question and changes for any regional processing sectors for which linkages have been quantified.

Final demand is not equivalent to total industrial output for most agricultural sectors within IMPLAN. While the use of final demand changes for impact estimation may result in and over- or under-estimation of impacts depending on such factors as regional purchasing patterns and locational sources for production inputs, it is a reasonable approach. In this study, the procedure results in changes in output levels, calculated by the I-O models, that correspond closely to the figures initially taken from the CVPM Technical Appendix. In some cases, particularly for Alternatives 3 and 4 in the Sacramento River Region, this procedure results in an under-estimation of agricultural output impacts. Details are provided within the discussion of each alternative.

The changes in water costs and water sales represent "income effects." They do not directly affect crop acreages and prices, but rather affect the cost of production and the resultant net incomes to irrigators. Both the gross revenue and income effects indirectly affects other sectors of the regional economy (e.g., in agricultural chemical and equipment sales, transportation, borrowing, and farm employment).

When net farm income changes, the change is reflected in the farming sector by variations in both the level of capital investment expenditures and the level of household consumption expenditures. However, there are no surveys available that address how much of the change in net farm income is allocated to capital investment and how much to household consumption expenditures. In the absence of empirical data, therefore, it is assumed that any change in net farm income attributable to increased ground water pumping, higher surface water costs, or water sales is split equally between farm investment and household consumption.

A change in household expenditures is incorporated into the input-output model as a reduction in the vectors of personal consumption expenditures. These vectors are included as part of the base data provided by the IMPLAN modeling software. The personal consumption data base included in IMPLAN is based on national average expenditure patterns for general expenditure categories. There is no distinction in the data base between farm and non-farm consumers. Expenditures are distributed across many of the 528 IMPLAN sectors. Table III-1 shows the percentages of consumer expenditures for the Sacramento River Region, with expenditure categories at the 1-digit SIC level. The percentages for other regions are comparable.

TABLE III-1

PERSONAL CONSUMPTION EXPENDITURES, BY CATEGORY SACRAMENTO RIVER REGION

1-Digit SIC Category	Percent of Total Consumption Expenditures
Agriculture, Forestry, Fishing	0.5
Mining	<0.1
Construction	0.0
Manufacturing	5.5
Transportation, Communications, Utilities	5.8
Wholesale and Retail Trade	21.1
Finance, Insurance, Real Estate	28.8
Services	30.8
Government, Miscellaneous	7.4

URBAN IMPACTS

Implementation of the CVPIA could cause direct impacts on existing CVP municipal water service contractors through changes in water supply and prices. Implementation could also potentially cause direct impacts on major urban areas because of the increased availability of SWP water. Both are included in the regional economic analysis as "income effects," in which differences in urban water customer costs in a region represent changes in disposable income available for other purchases. As urban water costs change, it is assumed that disposable income changes, dollar for dollar, in the opposite direction. The income change then is allocated among all consumer expenditure categories by the coefficients within each regional input-output model. Changes in consumer spending triggers rounds of indirect and induced impacts throughout the regional economy.

FISH, WILDLIFE, AND RECREATION IMPACTS

Implementation of the CVPIA could cause direct impacts on fish, wildlife, and recreation activities. The principal activities that are likely to be affected and that are analyzed in this study include recreational fishing on rivers and reservoirs, instream uses such as boating and rafting, commercial fishing, and other reservoir recreation activities. Subsistence and commercial fishing activities on Indian Trust lands may also be affected, but are not included in the regional economic analysis. In each case, expenditures on the activity are related to water supplies, reservoir operations, and other environmental conditions (See Fish, Wildlife, and Recreation Economics Technical Appendix). Recreation-related expenditures are estimated for five sectors expected to be most directly affected by the alternatives: food stores, service stations, eating and drinking establishments, hotels and lodging places, and miscellaneous retail establishments. For the baseline, service stations represent 27 percent of recreation expenditures in the three regions analyzed; hotels and lodging places, 26 percent; eating and drinking places, 16 percent; miscellaneous retail, 16 percent; and food stores, 15 percent.

Each is measured as a direct impact. The estimates are based on several important assumptions:

- Residents of a region for which recreational use is affected by an alternative are able to use other site(s) in the region so that their recreational expenditures are not affected.

- Non-residents of a region affected by an alternative do not substitute between sites in the region; hence, all changes in expenditures by non-residents accrue as changes in expenditures in the affected region.

- Among non-residents using recreational sites in the Sacramento River Region and the San Joaquin River Region, 80 percent of the associated expenditures occur within the affected regions and 20 percent occur within their home regions.

- Among non-residents using recreational sites in the coastal regions, 70 percent of the associated expenditures occur within the affected regions and 30 percent occur within their home regions.

While each of the assumptions described could bias the estimated impacts, the combination of assumptions is believed to be neutral. For example, if the level of a particular reservoir is lowered because of an alternative, it is assumed that some of the non-residents who use that reservoir will use alternative recreational sites outside the impacted area, which represents a loss to that area and a gain to the other area. Conversely it is assumed that impacted resident users of the reservoir are able to find alternative sites within the same area, and that no loss to the area results. The assumption about non-residents may overstate the regional impacts, as the affected parties may shift some of their recreation expenditures to other sites in the same area. And the assumption about residents may understate the regional impacts, as the affected parties may not have alternative sites available to them within the region. It is believed, however, that the impacts of these assumptions will be offsetting. The absence of survey or other empirical data prohibits the use of other assumptions.

No recreation impacts are shown for the North Coast and Central Coast regions. Recreation was considered the only sector in these regions that will be affected by the CVPIA, and it was determined that the recreation-related impacts of the alternatives would be unchanged from those contained in the recreation analysis of the No-Action Alternative.

NO-ACTION ALTERNATIVE

The structure of the regional economy in the year 2020 cannot be accurately predicted without much speculation. Therefore, for purposes of assessing impacts, the structure of the No-Action Alternative regional economy is assumed to be similar to recent conditions as described in Affected Environment. The quantitative evaluation of regional impacts uses the 1991 IMPLAN database as the baseline condition, as described in Affected Environment. It is implicitly assumed that the structure of the California economy and the technical relationships and production processes incorporated into the model will be valid at a 2020 level of development (See "Data Limitations and Other Issues" in this chapter).

Input-output models such as IMPLAN are independent of the scale of the regional economy. The method assumes constant returns to scale, and the structure of the regional economy does not change with respect to scale. If the regional economy doubles in size, the dollar or employment impacts of a dollar change in final demand are the same. However, the impact as a share of the size of the doubled economy will be one-half of the same impact as a share of the baseline economy.

Structural economic change would require consideration of how shares of economic activity, as opposed to the size of the economy, change over time. Changes in technology, trade patterns and relative prices change regional economic structure in ways that cannot be predicted by input-output models. In recent years, several structural economic changes have occurred.

First, economic activity has become more integrated across regions over time. Small economic regions become relatively less independent over time as a larger share of trade is conducted outside of the region. This tends to reduce regional economic multipliers because there is more leakage to the outside economy.

Second, Central Valley agriculture has become a smaller component of the economy of the entire region. Economic trends that have affected California and the nation as a whole include a relatively fast rate of growth in service industries and in labor-intensive research and development "high-tech" industries, and a relative decline in heavy manufacturing, mining, and agriculture. While these trends might be expected to continue, the rate at which they might occur is highly uncertain. Therefore further structural changes have not been assumed for the No-Action Alternative. Some IMPLAN results are presented in terms of percent of the 1991 baseline levels, to provide the reader with a reference for magnitude of change. These results are presented for comparison purposes only and must be qualified by noting that baseline levels may change between 1991 and 2020.

The changes in regional economic activity between the alternatives and the No-Action Alternative are based on the changes in direct economic activity. These changes are estimated by each of the economic analysis tools and then input into IMPLAN. Each of the tools has a No-Action Alternative simulation to allow the estimate of direct changes at the 2020 level of development. These direct changes, relative to the No-Action Alternative, are then used within IMPLAN to estimate secondary economic impacts.

ALTERNATIVE 1

Alternative 1 implements the CVPIA provisions for dedicating water for fish and wildlife restoration. This reallocation of project yield reduces supplies available for delivery to CVP users, with most of the impact felt by agricultural water service contractors. In addition, Alternative 1 imposes higher water prices and restoration charges on all agricultural and urban water service contractors. Re-operation of reservoirs and streams, and firm water supply to wildlife refuges can affect recreational use and spending. Alternative 1 also assumes that habitat restoration actions listed in Attachment G of the PEIS would be implemented. These mechanisms and their potential impacts on the regional economy are discussed further below.

Table III-2 presents the employment, output, and income effects on all sectors, in each regional economy, of changes initiated in three key sectors: agriculture, recreation, and M&I water use. For example, reduced agricultural output in the Sacramento River Region causes a direct loss of about 10 jobs in agriculture, but a total loss throughout the region of about 110 jobs. Similarly in the Sacramento River Region, increased recreation availability causes the direct gain of about 10 recreation-related jobs (in food stores, service stations, eating and drinking places, hotels and lodging places, and miscellaneous retail), but a total gain of about 20 jobs.

Table III-3 shows the impacts of implementation of Alternative 1 on individual sectors. Aside from differences due to rounding, the California and regional totals are identical to those in Table III-2. The largest total employment and output impacts (sum of direct, indirect, and induced) in California occur in the agricultural sector because of both land fallowing and higher water costs. The next largest employment impacts are in the trade sector because of reduced spending by farmers for production inputs and for household items; lower recreational spending; and lower spending on non-water items by all households that must pay higher water costs. The largest total place of work (POW) income impacts are in the trade sector.

The direct reduction in agricultural output in Table III-2 can be smaller than the direct reduction in the Agriculture Forestry, and Fisheries sector in Table III-3. This is due to the forward linking of some agricultural output into the processing sector, especially in the Sacramento Valley. As a result, a large portion of direct impact from reduced agricultural output appears as a reduction in the manufacturing sector in Table III-3.

SACRAMENTO RIVER REGION

Agriculture

Impacts Due to Cropping Changes. Alternative 1 would result in few changes in agricultural activity in the Sacramento River Region relative to the No-Action Alternative. Total irrigated land would decline by 1,600 acres relative to the No-Action Alternative, of which rice constitutes 1,200 acres and irrigated pasture 300 acres (see Agricultural Economics and Land Use Technical Appendix).

The impacts of these changes are analyzed by calculating final demand impacts for the crops affected and, where pertinent, for the forward-linked sectors of those crops. Table III-1 in the IMPLAN Technical Appendix illustrates the procedure and data used to measure forward linkages. I-O analysis measures effects through backward linkages. However, for sectors such as rice, direct final demand for the raw product is relatively low, as most rice is processed before reaching the consumer. In such cases, one or more forward-linked sectors are identified in order to capture the effects of changes in production of the raw product.

For Alternative 1 in the Sacramento River Region, the gross revenue change estimated by CVPM is $1.022 million. By use of the data in Table III-1 from the IMPLAN Technical Appendix, the gross revenue change is converted to changes in final demands for crops (directly) as $0.1 million and for rice milling, canning, and other forward linked sectors as $3.3 million. Hence, the total direct impact on the entire region due to reduced agricultural output is $3.4 million.

TABLE III-2

REGIONAL ECONOMIC IMPACTS ON ALL SECTORS OF ALTERNATIVE 1

	Impacts on All Sectors					
	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Directly Impacted Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agriculture						
Reduced Output	-10	-110	-3.4	-9.1	-0.7	-3.8
Reduced Net Income	-30	-60	-1.8	-3.7	-1.0	-2.1
Increased Income from Water Sales	0	0	0.0	0.0	0.0	0.0
Total Agriculture	-40	-160	-5.3	-12.9	-1.7	-5.9
Recreation	10	20	0.3	0.8	0.2	0.5
M & I Water Costs	-50	-110	-3.6	-7.5	-2.0	-4.3
TOTAL (1)	-80	-260	-8.6	-19.6	-3.5	-9.8
San Joaquin River						
Agriculture						
Reduced Output	-470	-1,510	-47.2	-106.7	-11.8	-43.6
Reduced Net Income	-470	-860	-30.9	-54.2	-17.1	-30.8
Increased Income from Water Sales	0	0	0.0	0.0	0.0	0.0
Total Agriculture	-950	-2,370	-78.1	-160.9	-28.9	-74.4
Recreation	10	10	0.3	0.6	0.2	0.4
M & I Water Costs	-50	-100	-3.3	-6.0	-1.8	-3.4
TOTAL (1)	-990	-2,450	-81.1	-166.3	-30.6	-77.5
Tulare Lake						
Agriculture						
Reduced Output	-210	-570	-16.4	-36.6	-3.7	-14.3
Reduced Net Income	-220	-370	-13.9	-23.0	-7.6	-12.8
Increased Income from Water Sales	0	0	0.0	0.0	0.0	0.0
Total Agriculture	-430	-940	-30.3	-59.6	-11.3	-27.0
Recreation	0	0	0.0	0.0	0.0	0.0
M & I Water Costs	0	0	0.0	0.0	0.0	0.0
TOTAL (1)	-430	-940	-30.3	-59.6	-11.3	-27.0
South & Central Coast						
M & I Water Costs	410	960	30.6	69.6	16.3	38.9
Bay Area						
M & I Water Costs	-50	-100	-3.5	-7.4	-1.9	-4.2
California Total						
Agriculture						
Reduced Output	-690	-2,190	-67.0	-152.5	-16.2	-61.7
Reduced Net Income	-720	-1,280	-46.6	-80.9	-25.7	-45.7
Increased Income from Water Sales	0	0	0.0	0.0	0.0	0.0
Total Agriculture	-1,410	-3,480	-113.6	-233.4	-41.9	-107.4
Recreation	20	30	0.6	1.4	0.4	0.8
M & I Water Costs	260	650	20.1	48.6	10.6	27.0
TOTAL (1)	-1,130	-2,790	-92.9	-183.4	-31.0	-79.6

NOTE:
(1) May differ from sum of elements because of rounding.

TABLE III-3
REGIONAL ECONOMIC IMPACTS OF ALTERNATIVE 1, BY AFFECTED SECTOR

	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Affected Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agric., Frst., Fish	-10	-30	-0.1	-1.2	0.0	-0.4
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0.0	-0.3	0.0	-0.2
Manufacturing	-20	-30	-5.0	-5.7	-1.3	-1.6
TCU	0	-10	-0.2	-1.7	-0.1	-0.8
Trade	-20	-70	-0.9	-2.6	-0.6	-1.7
FIRE	-10	-30	-1.0	-3.4	-0.6	-2.2
Services	-20	-80	-1.1	-3.7	-0.6	-2.3
Government & Misc.	0	-10	-0.3	-1.0	-0.1	-0.6
TOTAL (1)	-80	-260	-8.6	-19.6	-3.5	-9.8
San Joaquin River						
Agric., Frst., Fish	-400	-720	-33.3	-45.2	-7.1	-11.2
Mining	0	0	-0.2	-0.4	-0.1	-0.2
Construction	0	-30	0.0	-2.0	0.0	-1.1
Manufacturing	-190	-240	-26.9	-35.9	-10.2	-13.0
TCU	-10	-70	-1.2	-8.2	-0.6	-3.7
Trade	-260	-640	-10.1	-23.7	-6.9	-15.9
FIRE	-30	-210	-4.1	-24.7	-2.6	-16.2
Services	-100	-520	-4.4	-23.3	-2.7	-14.5
Government & Misc.	-10	-30	-0.8	-3.0	-0.5	-1.6
TOTAL (1)	-990	-2,450	-81.1	-166.3	-30.6	-77.5
Tulare Lake						
Agric., Frst., Fish	-210	-350	-16.5	-21.2	-3.7	-5.4
Mining	0	0	0.0	-0.4	0.0	-0.2
Construction	0	-10	0.0	-0.7	0.0	-0.4
Manufacturing	-50	-60	-5.5	-8.4	-2.3	-3.1
TCU	0	-20	-0.5	-3.2	-0.3	-1.5
Trade	-110	-240	-4.3	-8.8	-2.9	-5.9
FIRE	-10	-60	-1.5	-7.6	-1.0	-5.0
Services	-40	-180	-1.6	-8.0	-1.0	-4.9
Government & Misc.	0	-10	-0.3	-1.2	-0.1	-0.5
TOTAL (1)	-430	-940	-30.3	-59.6	-11.3	-27.0
Bay Area						
Agric., Frst., Fish	0	0	0.0	-0.1	0.0	0.0
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0.0	-0.1	0.0	-0.1
Manufacturing	-10	-10	-0.9	-1.4	-0.3	-0.5
TCU	0	0	-0.2	-0.6	-0.1	-0.3
Trade	-20	-30	-0.6	-1.2	-0.4	-0.8
FIRE	0	-10	-0.8	-1.7	-0.5	-1.1
Services	-20	-40	-0.9	-2.0	-0.5	-1.2
Government & Misc.	0	0	-0.2	-0.3	-0.1	-0.1
TOTAL (1)	-50	-100	-3.5	-7.4	-1.9	-4.2
South & Central Coast						
Agric., Frst., Fish	0	10	0.2	0.6	0.1	0.3
Mining	0	0	0.0	0.1	0.0	0.0
Construction	0	10	0.0	0.9	0.0	0.5
Manufacturing	50	90	7.7	13.6	10.8	4.8
TCU	20	50	2.1	6.3	0.1	3.3
Trade	140	290	5.4	11.3	3.2	6.9
FIRE	40	110	6.6	16.0	4.2	10.6
Services	150	370	7.4	18.2	4.5	11.5
Government & Misc.	10	20	1.1	2.5	0.5	1.1
TOTAL (1)	410	960	30.6	69.6	16.3	38.9
California Total						
Agric., Frst., Fish	-610	-1,090	-49.7	-67.1	-11.0	-16.8
Mining	0	0	-0.2	-0.7	-0.1	-0.4
Construction	0	-40	0.0	-2.2	0.0	-1.2
Manufacturing	-210	-250	-30.5	-38.0	-11.4	-13.6
TCU	0	-60	-0.1	-7.4	0.0	-3.1
Trade	-270	-680	-10.6	-25.0	-7.6	-17.4
FIRE	-20	-200	-0.7	-21.4	-0.4	-13.9
Services	-30	-450	-0.5	-18.7	-0.4	-11.5
Government & Misc.	0	-30	-0.5	-3.0	-0.3	-1.8
TOTAL (1)	-1,130	-2,790	-92.9	-183.4	-31.0	-79.6

NOTE:
(1) May differ from sum of elements because of rounding.

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This would cause a direct loss of about 10 jobs in direct agricultural production and additional agricultural job losses in rice milling and fruit processing sectors.

While rice acreage declines, vegetable acreage increases and offsets about 7 percent of the gross revenue loss for rice. The impacts on the processing sector are concentrated in rice, although increased vegetable processing offsets about 7 percent of the gross revenue loss. Total regional impacts attributable to cropping changes include losses of about 110 jobs, $9.1 million in regional output, and $3.2 million in POW income.

Impacts Due to Reduced Net Income. Alternative 1 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 30 jobs, $1.8 million in regional output, and $1 million in regional POW income. Total regional impacts include losses of about 60 jobs, $3.7 million in regional output, and $2.1 million in regional POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 1 changes in agriculture include direct losses of about 40 jobs, $5.3 million in output, and $1.7 million in POW income. Total direct, indirect, and induced impacts include losses of about 160 jobs, $12.9 million in output, and $5.9 million in POW income.

Recreation

Alternative 1 results in an increase of $312,000 in recreational spending relative to baseline conditions (Table III-4), or about a ½ percent increase. The resultant changes in final demands, relative to the No-Action Alternative, cause direct gains in the impacted retail and service sectors of about 10 jobs, $300,000 in output, and $200,000 in POW income. Total impacts include the loss of about 20 jobs, $800,000 in output, and $500,000 in POW income. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

Municipal and Industrial Water Costs

Alternative 1 results in reduced personal income of $3.8 million per year because of higher water costs, due primarily to the installation of household water meters and Restoration Fund payments. The resultant declines in consumer spending cause direct losses of about 50 jobs, $3.6 million in output, and $2.0 million in POW income. Total impacts include losses of about 110 jobs, $7.5 million in output, and $4.3 million in POW income.

Total Impacts

Total direct impacts, relative to the No-Action Alternative, include losses of about 90 jobs, $6.8 million in output, and $3.5 million in POW income. Total direct, indirect, and induced impacts include losses of about 260 jobs, $19.6 million in output, and $9.8 million in POW income. Total direct, indirect, and induced impacts represent 0.020 percent, 0.024 percent, and 0.020 percent of the baseline values of the respective variables. The greatest total regional effects on employment, output and POW income are attributable to the direct impacts on agriculture.

TABLE III-4

ANNUAL CHANGES IN REGIONAL RECREATION EXPENDITURES BY SECTOR (Thousands of 1992 Dollars)

	Baseline	Alt. 1	Alt. 2	Alt. 3	Alt. 4
SACRAMENTO RIVER REGION					
Food Stores	8,603	46	123	123	123
Service Stations	15,495	91	245	245	245
Eating and Drinking Places	9,172	80	219	219	219
Hotels and Lodging Places	14,834	47	121	121	121
Miscellaneous Retail	8,992	48	130	130	130
Total	57,096	312	838	838	838
SAN JOAQUIN RIVER REGION					
Food Stores	3,555	43	100	155	155
Service Stations	6,027	87	204	301	301
Eating and Drinking Places	3,602	81	188	245	245
Hotels and Lodging Places	6,027	38	90	185	185
Miscellaneous Retail	3,698	45	106	164	164
Total	22,909	294	688	1,050	1,050
TULARE LAKE REGION					
Food Stores	5	0	8	8	8
Service Stations	9	0	14	14	14
Eating and Drinking Places	5	0	8	8	8
Hotels and Lodging Places	9	0	14	14	14
Miscellaneous Retail	6	0	8	8	8
Total	34	0	52	52	52

The largest employment and income impacts are in services (see Table III-3). Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Reduced recreation expenditures and higher M&I water costs affect the trade and service sectors as well.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $100,000; all of this decline is in agriculture. The decline is about 10 percent of to the initial gross revenue change of $1.0 million taken from CVPM. Much of the remaining 90 percent represents rice milled in the region.

SAN JOAQUIN RIVER REGION

Agriculture

Impacts Due to Cropping Changes. The absolute impacts of Alternative 1 on San Joaquin River Region agriculture, relative to the No-Action Alternative, are larger than those on the Sacramento River Region because of greater reductions in CVP water availability in the San Joaquin River Region. Total irrigated land declines by 31,000 acres; 19,000 acres are of cotton, 6,000 are field crops and hay, and 2,000 are grains. Gross revenues from cotton fall $21 million, those from vegetables decline $6 million, and those from hay and pasture fall $2 million. Resultant cropping changes cause a direct loss of about 470 jobs in agricultural production and food processing, the latter in fruit and vegetable processing and sugar beet refining. Fruit and vegetable processing and sugar beet refining are examples of forward-linked industries, as discussed in the "Impacts Due to Cropping Changes" section for the Sacramento River Region. Total regional impacts include losses of about 1,500 jobs, $106.7 million in output, and $43.6 million in POW income.

Impacts Due to Reduced Net Income. Alternative 1 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 470 jobs, $30.9 million in regional output, and $17.1 million in regional POW income. Total regional impacts include losses of about 860 jobs, $54.2 million in regional output, and $30.8 million in regional POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 1 changes in agriculture include direct losses of about 950 jobs, $78.1 million in output, and $28.9 million in POW income. Total direct, indirect, and induced impacts include losses of about 2,370 jobs, $160.9 million in output, and $74.4 million in POW income.

Recreation

Alternative 1 results in an increase of $300,000 in recreational spending relative to baseline conditions (Table III-4), or about a 1 percent increase. The resultant changes in final demands, relative to the No-Action Alternative, cause direct gains in the impacted retail and service sectors of about 10 jobs, $300,000 in output, and $200,000 in POW income. Total impacts include gains of about 20 jobs, $800,000 in output, and $500,000 in POW income. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

Municipal and Industrial Water Costs

Alternative 1 results in reduced personal income of $3.6 million per year because of higher M&I water costs, due primarily to household metering costs and restoration payments. The resultant declines in consumer spending cause direct losses of 52 jobs, $3.6 million in output, and $2.0 million in POW income. Total impacts include losses of about 100 jobs, $6 million in output, and $3.4 million in POW income.

Total Impacts

Total direct impacts, relative to the No-Action Alternative, include losses of about 990 jobs, $81.1 million in output, and $30.6 million in POW income. Total direct, indirect, and induced impacts include losses of about 2,450 jobs, $166.3 million in output, and $77.5 million in POW income. The total direct, indirect, and induced impacts represent 0.28 percent, 0.28 percent, and 0.26 percent of the baseline values of the respective variables.

The largest employment impacts are in agriculture, trade, and services (see Table III-3). The largest output impacts are in agriculture, manufacturing, and finance, insurance, and real estate (FIRE). The largest POW income impacts are in FIRE, trade, and services. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the manufacturing, FIRE, and trade and services sectors. Reduced recreation expenditures and higher M&I water costs affect the trade and service sectors as well.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $33.3 million. All of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $32.9 million taken from CVPM.

TULARE LAKE REGION

Agriculture

Impacts Due to Cropping Changes. The absolute impacts of Alternative 1 on Tulare Lake Region agriculture, relative to the No-Action Alternative, are about half those for the San Joaquin River Region because of the availability of local groundwater supplies in the Tulare Lake Region to replace reduced CVP supplies. Total irrigated land declines by 15,600 acres in the Tulare Lake Region, of which 9,700 are cotton, 2,500 are alfalfa, and 2,500 are grain and other field crops. Gross revenues for cotton fall about $9.8 million. Gross revenues for vegetables fall about $1.9 million. Resultant cropping changes cause a direct loss of about 210 jobs in agricultural production. Total regional impacts include losses of about 570 jobs, $36.6 million in output, and $14.3 million in POW income.

Impacts Due to Reduced Net Income. Alternative 1 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 220 jobs, $13.9 million in regional output, and $7.6 million in regional POW income. Total regional impacts include losses of about 370 jobs, $23 million in regional output, and $12.8 million in regional POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 1 changes in agriculture, relative to the No-Action Alternative, include direct losses of about 430 jobs, $30.3 million in output, and $11.3 million in POW income. Total direct, indirect, and induced impacts include losses of about 940 jobs, $59.6 million in output, and $27 million in POW income.

Recreation

Alternative 1 causes no impacts on recreational spending relative to the No-Action Alternative. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

Municipal and Industrial Water Costs

Alternative 1 causes no impacts on municipal and industrial water costs in the Tulare Lake Region, relative to No-Action Alternative.

Total Impacts

Total direct impacts are the same as those shown for agriculture. Total direct, indirect, and induced impacts represent 0.20 percent, 0.19 percent, and 0.18 percent of the baseline values of the respective variables.

The largest employment impacts are in agriculture, trade, and services. The largest output impacts are in agriculture, trade, and manufacturing (see Table III-2). The largest income impacts are in trade, agriculture, and FIRE. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $16.5 million; all of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $16.0 million taken from CVPM.

NORTH COAST REGION

Alternative 1 causes no impacts on recreational spending relative to the No-Action Alternative. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

CENTRAL COAST REGION

For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

SOUTH COAST REGION

Alternative 1 causes no impacts on recreational spending relative to the No-Action Alternative. Alternative 1 results in greater deliveries of SWP water for M&I purposes in the South Coast Region. M&I water costs decline, and discretionary income available for non-water purchases increases by $32.7 million per year. The resultant increases in consumer spending cause direct gains of about 410 jobs, $30.6 million in output, and $16.3 million in POW income. Total impacts include gains of about 960 jobs, $69.6 million in output, and $38.9 million in POW income.

SAN FRANCISCO BAY REGION

Alternative 1 results in reduced personal income of $3.8 million per year in the San Francisco Bay Region because of higher water costs, due primarily to restoration payments. The resultant declines in consumer spending cause direct losses of about 45 jobs, $3.5 million in output, and $1.9 million in POW income. Total impacts include losses of about 100 jobs, $7.4 million in output, and $4.2 million in POW income.

TOTAL CALIFORNIA IMPACTS

Total direct impacts across all impacted regions in California, relative to the No-Action Alternative, include losses of about 1,130 jobs, $92.9 million in output, and $31.0 million in POW income. Total direct, indirect, and induced impacts include losses of about 2,790 jobs, $183.4 million in output, and $80 million in POW income. The total direct, indirect, and induced impacts represent 0.018 percent, 0.015 percent, and 0.012 percent of the baseline values of the respective variables. Total regional job losses due to agricultural impacts include about 2,190 due to fallowed land and about 1,280 due to reduced net income. Those losses are offset in part by the positive effects of increased M&I deliveries and resultant job gains in the South Coast Region.

ALTERNATIVE 2

Provisions of CVPIA implemented in Alternative 2 include all features of Alternative 1 plus the acquisition of water for in-stream flow and wildlife refuges. By assumption, (b)(3) water is acquired from willing agricultural sellers who would reduce acreage to provide water for sale, and acquisition is limited to an amount achievable within the limits of the Restoration Fund.

Table III-5 includes the employment, output, and income effects on all sectors, in each regional economy, of changes initiated in three key sectors: agriculture, recreation, and M&I water use. Table III-6 shows the impacts of implementation of Alternative 2 on individual sectors within each region.

TABLE III-5

REGIONAL ECONOMIC IMPACTS ON ALL SECTORS OF ALTERNATIVE 2

	Impacts on All Sectors					
	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Directly Impacted Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agriculture						
Reduced Output	-60	-460	-15.1	-38.8	-3.4	-16.3
Reduced Net Income	-30	-70	-2.2	-4.4	-1.2	-2.5
Increased Income from Water Sales	20	40	1.2	2.4	0.7	1.4
Total Agriculture	-80	-490	-16.1	-40.8	-4.0	-17.4
Recreation	20	40	0.8	2.1	0.5	1.3
M & I Water Costs	-50	-110	-3.6	-7.5	-2.0	-4.3
TOTAL (1)	-110	-560	-18.9	-46.3	-5.5	-20.5
San Joaquin River						
Agriculture						
Reduced Output	-830	-2,420	-73.8	-165.9	-19.6	-69.3
Reduced Net Income	-510	-930	-33.3	-58.5	-18.5	-33.2
Increased Income from Water Sales	240	430	15.4	27.0	8.5	15.4
Total Agriculture	-1,100	-2,920	-91.7	-197.4	-29.5	-87.1
Recreation	20	30	0.7	1.5	0.4	0.9
M & I Water Costs	-50	-100	-3.3	-6.0	-1.8	-3.4
TOTAL (1)	-1,130	-2,990	-94.3	-201.9	-30.9	-89.7
Tulare Lake						
Agriculture						
Reduced Output	-190	-530	-15.2	-34.1	-3.4	-13.2
Reduced Net Income	-240	-400	-15.3	-25.3	-8.3	-14.0
Increased Income from Water Sales	40	60	2.4	4.0	1.3	2.2
Total Agriculture	-390	-870	-28.1	-55.4	-10.4	-25.1
Recreation	0	0	0.0	0.1	0.0	0.1
M & I Water Costs	0	0	0.0	0.0	0.0	0.0
TOTAL (1)	-390	-870	-28.0	-55.3	-10.4	-25.0
South & Central Coast						
M & I Water Costs	410	960	30.6	69.6	16.3	38.9
Bay Area						
M & I Water Costs	-50	-100	-3.5	-7.4	-1.9	-4.2
California Total						
Agriculture						
Reduced Output	-1,080	-3,410	-104.1	-238.8	-26.4	-98.8
Reduced Net Income	-780	-1,400	-50.7	-88.2	-28.0	-49.8
Increased Income from Water Sales	290	530	19.0	33.4	10.5	18.9
Total Agriculture	-1,570	-4,280	-135.8	-293.6	-43.9	-129.6
Recreation	40	80	1.5	3.6	0.9	2.2
M & I Water Costs	260	650	20.1	48.6	10.6	27.0
TOTAL (1)	-1,270	-3,550	-114.2	-241.3	-32.4	-100.5

NOTE:
(1) May differ from sum of elements because of rounding.

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TABLE III-6
REGIONAL ECONOMIC IMPACTS OF ALTERNATIVE 2, BY AFFECTED SECTOR

	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Affected Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agric., Frst., Fish	-20	-130	-1.3	-5.2	-0.3	-1.6
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	-10	0.0	-0.6	0.0	-0.4
Manufacturing	-50	-70	-15.1	-16.9	-3.6	-4.3
TCU	0	-30	-0.2	-4.4	-0.1	-2.0
Trade	-10	-110	-0.2	-4.3	-0.2	-2.9
FIRE	-10	-50	-0.9	-6.2	-0.6	-4.0
Services	-20	-140	-0.9	-6.7	-0.5	-4.2
Government & Misc.	0	-10	-0.2	-1.9	-0.1	-1.1
TOTAL (1)	-110	-560	-18.9	-46.3	-5.5	-20.5
San Joaquin River						
Agric., Frst., Fish	-720	-1,180	-54.6	-71.1	-13.1	-18.9
Mining	0	0	-0.1	-0.4	0.0	-0.2
Construction	0	-40	0.0	-2.4	0.0	-1.3
Manufacturing	-170	-240	-27.0	-38.5	-9.7	-13.3
TCU	-10	-80	-0.8	-9.4	-0.4	-4.2
Trade	-140	-600	-5.7	-22.4	-3.9	-15.0
FIRE	-20	-240	-2.7	-29.0	-1.7	-19.1
Services	-60	-570	-2.9	-25.7	-1.8	-16.0
Government & Misc.	0	-30	-0.5	-3.1	-0.3	-1.7
TOTAL (1)	-1,130	-2,990	-94.3	-201.9	-30.9	-89.7
Tulare Lake						
Agric., Frst., Fish	-190	-320	-15.3	-19.8	-3.4	-5.0
Mining	0	0	0.0	-0.4	0.0	-0.2
Construction	0	-10	0.0	-0.7	0.0	-0.4
Manufacturing	-40	-50	-5.1	-7.8	-2.1	-2.9
TCU	0	-20	-0.5	-2.9	-0.3	-1.4
Trade	-100	-220	-4.0	-8.1	-2.7	-5.5
FIRE	-10	-60	-1.4	-7.0	-0.9	-4.6
Services	-30	-170	-1.5	-7.4	-0.9	-4.6
Government & Misc.	0	-10	-0.3	-1.1	-0.1	-0.5
TOTAL (1)	-390	-870	-28.0	-55.3	-10.4	-25.0
Bay Area						
Agric., Frst., Fish	0	0	0.0	-0.1	0.0	0.0
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0.0	-0.1	0.0	-0.1
Manufacturing	-10	-10	-0.9	-1.4	-0.3	-0.5
TCU	0	0	-0.2	-0.6	-0.1	-0.3
Trade	-20	-30	-0.6	-1.2	-0.4	-0.8
FIRE	0	-10	-0.8	-1.7	-0.5	-1.1
Services	-20	-40	-0.9	-2.0	-0.5	-1.2
Government & Misc.	0	0	-0.2	-0.3	-0.1	-0.1
TOTAL (1)	-50	-100	-3.5	-7.4	-1.9	-4.2
South & Central Coast						
Agric., Frst., Fish	0	10	0.2	0.6	0.1	0.3
Mining	0	0	0.0	0.1	0.0	0.0
Construction	0	10	0.0	0.9	0.0	0.5
Manufacturing	50	90	7.7	13.6	2.6	4.8
TCU	20	50	2.1	6.3	1.1	3.3
Trade	140	290	5.4	11.3	3.2	6.9
FIRE	40	110	6.6	16.0	4.2	10.6
Services	150	370	7.4	18.2	4.5	11.5
Government & Misc.	10	20	1.1	2.5	0.5	1.1
TOTAL (1)	410	960	30.6	69.6	16.3	38.9
California Total						
Agric., Frst., Fish	-930	-1,620	-71.0	-95.5	-16.8	-25.2
Mining	0	0	-0.1	-0.7	-0.1	-0.4
Construction	0	-50	0.0	-2.8	0.0	-1.6
Manufacturing	-220	-280	-40.4	-51.1	-13.1	-16.3
TCU	0	-90	0.3	-11.1	0.2	-4.6
Trade	-120	-670	-5.1	-24.7	-3.9	-17.3
FIRE	-10	-260	0.9	-27.9	0.6	-18.3
Services	20	-550	1.3	-23.6	0.8	-14.5
Government & Misc.	0	-40	-0.1	-4.0	-0.1	-2.3
TOTAL (1)	-1,270	-3,550	-114.2	-241.3	-32.4	-100.5

NOTE:
(1) May differ from sum of elements because of rounding.

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SACRAMENTO RIVER REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land would decline by 6,000 acres, relative to the No-Action Alternative; 4,300 acres are rice and 1,700 are field crops and grains. These changes are converted to changes in final demands for crops and for forward-linked sections, using the procedure described for Alternative 1. Resultant cropping changes cause a direct loss of about 60 jobs in agricultural production. Total regional impacts include losses of about 460 jobs, $38.8 million in regional output, and $16.3 million in POW income.

Impacts Due to Reduced Net Income. Alternative 2 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 30 jobs, $2.2 million in regional output, and $1.2 million in regional POW income. Total regional impacts include losses of about 70 jobs, $4.4 million in regional output, and $2.5 million in regional POW income.

Impacts Due to Water Sales. Alternative 2 provides for the sale of water by willing sellers for Level 4 refuge water supplies. Net income of irrigators increases $0.7 million, leading to direct gains of about 20 jobs, $1.2 million in regional output, and $700,000 in POW income. Total regional impacts include gains of about 40 jobs, $2.4 million in output, and $1.4 million in POW income.

Total Impacts Due to Changes in Agriculture. Total regional impacts due to Alternative 2 changes in agriculture, relative to the No-Action Alternative, include direct losses of about 80 jobs, $16.1 million in output, and $4.0 million in POW income. Total direct, indirect, and induced impacts include losses of about 490 jobs, $40.8 million in output, and $17.4 million in POW income.

Recreation

Alternative 2 results in an increase of $838,000 in recreational spending relative to baseline conditions (Table III-4), or about a 1 percent increase. The resultant changes in final demands, relative to the No-Action Alternative, cause direct gains in the impacted retail and service sectors of about 20 jobs, $800,000 in output, and $500,000 in POW income. Total impacts include the gain of about 40 jobs, $2.1 million in output, and $1.3 million in POW income. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

Municipal and Industrial Water Costs

The losses attributable to the impacts of Alternative 2 on M&I water costs are the same as those attributable to Alternative 1.

Total Impacts

Total direct impacts of Alternative 2, relative to the No-Action Alternative, include losses of about 110 jobs, $18.9 million in output, and $5.5 million in POW income. Total direct, indirect, and induced impacts include losses of about 560 jobs, $46 million in output, and $20 million in POW income. The total direct, indirect, and induced impacts represent 0.042 percent, 0.056 percent, and 0.043 percent of the baseline values of the respective variables. The greatest total regional effects on employment, output, and income are attributable to the direct impacts on agriculture.

The largest employment impacts are in agriculture. The largest output impacts are in manufacturing. The largest income impacts are in FIRE and services. Reduced rice output and lower net farm income cause reduced output by the rice milling sector and lower demands for production inputs. Higher M&I water costs also reduce economic activity, while increased recreation expenditures offset some of the decline.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $1.3 million; all of this decline is in agriculture. The decline is about 28 percent of the initial gross revenue change of $4.6 million taken from CVPM. Much of the remaining 72 percent represents rice milled in the region.

SAN JOAQUIN RIVER REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines by 64,000 acres, relative to the No-Action Alternative; 28,000 acres are cotton, 19,000 are field crops and hay, and 3,000 are grains. These changes are converted to changes in final demands for crops and for forward-linked sections, using the procedure described for Alternative 1. These changes are converted to changes in final demands for crops and for forward-lined sectors using the procedure described for Alternative 1. Gross revenues from cotton fall $28 million, those for vegetables decline $8 million, and those for hay and pasture fall $9 million. Resultant cropping changes cause a direct loss of about 830 jobs to agricultural production and food processing. Total regional impacts include the losses of about 2,420 jobs, $165.9 million in output, and $69.3 million in POW income.

Impacts Due to Reduced Net Income. Alternative 2 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 510 jobs, $33.3 million in regional output, and $18.5 million in regional POW income. Total regional impacts include losses of about 930 jobs, $58.5 million in regional output, and $33.2 million in regional POW income.

Impacts Due to Water Sales. Alternative 2 provides for the sale of water by willing sellers. Net income of irrigators increases $16.6 million, leading to direct gains of about 240 jobs, $15.4 million in output, and $8.5 million in POW income. Total regional impacts include gains of about 430 jobs, $27 million in output, and $15.4 million in POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 2 changes in agriculture include direct losses of about 1,100 jobs, $91.7 million in output, and $29.5 million in POW income. Total direct, indirect, and induced impacts include losses of about 2,920 jobs, $197.4 million in output, and $87.1 million in POW income.

Recreation

Alternative 2 results in an increase of $700,000 in recreational spending relative to baseline conditions (Table III-4), or about a 3 percent increase. The resultant changes in final demands, relative to the No-Action Alternative, cause direct gains in the impacted retail and service sectors of about 20 jobs, $700,000 in output, and $400,000 in POW income. Total impacts include gains of about 30 jobs, $1.5 million in output, and $900,000 in POW income. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

Municipal and Industrial Water Costs

The losses attributable to the impacts of Alternative 2 on M&I water costs are the same as those attributable to Alternative 1.

Total Impacts

Total direct impacts of Alternative 2, relative to the No-Action Alternative, include losses of about 1,1303 jobs, $94.3 million in output, and $30.9 million in POW income. Total direct, indirect, and induced impacts include losses of about 2,990 jobs, $201.9 million in output, and $89.7 million in POW income. The total direct, indirect, and induced impacts represent 0.34 percent, 0.34 percent, and 0.30 percent of the baseline values of the respective variables.

The largest employment impacts are in agriculture, trade, and services. The largest output impacts are in agriculture, manufacturing, and FIRE. The largest income impacts are in FIRE, agriculture, and services.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $54.6 million; all of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $54.1 million taken from CVPM.

TULARE LAKE REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines, relative to the No-Action Alternative, by 14,100 acres, of which 9,300 are cotton, 2,200 are alfalfa, and 1,700 are grain and other field crops. Gross revenues for cotton fall about $10 million. Gross revenues for hay and pasture fall about $1.4 million and for vegetables fall about $1.8 million. Resultant cropping changes cause a direct loss of about 190 jobs in agricultural production. Total regional impacts include the losses of about 530 jobs, $34.1 million in output, and $13.2 million in POW income.

Impacts Due to Reduced Net Income. Alternative 2 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 240 jobs, $15.3 million in regional output, and $8.3 million in regional POW income. Total regional impacts include losses of about 400 jobs, $25.3 million in regional output, and $14 million in regional POW income.

Impacts Due to Water Sales. Alternative 2 provides for the sale of water by willing sellers. Net income of irrigators increases $2.6 million, leading to direct gains of about 40 jobs, $ 2.4 million in output, and $1.3 million in POW income. Total regional impacts include gains of about 60 jobs, $4 million in output, and $2.2 million in POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 2 changes in agriculture include direct losses of about 390 jobs, $28.0 million in output, and $10.4 million in POW income. Total direct, indirect, and induced impacts include losses of about 870 jobs, $55.3 million in output, and $25.0 million in POW income.

Recreation

Alternative 2 causes a 53 percent increase in recreational spending relative to baseline conditions, from $34,000 to $52,000. While the percentage gain is large, the absolute gain is modest. Direct gains include increases of one job and small increments in both output and POW income. Total impacts include gains of two jobs and approximately $100,000 in both regional output and POW income. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

Municipal and Industrial Water Costs

Alternative 2 has no impacts on municipal and industrial water costs in the Tulare Lake Region.

Total Impacts

Total direct impacts of Alternative 2 on the Tulare Lake Region, relative to the No-Action Alternative, include direct losses of about 390 jobs, $28 million in output, and $10.4 million in POW income. Total direct, indirect, and induced impacts include losses of about 870 jobs, $55.3 million in output, and $25.0 million in POW income. The total direct, indirect, and induced impacts represent 0.17 percent, 0.18 percent, and 0.17 percent of the baseline values of the respective variables.

The largest employment impacts are in agriculture, trade, and services. The largest output impacts are in agriculture, trade, and manufacturing. The largest income impacts are in trade, agriculture, and FIRE and services. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $15.3 million; all of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $14.8 million taken from CVPM.

NORTH COAST REGION

Alternative 2 causes no impacts on recreational spending in the North Coast Region relative to the No-Action Alternative. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

CENTRAL COAST REGION

Alternative 2 causes no impacts on recreational spending in the Central Coast Region relative to the No-Action Alternative. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

SOUTH COAST REGION

Alternative 2 results in greater deliveries of SWP water for M&I purposes in the South Coast Region. The impacts are the same as those for Alternative 1.

SAN FRANCISCO BAY REGION

Alternative 2 results in higher M&I water costs for the San Francisco Bay Region. The impacts are the same as those for Alternative 1.

TOTAL CALIFORNIA IMPACTS

The total direct impacts of Alternative 2 across all impacted regions in California, relative to the No-Action Alternative, include losses of about 1,270 jobs, $114.2 million in output, and $32.4 million in POW income. Total direct, indirect, and induced impacts include losses of about 3,550 jobs, $241 million in output, and $100 million in POW income. The total direct, indirect, and induced impacts represent 0.002 percent, 0.006 percent, and 0.001 percent of the baseline values of the respective variables.

ALTERNATIVE 3

Alternative 3 includes the same implementation options as Alternative 2, with additional water acquisition for instream flow needs on the eastside Sacramento and San Joaquin River tributaries. Under Alternative 3, water acquired and released for instream flow can be diverted from the Delta for export to the San Joaquin Valley and coastal regions, if consistent with other existing water quality and environmental restrictions.

Table III-7 includes the employment, output, and income effects on all sectors, in each regional economy, of changes initiated in three key sectors: agriculture, recreation, and M&I water use. Table III-8 shows the impacts of implementation of Alternative 3 on individual sectors within each region.

SACRAMENTO RIVER REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines by 23,800 acres relative to the No-Action Alternative. Rice acreage declines by 12,700, and irrigated pasture declines by 5,400. Field crops and grains decline by 3,400 acres. These changes are converted to changes in final demands for crops and for forward-linked industries, as described previously. Resultant cropping changes cause a direct loss of about 210 jobs in agricultural production. Total regional impacts include losses of about 1,380 jobs, $115.5 million in regional output, and $49 million in POW income.

Impacts Due to Reduced Net Income. Alternative 3 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 50 jobs, $3.5 million in regional output, and $1.9 million in regional POW income. Total regional impacts include losses of about 110 jobs, $7.1 million in regional output, and $4.1 million in regional POW income.

Impacts Due to Water Sales. Alternative 3 provides for the sale of water by willing sellers to willing buyers. Net income of irrigators increases $8.7 million, leading to direct gains of about 120 jobs, $8.1 million in regional output, and $4.4 million in POW income. Total regional impacts include gains of about 250 jobs, $16.3 million in output, and $9.3 million in POW income.

Total Impacts Due to Changes in Agriculture. Total regional impacts due to Alternative 3 changes in agriculture, relative to the No-Action Alternative, include direct losses of about 140 jobs, $40.1 in output, and $7.9 million in POW income. Total direct, indirect, and induced impacts include losses of about 1,240 jobs, $106 million in output, and $36.6 million in POW income.

Recreation

The gains attributable to the impacts of Alternative 3 on recreation are the same as Alternative 2.

Municipal and Industrial Water Costs

The losses attributable to the impacts of Alternative 3 on M&I costs differ by only $10,000 from those attributable to Alternative 2.

TABLE III-7
REGIONAL ECONOMIC IMPACTS ON ALL SECTORS OF ALTERNATIVE 3

	Impacts on All Sectors					
	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Directly Impacted Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agriculture						
Reduced Output	-210	-1,380	-44.7	-115.5	-10.4	-48.9
Reduced Net Income	-50	-110	-3.5	-7.1	-1.9	-4.1
Increased Income from Water Sales	120	250	8.1	16.3	4.4	9.3
Total Agriculture	-140	-1,240	-40.1	-106.4	-7.9	-43.6
Recreation	20	40	0.8	2.1	0.5	1.3
M & I Water Costs	-50	-110	-3.6	-7.5	-2.0	-4.3
TOTAL (1)	-170	-1,310	-43.0	-111.8	-9.4	-46.7
San Joaquin River						
Agriculture						
Reduced Output	-1,370	-3,640	-107.1	-239.3	-30.7	-102.7
Reduced Net Income	-440	-800	-28.5	-50.1	-15.8	-28.5
Increased Income from Water Sales	820	1,490	53.4	93.9	29.7	53.3
Total Agriculture	-990	-2,950	-82.2	-195.6	-16.9	-77.9
Recreation	30	50	1.0	2.2	0.6	1.3
M & I Water Costs	-40	-70	-2.4	-4.3	-1.3	-2.5
TOTAL (1)	-1,000	-2,960	-83.6	-197.7	-17.6	-79.0
Tulare Lake						
Agriculture						
Reduced Output	-180	-510	-14.7	-33.1	-3.2	-12.7
Reduced Net Income	-200	-330	-12.4	-20.5	-6.8	-11.4
Increased Income from Water Sales	20	40	1.5	2.4	0.8	1.3
Total Agriculture	-350	-800	-25.6	-51.1	-9.1	-22.8
Recreation	0	0	0.0	0.1	0.0	0.1
M & I Water Costs	0	0	0.0	0.0	0.0	0.0
TOTAL (1)	-350	-800	-25.6	-51.1	-9.1	-22.7
South & Central Coast						
M & I Water Costs	1,330	3,110	98.8	225.0	52.9	125.9
Bay Area						
M & I Water Costs	-40	-90	-3.4	-7.0	-1.8	-4.0
California Total						
Agriculture						
Reduced Output	-1,760	-5,530	-166.5	-387.9	-44.3	-164.3
Reduced Net Income	-680	-1,230	-44.4	-77.7	-24.5	-43.9
Increased Income from Water Sales	960	1,780	62.9	112.5	34.9	64.0
Total Agriculture	-1,490	-4,990	-148.0	-353.1	-33.9	-144.2
Recreation	50	100	1.8	4.4	1.2	2.7
M & I Water Costs	1,200	2,830	89.5	206.1	47.7	115.1
TOTAL (1)	-240	-2,060	-56.7	-142.7	15.0	-26.5

NOTE:
(1) May differ from sum of elements because of rounding.

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TABLE III-8
REGIONAL ECONOMIC IMPACTS OF ALTERNATIVE 3, BY AFFECTED SECTOR

	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Affected Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agric., Frst., Fish	-90	-400	-4.9	-16.0	-1.5	-5.1
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	-20	0.0	-1.4	0.0	-0.9
Manufacturing	-110	-150	-38.9	-43.3	-8.5	-10.2
TCU	0	-80	-0.1	-11.2	0.0	-4.9
Trade	40	-210	1.5	-8.6	1.0	-5.9
FIRE	0	-120	-0.3	-13.1	-0.2	-8.4
Services	0	-300	-0.3	-14.0	-0.1	-8.8
Government & Misc.	0	-30	0.0	-4.2	0.0	-2.4
TOTAL (1)	-170	-1,310	-43.0	-111.8	-9.4	-46.7
San Joaquin River						
Agric., Frst., Fish	-1,250	-1,810	-83.8	-103.8	-22.8	-29.8
Mining	0	0	0.1	-0.2	0.0	-0.2
Construction	0	-40	0.0	-2.3	0.0	-1.3
Manufacturing	-50	-120	-14.2	-26.5	-4.0	-7.6
TCU	10	-70	0.7	-8.1	0.3	-3.5
Trade	210	-250	8.3	-8.5	5.6	-5.6
FIRE	20	-230	2.2	-26.3	1.4	-17.6
Services	60	-430	2.5	-20.0	1.6	-12.3
Government & Misc.	0	-20	0.5	-2.0	0.3	-1.1
TOTAL (1)	-1,000	-2,960	-83.6	-197.7	-17.6	-79.0
Tulare Lake						
Agric., Frst., Fish	-180	-310	-14.8	-19.2	-3.2	-4.8
Mining	0	0	0.0	-0.3	0.0	-0.1
Construction	0	-10	0.0	-0.6	0.0	-0.3
Manufacturing	-40	-50	-4.3	-6.8	-1.8	-2.5
TCU	0	-20	-0.4	-2.7	-0.2	-1.3
Trade	-90	-190	-3.3	-7.2	-2.3	-4.8
FIRE	-10	-50	-1.2	-6.4	-0.7	-4.2
Services	-30	-150	-1.2	-6.7	-0.8	-4.1
Government & Misc.	0	-10	-0.3	-1.0	-0.1	-0.4
TOTAL (1)	-350	-800	-25.6	-51.1	-9.1	-22.7
Bay Area						
Agric., Frst., Fish	0	0	0.0	-0.1	0.0	0.0
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0.0	-0.1	0.0	-0.1
Manufacturing	0	-10	-0.9	-1.4	-0.3	-0.5
TCU	0	0	-0.2	-0.6	-0.1	-0.3
Trade	-10	-30	-0.6	-1.2	-0.4	-0.7
FIRE	0	-10	-0.7	-1.6	-0.5	-1.1
Services	-20	-40	-0.8	-1.9	-0.5	-1.2
Government & Misc.	0	0	-0.1	-0.3	-0.1	-0.1
TOTAL (1)	-40	-90	-3.4	-7.0	-1.8	-4.0
South & Central Coast						
Agric., Frst., Fish	10	40	0.7	2.1	0.3	0.9
Mining	0	0	0.1	0.3	0.0	0.1
Construction	0	40	0.0	3.0	0.0	1.7
Manufacturing	160	290	25.0	43.9	8.5	15.4
TCU	50	150	6.7	20.2	3.6	10.7
Trade	460	950	17.4	36.7	10.5	22.2
FIRE	120	360	21.4	51.8	13.6	34.2
Services	490	1,190	23.9	58.9	14.6	37.2
Government & Misc.	30	80	3.6	8.0	1.8	3.5
TOTAL (1)	1,330	3,110	98.8	225.0	52.9	125.9
California Total						
Agric., Frst., Fish	-1,510	-2,490	-102.8	-136.9	-27.2	-38.9
Mining	0	0	0.2	-0.3	0.1	-0.3
Construction	0	-30	0.0	-1.4	0.0	-0.9
Manufacturing	-40	-300	-33.2	-34.1	-0.6	-5.4
TCU	50	-20	6.6	2.3	3.6	0.7
Trade	610	270	23.3	11.2	14.4	5.1
FIRE	120	-50	21.3	4.3	13.6	2.9
Services	500	270	24.1	16.3	14.7	10.7
Government & Misc.	30	10	3.7	0.5	1.8	-0.6
TOTAL (1)	-240	-2,060	-56.7	-142.7	15.0	-26.5

NOTE:
(1) May differ from sum of elements because of rounding.

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Total Impacts

Total direct impacts of Alternative 3, relative to the No-Action Alternative, include losses of about 170 jobs, $43 million in output, and $9.4 million in POW income. Total direct, indirect, and induced impacts include losses of about 1,310 jobs, $111.8 million in output, and $46.7 million in POW income. The total direct, indirect, and induced impacts represent 0.10 percent, 0.138 percent, and 0.099 percent of the baseline values of the respective variables. The greatest total regional effects on employment, output, and POW income are attributable to the direct impacts on agriculture.

The largest employment and output impacts are in agriculture. The largest POW income impacts are in FIRE. Reduced rice output and lower net farm income cause reduced output by the rice milling sector and lower demands for production inputs. Reduced recreation expenditures and higher M&I water costs also affect the trade and services sectors.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $4.7 million; all of this decline is in agriculture. The decline is about 32 percent of the initial gross revenue change of $14.7 million taken from CVPM.

SAN JOAQUIN RIVER REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines by 129,700 acres relative to the No-Action Alternative, of which 27,700 acres are in cotton, 39,800 are in field crops and hay, 47,200 are in irrigated pasture, and 5,300 are in grains. Gross revenues from cotton fall $30 million, those for vegetables decline $7.5 million, and those for hay and pasture fall $22.2 million. Fruits and nuts fall $5.3 million because of the reduced availability of water and the resultant fallowing of some permanent crop land. These changes are converted to changes in final demands for crops and forward-linked sectors, as described previously. Resultant cropping changes cause a direct loss of about 1,370 jobs to agricultural production and food processing. Total regional impacts include the losses of about 3,640 jobs, $239.3 million in output, and $102.7 million in POW income.

Impacts Due to Reduced Net Income. Alternative 3 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 440 jobs, $28.5 million in regional output, and $15.8 million in regional POW income. Total regional impacts include losses of about 800 jobs, $50.1 million in regional output, and $28.5 million in regional POW income.

Impacts Due to Water Sales. Alternative 3 provides for the sale of water by willing sellers in the San Joaquin River Region. Net income of irrigators increases $57.6 million, leading to direct gains of about 820 jobs, $53.4 million in output, and $29.7 million in POW income. Total regional impacts include gains of about 1,490 jobs, $93.9 million in output, and $53.3 million in POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 3 changes, relative to the No-Action Alternative, in agriculture include direct losses of about 990 jobs, $82.2 million in output, and $16.9 million in POW income. The losses due to cropping changes and higher water costs are offset in part by the impacts of increased water sales on trade employment. Total direct, indirect, and induced impacts include losses of about 2,950 jobs, $195.6 million in output, and $77.9 million in POW income.

Recreation

Alternative 3 results in an increase of $1.05 million in recreational spending relative to baseline conditions (Table III-4), or about a 5 percent increase. The resultant changes in final demands, relative to the No-Action Alternative, cause direct gains in the impacted retail and service sectors of about 30 jobs, $1 million in output, and $600,000 in POW income. Total impacts include the gain of about 50 jobs, $2.2 million in output, and $1.3 million in POW income. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

Municipal and Industrial Water Costs

Alternative 3 results in reduced personal income of $2.6 million per year because of higher M&I water costs, due primarily to household metering costs and restoration payments. The resultant declines in consumer spending cause direct losses of about 40 jobs, $2.4 million in output, and $1.3 million in POW income. Total impacts include losses of about 70 jobs, $4.3 million in output, and $2.5 in POW income.

Total Impacts

Total direct impacts of Alternative 3, relative to the No-Action Alternative, include losses of about 1,000 jobs, $83.6 million in output, and a gain of $17.6 million in POW income. Total direct, indirect, and induced impacts include losses of about 2,960 jobs, $197.7 million in output, and $79 million in POW income. The total direct, indirect, and induced impacts represent 0.28 percent, 0.29 percent, and 0.26 percent of the baseline values of the respective variables.

The largest employment impacts are in agriculture, services, and trade(s). The largest output impacts are in agriculture, manufacturing, and FIRE. The largest income impacts are in agriculture, FIRE, and services.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $83.6 million; all of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $83.2 million taken from CVPM.

TULARE LAKE REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines by 13,400 acres, relative to the No-Action Alternative, of which 9,200 are in cotton, 2,300 are in grain and other field

crops, and 1,300 are in alfalfa hay. Gross revenues for cotton fall about $9.8 million. Gross revenues for vegetables fall $1.9 million and hay and pasture fall about $800,000. These changes are converted to changes in final demands for crops, as described previously. Resultant cropping changes cause a direct loss of about 180 jobs in agricultural production. Total regional impacts include the losses of about 510 jobs, $33.1 million in output, and $12.7 million in POW income.

Impacts Due to Reduced Net Income. Alternative 3 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 200 jobs, $12.4 million in regional output, and $6.8 million in regional POW income. Total regional impacts include losses of about 330 jobs, $20,500,000 in regional output, and $11.4 million in regional POW income.

Impacts Due to Water Sales. Alternative 3 provides for the sale of water by willing sellers to willing buyers. Net income of irrigators increases $1.6 million, leading to direct gains of about 20 jobs, $1.5 million in regional output, and $800,000 in POW income. Total regional impacts include gains of about 40 jobs, $2.4 million in output, and $1.3 million in POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 3 changes in agriculture include direct losses of about 350 jobs, $25.6 million in output, and $9.1 million in POW income. Total direct, indirect, and induced impacts include losses of about 800 jobs, $51.1 million in output, and $22.8 million in POW income.

Recreation

The recreational gains attributable to Alternative 3 are the same as those attributable to Alternative 2.

Municipal and Industrial Water Costs

Alternative 3 causes no impacts on municipal and industrial water costs in the Tulare Lake Region.

Total Impacts

Total direct impacts of Alternative 3 on the Tulare Lake Region, relative to the No-Action Alternative, include direct losses of about 350 jobs, $25.6 million in output, and $9.1 million in POW income. Total direct, indirect, and induced impacts include losses of about 800 jobs, $51.1 million in output, and $22.7 million in POW income. The total direct, indirect, and induced impacts represent 0.17 percent, 0.17 percent, and 0.15 percent of the baseline values of the respective variables.

The largest employment and output impacts are in agriculture. The largest POW income impacts are in agriculture and trade. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $14.8 million; all of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $14.4 million taken from CVPM.

NORTH COAST REGION

Alternative 3 causes no impacts on recreational spending in the North Coast Region relative to the No-Action Alternative. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

SOUTH COAST REGION

Alternative 3 results in greater deliveries of SWP water for M&I purposes in the South Coast Region. M&I water costs decline, and discretionary income available for non-water purchases increases by $105.9 million per year. The resultant increases in consumer spending cause direct gains of about 1,330 jobs, $98.8 million in output, and $52.9 million in POW income. Total impacts include gains of about 3,110 jobs, $225 million in output, and $125.9 million in POW income.

SAN FRANCISCO BAY REGION

Alternative 3 results in reduced personal income of $3.6 million per year because of higher M&I water costs, due primarily to household metering costs and restoration payments. The resultant declines in consumer spending cause direct losses of about 40 jobs, $3.4 million in output, and $1.8 million in POW income. Total impacts include losses of about 90 jobs, $7 million in output, and $4 million in POW income.

TOTAL CALIFORNIA IMPACTS

The total direct impacts of Alternative 3 across all impacted regions in California, relative to the No-Action Alternative, include losses of about 240 jobs and $56.7 million in output, and a gain of $15.0 million in POW income. Total direct, indirect, and induced impacts include losses of about 2,060 jobs, $142.7 million in output, and $26.5 million in POW income. The total direct, indirect, and induced impacts represent 0.01 percent, 0.018 percent, and 0.003 percent of the baseline values of the respective variables.

The direct POW income impacts are positive, while the total POW income impacts are negative because of the relative magnitudes of the multipliers for fallowed land, higher water costs, and increased water sales. The multiplier for fallowed land (reduced output) is 3.3 for the specific combination of crop acres idled under this alternative. The multiplier for income from water sales is 1.8. Hence, every $1.00 in reduced output from fallowed land causes a $3.30 decline in total regional output across all sectors. Every $1.00 in increased income from water sales causes a $1.80 increase in total regional output. As a result, while the direct negative impacts of fallowed land do not outweigh the direct positive impacts of water sales, the total negative impacts from fallowed land more than offset the total positive impacts from water sales.

ALTERNATIVE 4

Alternative 4 includes the same assumptions for CVPIA implementation as Alternative 3, except that both dedicated water and acquired water are prescribed for in-Delta purposes, therefore reducing the ability of the CVP and SWP to export that water to San Joaquin Valley and coastal regions.

Table III-9 includes the employment, output, and income effects on all sectors, in each regional economy, of changes initiated in three key sectors: agriculture, recreation, and M&I water use. Table III-10 shows the impacts of implementation of Alternative 4 on individual sectors within each region.

SACRAMENTO RIVER REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines by 23,300 acres relative to the No-Action Alternative. Rice acreage declines by 12,600, irrigated pasture declines by 5,300 acres, and field and grain crops decline by 4,400 acres. These changes are converted to changes in final demands for crops and for forward-linked industries, as described previously. Resultant cropping changes cause a direct loss of about 200 jobs in agricultural production. Total regional impacts include losses of about 1,360 jobs, $113.4 million in regional output, and $47.9 million in POW income.

Impacts Due to Reduced Net Income. Alternative 4 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 60 jobs, $4.1 million in regional output, and $2.2 million in regional POW income. Total regional impacts include losses of about 120 jobs, $8.2 million in regional output, and $4.7 million in regional POW income.

Impacts Due to Water Sales. Alternative 4 provides for the sale of water by willing sellers in the Sacramento River Region. Net income of irrigators increases $8.76 million, leading to direct gains of about 120 jobs, $8.1 million in output, and $4.4 million in POW income. Total regional impacts include gains of about 250 jobs, $16.4 million in output, and $9.4 million in POW income.

Total Impacts Due to Changes in Agriculture. Total regional impacts due to Alternative 4 changes in agriculture include direct losses of about 140 jobs, $40.1 million in output, and $7.9 million in POW income. Total direct, indirect, and induced impacts include losses of about 1,240 jobs, $106.41 million in output, and $43.6 million in POW income.

Recreation

The gains attributable to the impacts of Alternative 4 on recreation are the same as attributable to Alternatives 2 and 3.

TABLE III-9
REGIONAL ECONOMIC IMPACTS ON ALL SECTORS OF ALTERNATIVE 4

	Impacts on All Sectors					
	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Directly Impacted Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agriculture						
Reduced Output	-200	-1,360	-43.7	-113.4	-10.1	-47.9
Reduced Net Income	-60	-120	-4.1	-8.2	-2.2	-4.7
Increased Income from Water Sales	120	250	8.1	16.4	4.4	9.4
Total Agriculture	-150	-1,230	-39.7	-105.3	-7.9	-43.3
Recreation	20	40	0.8	2.1	0.5	1.3
M & I Water Costs	-50	-110	-3.6	-7.5	-2.0	-4.3
TOTAL (1)	-170	-1,310	-42.6	-110.8	-9.4	-46.3
San Joaquin River						
Agriculture						
Reduced Output	-1,610	-4,340	-127.6	-286.3	-35.9	-122.2
Reduced Net Income	-530	-970	-34.8	-61.2	-19.3	-34.7
Increased Income from Water Sales	830	1,510	54.2	95.2	30.1	54.1
Total Agriculture	-1,310	-3,800	-108.2	-252.3	-25.2	-102.9
Recreation	30	50	1.0	2.2	0.6	1.3
M & I Water Costs	-60	-110	-3.8	-6.9	-2.1	-3.9
TOTAL (1)	-1,340	-3,860	-111.0	-257.0	-26.6	-105.4
Tulare Lake						
Agriculture						
Reduced Output	-240	-680	-19.1	-43.0	-4.3	-16.7
Reduced Net Income	-280	-470	-17.6	-29.1	-9.6	-16.2
Increased Income from Water Sales	30	40	1.6	2.6	0.9	1.5
Total Agriculture	-500	-1,100	-35.1	-69.5	-13.0	-31.4
Recreation	0	0	0.0	0.1	0.0	0.1
M & I Water Costs	0	0	0.0	0.0	0.0	0.0
TOTAL (1)	-490	-1,100	-35.0	-69.4	-13.0	-31.4
South & Central Coast						
M & I Water Costs	-70	-180	-5.6	-12.7	-3.0	-7.1
Bay Area						
M & I Water Costs	-40	-100	-3.5	-7.4	-1.9	-4.2
California Total						
Agriculture						
Reduced Output	-2,050	-6,380	-190.5	-442.8	-50.3	-186.9
Reduced Net Income	-870	-1,560	-56.5	-98.6	-31.2	-55.6
Increased Income from Water Sales	970	1,800	63.9	114.2	35.4	64.9
Total Agriculture	-1,950	-6,140	-183.0	-427.1	-46.1	-177.6
Recreation	50	100	1.8	4.4	1.2	2.7
M & I Water Costs	-230	-500	-16.5	-34.5	-9.0	-19.5
TOTAL (1)	-2,130	-6,540	-197.7	-457.2	-53.9	-194.5

NOTE:
(1) *May differ from sum of elements because of rounding.*

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TABLE III-10
REGIONAL ECONOMIC IMPACTS OF ALTERNATIVE 4, BY AFFECTED SECTOR

	Employment (# of jobs)		Output ($MM)		PoW Income ($MM)	
Region and Affected Sectors	**Direct**	**Total**	**Direct**	**Total**	**Direct**	**Total**
Sacramento River						
Agric., Frst., Fish	-90	-390	-407.0	-15.6	-1.4	-5.0
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	-20	0.0	-1.4	0.0	-0.8
Manufacturing	-110	-150	-38.4	-42.7	-8.4	-10.1
TCU	0	-80	-0.1	-11.1	0.0	-4.9
Trade	30	-220	1.3	-8.6	0.9	-6.0
FIRE	0	-120	-0.4	-13.0	-0.2	-8.4
Services	-10	-300	-0.3	-14.0	-0.2	-8.8
Government & Misc.	0	-30	0.0	-4.2	0.0	-2.3
TOTAL (1)	-170	-1,310	-42.6	-110.8	-9.4	-46.3
San Joaquin River						
Agric., Frst., Fish	-1,460	-2,170	-100.3	-125.3	-26.7	-35.5
Mining	0	0	0.1	-0.3	0.0	-0.3
Construction	0	-50	0.0	-3.0	0.0	-1.7
Manufacturing	-90	-180	-20.7	-36.1	-6.4	-10.9
TCU	0	-90	0.4	-10.8	0.2	-4.7
Trade	160	-430	6.3	-15.4	4.3	-10.2
FIRE	10	-300	1.3	-35.1	0.8	-23.4
Services	40	-610	1.5	-27.8	1.0	-17.2
Government & Misc.	0	-30	0.3	-3.0	0.2	-1.6
TOTAL (1)	-1,340	-3,860	-111.0	-257.0	-26.6	-105.4
Tulare Lake						
Agric., Frst., Fish	-240	-420	-19.2	-24.9	-4.3	-6.4
Mining	0	0	0.0	-0.5	0.0	-0.2
Construction	0	-10	0.0	-0.9	0.0	-0.5
Manufacturing	-50	-70	-6.3	-9.8	-2.6	-3.6
TCU	-10	-30	-0.6	-3.7	-0.3	-1.8
Trade	-130	-270	-4.9	-10.2	-3.4	-6.8
FIRE	-20	-70	-1.8	-8.8	-1.1	-5.8
Services	-40	-210	-1.8	-9.3	-1.1	-5.7
Government & Misc.	0	-10	-0.4	-1.4	-0.1	-0.6
TOTAL (1)	-490	-1,100	-35.0	-69.4	-13.0	-31.4
Bay Area						
Agric., Frst., Fish	0	0	0.0	-0.1	0.0	0.0
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0.0	-0.1	0.0	-0.1
Manufacturing	-10	-10	-0.9	-1.4	-0.3	-0.5
TCU	0	0	-0.2	-0.6	-0.1	-0.3
Trade	-20	-30	-0.6	-1.2	-0.4	-0.8
FIRE	0	-10	-0.8	-1.7	-0.5	-1.1
Services	-20	-40	-0.9	-2.0	-0.5	-1.2
Government & Misc.	0	0	-0.1	-0.3	-0.1	-0.1
TOTAL (1)	-40	-100	-3.5	-7.4	-1.9	-4.2
South & Central Coast						
Agric., Frst., Fish	0	0	0.0	-0.1	0.0	0.0
Mining	0	0	0.0	0.0	0.0	0.0
Construction	0	0	0.0	-0.2	0.0	-0.1
Manufacturing	-10	-20	-1.4	-2.5	-0.5	-0.9
TCU	0	-10	-0.4	-1.1	-0.2	-0.6
Trade	-30	-50	-1.0	-2.1	-0.6	-1.3
FIRE	-10	-20	-1.2	-2.9	-0.8	-1.9
Services	-30	-70	-1.4	-3.3	-0.8	-2.1
Government & Misc.	0	0	-0.2	-0.5	-0.1	-0.2
TOTAL (1)	-70	-180	-5.6	-12.7	-3.0	-7.1
California Total						
Agric., Frst., Fish	-1,790	-2,970	-124.1	-166.0	-32.4	-46.9
Mining	0	0	0.0	-0.8	0.0	-0.5
Construction	0	-90	0.0	-5.5	0.0	-3.2
Manufacturing	-270	-420	-67.7	-92.5	-18.2	-26.0
TCU	-10	-2,170	-0.9	-27.4	-0.5	-12.3
Trade	30	-1,010	1.1	-37.5	0.8	-25.0
FIRE	-20	-520	-2.8	-61.6	-1.8	-40.6
Services	-60	-1,230	-2.8	-56.4	-1.7	-35.0
Government & Misc.	0	-80	-0.5	-9.4	-0.2	-4.9
TOTAL (1)	-2,130	-6,540	-197.7	-457.2	-53.9	-194.5

NOTE:
(1) May differ from sum of elements because of rounding.

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Municipal and Industrial Water Costs

The losses attributable to the impacts of Alternative 4 on M&I water costs are the same as those attributable to Alternative 3.

Total Impacts

Total direct impacts of Alternative 4 include losses of about 170 jobs, $43.0 million in output, and $9.4 million in POW income. Total direct, indirect, and induced impacts include losses of about 1,310 jobs, $111.8 million in output, and $46.7 million in POW income. The total direct, indirect, and induced impacts represent 0.102 percent, 0.138 percent, and 0.10 percent of the baseline values of the respective variables. The greatest total regional effects on employment, output, and income are attributable to the direct impacts on agriculture.

The largest employment and output impacts are in agriculture. The largest POW income impacts are in FIRE.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $4.7 million; all of this decline is in agriculture. The decline is about 33 percent of the initial gross revenue change of $14.4 million taken from CVPM.

SAN JOAQUIN RIVER REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines by 148,500 acres, relative to the No-Action Alternative. Cotton declines by 37,200 acres, field crops and hay by 46,000, irrigated pasture by 49,200, and grains by 4,700. Gross revenues from cotton fall $40.1 million, those for vegetables decline $9.2 million, and those for hay and pasture fall $25.3 million. Grains fall $2.4 million, and fruits and nuts fall $5.4 million. These changes are converted to changes in final demands for crops and for forward-linked industries, as described previously. Resultant cropping changes cause a direct loss of about 1,610 jobs to agricultural production and food processing. Total regional impacts include the losses of about 4,340 jobs, $286.3 million in output, and $122.2 million in POW income.

Impacts Due to Reduced Net Income. Alternative 4 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 530 jobs, $34.8 million in regional output, and $19.3 million in regional POW income. Total regional impacts include losses of about 970 jobs, $61.2 million in regional output, and $34.7 million in regional POW income.

Impacts Due to Water Sales. Alternative 4 provides for the sale of water by willing sellers in the San Joaquin River Region. Net income of irrigators increases $58.5 million, leading to direct gains of about 830 jobs, $54.2 million in output, and $30.1 million in POW income. Total regional impacts include gains of about 1,510 jobs, $95.2 million in output, and $54.1 million in POW income.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 4 changes in agriculture include direct losses of about 1,310 jobs and $108.2 million in output, and $25.2 million in POW income. Total direct, indirect, and induced impacts include losses of about 3,800 jobs, $252.3 million in output, and $102.9 million in POW income.

Recreation

The gains attributable to the impacts of Alternative 4 on recreation are the same as those attributable to Alternative 3.

Municipal and Industrial Water Costs

Alternative 4 results in reduced personal income of $4.1 million per year because of higher M&I water costs, due primarily to household metering costs and restoration payments. The resultant declines in consumer spending cause direct losses of about 60 jobs, $3.8 million in output, and $2.1 million in POW income. Total impacts include losses of about 110 jobs, $6.9 million in output, and $3.9 million in POW income.

Total Impacts

Total direct impacts of Alternative 4, relative to the No-Action Alternative, include losses of about 1,340 jobs, $111 million in output, and $26.6 million in POW income. Total direct, indirect, and induced impacts include losses of about 3,860 jobs, $257 million in output, and $105.4 million in POW income. The total direct, indirect, and induced impacts represent 0.43 percent, 0.42 percent, and 0.34 percent of the baseline values of the respective variables. The largest employment, output, and income impacts are in agriculture.

The direct output impact on Agriculture, Forestry, and Fisheries is a reduction of $100.3 million; all of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $99.4 million taken from CVPM.

TULARE LAKE REGION

Agriculture

Impacts Due to Cropping Changes. Total irrigated land declines by 18,800 acres, relative to the No-Action Alternative. Cotton declines by 12,700 acres, alfalfa hay by 3,600, and field crops and grains by 1,700. Gross revenues for cotton fall about $13.5 million, while alfalfa falls about $2.2 million. Grains and field crops fall about $1 million. These changes are converted to changes in final demands for crops, as described previously. Resultant cropping changes cause a direct loss of about 240 jobs, $19.1 million in output, and $4.3 million in POW income. Total regional impacts include the losses of about 680 jobs, $43.0 million in output, and $16.7 million in POW income.

Impacts Due to Reduced Net Income. Alternative 4 results in higher costs for groundwater pumping, CVP water, and irrigation systems for irrigators. Net farm income declines, leading to direct losses of about 280 jobs, $17.6 million in output, and $9.6 million in POW income. Total

regional impacts include losses of about 470 jobs, $29.1 million in output, and $16.2 million in POW income.

Impacts Due to Water Sales. The gains attributable to Alternative 4 water sales are almost identical to those attributable to Alternative 3.

Total Impacts Due To Changes in Agriculture. Total regional impacts due to Alternative 4 changes in agriculture include direct losses of about 500 jobs, $35.1 million in output, and $13 million in POW income. Total direct, indirect, and induced impacts include losses of about 1,100 jobs, $69.5 million in output, and $31.4 million in POW income.

Recreation

The recreational gains attributable to Alternative 4 are the same as those attributable to Alternative 3.

Municipal and Industrial Water Costs

Alternative 4 causes no impacts on municipal and industrial water costs in the Tulare Lake Region.

Total Impacts

Total direct impacts of Alternative 4 on the Tulare Lake Region, relative to the No-Action Alternative, include direct losses of about 490 jobs, $35 million in output, and $13 million in POW income. Total direct, indirect, and induced impacts include losses of about 1,100 jobs, $69.4 million in output, and $31.4 million in POW income. The total direct, indirect, and induced impacts represent 0.23 percent, 0.23 percent, and 0.21 percent of the baseline values of the respective variables.

The largest employment and output impacts are in agriculture. The largest POW income impacts are in trade. Land fallowing and reduced net farm income cause reduced spending for production inputs and household items, with attendant effects on the trade and services sectors. Other impacts are attributable primarily to those originating in agriculture.

The direct output impact on agriculture, forestry, and fisheries is a reduction of $19.2 million; all of this decline is in agriculture. The decline is relatively close to the initial gross revenue change of $18.6 million taken from CVPM.

NORTH COAST REGION

Alternative 4 causes no impacts on recreational spending in the North Coast Region relative to the No-Action Alternative. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

CENTRAL COAST REGION

Alternative 4 causes no impacts on recreational spending in the Central Coast Region relative to the No-Action Alternative. For an analysis of the recreational and other effects of changes in fish harvest, see the commercial fishing scenario included as an attachment to the Fish, Wildlife, and Recreation Technical Appendix.

SOUTH COAST REGION

Alternative 4 results in reduced personal income of $6.0 million per year because of higher M&I water costs, due primarily to household metering costs and restoration payments. The resultant declines in consumer spending cause direct losses of about 70 jobs, $5.6 million in output, and $3 million in POW income. Total impacts include losses of about 180 jobs, $12.7 million in output, and $7.1 million in POW income.

SAN FRANCISCO BAY REGION

Alternative 4 results in higher M&I water costs for the Bay Region. The impacts are almost identical to those for Alternative 2.

TOTAL CALIFORNIA IMPACTS

The total direct impacts of Alternative 4 across all impacted regions in California , relative to the No-Action Alternative, include losses of about 2,130 jobs, $197.7 million in output, and $53.9 million in POW income. Total direct, indirect, and induced impacts include losses of about 6,540 jobs, $457.2 million in output, and $194.5 million in POW income. The total direct, indirect, and induced impacts represent 0.042 percent, 0.040 percent, and 0.029 percent of the baseline values of the respective variables.

SUMMARY

Table III-11 compares the total employment, output, and POW income impacts of the various Alternatives for each region, relative to the No-Action Alternative. For example, it shows that in the Sacramento River Region, total job losses range from about 260 for Alternative 1 to about 1,310 for Alternative 3. Similarly, in the San Joaquin River Region, total job losses range from about 2,450 to about 3,860. Total impacts across all regions in California include job losses ranging from about 2,060 to about 6,540.

Table III-11 also expresses the total employment, output, and POW income impacts of the various alternatives for each region as percentages of baseline conditions. For example, it shows that the largest percentage changes are for Alternative 4 in the San Joaquin River Region, where changes relative to baseline are -0.43 percent of employment, -0.42 percent of output, and -0.34 percent of POW income. Within the Central Valley, the smallest impacts relative to baseline are in the Sacramento River Region for all alternatives. Total impacts across all regions in California are highest for Alternative 4 and lowest for Alternative 3.

TABLE III-11

COMPARISON OF TOTAL ECONOMIC IMPACTS AMONG ALTERNATIVES RELATIVE TO NO-ACTION ALTERNATIVE, BY REGION, ABSOLUTE AND PERCENT CHANGE FROM BASE CONDITIONS

Region	Alternatives			
	1	2	3	4
	Absolute Change Relative to No-Action Alternative			
Sacramento River				
Employment (#)	-260.0	-560.0	-1,310.0	-1,310.0
Output ($MM)	-19.6	-46.3	-111.8	-110.8
Income ($MM)	-9.8	-20.5	-46.7	-46.3
San Joaquin River				
Employment (#)	-2,450.0	-2,990.0	-2,960.0	-3,860.0
Output ($MM)	-166.3	-201.9	-197.7	-257.0
Income ($MM)	-77.5	-89.7	-79.0	-105.4
Tulare Lake				
Employment (#)	-940.0	-870.0	-800.0	-1,100.0
Output ($MM)	-59.6	-55.3	-51.1	-69.4
Income ($MM)	-27.0	-25.0	-22.7	-31.4
Bay Area				
Employment (#)	-100.0	-100.0	-90.0	-100.0
Output ($MM)	-7.4	-7.4	-7.0	-7.4
Income ($MM)	-4.2	-4.2	-4.0	-4.2
South & Central Coast				
Employment (#)	960.0	960.0	3,110.0	-180.0
Output ($MM)	69.6	69.6	225.0	-12.7
Income ($MM)	38.9	38.9	125.9	-7.1
California Total				
Employment (#)	-2,790.0	-3,550.0	-2,060.0	-6,540.0
Output ($MM)	-183.4	-241.3	-142.7	-457.2
Income ($MM)	-79.6	-100.5	-26.5	-194.5

Previous tables show that agriculture is the sector most directly affected by all the alternatives. M&I water costs are adversely affected by all alternatives in the San Joaquin River Region and Sacramento River Region, but the effects are small relative to those for agriculture. The positive and negative direct impacts of the alternatives on recreation are small relative to agriculture and M&I water costs.

The largest negative impacts for each alternative occur in the San Joaquin River Region because of the effects of the CVPIA on agriculture and the relative importance of agriculture in the region. The adverse impacts from fallowed land and higher water costs are partially offset by increased income from water sales, which increases POW income, but total impacts within the region are negative for all alternatives.

Water sales represent an offset to the adverse effects of Alternatives 2, 3 and 4 on crop acreage and net farm income. The relative importance of the offset differs by region and alternative. For Alternative 2, water sales offset 7.5 percent of the other agricultural losses in Sacramento River Region, 13 percent in the San Joaquin River Region, and 7 percent in the Tulare Lake Region. For Alternative 3, the corresponding figures are 17 percent, 34 percent, and 5 percent. For Alternative 4, they are 17 percent, 28 percent, and 4 percent. The relative size of the offset is greatest for the San Joaquin River Region and least for the Tulare Lake Region.

DATA LIMITATIONS AND OTHER ISSUES

Impact estimation for this study rests on several important assumptions relative to input-output methodology, data aggregation, timing and magnitude of impacts, incidence of impacts, and other issues. In addition, some issue areas are excluded from the analysis. Each is discussed below.

ADDITIONAL IMPACTS DURING THE PERIOD OF CONSTRUCTION

The 2020 analysis of alternatives included the impact of restoration fund payments as reduced agricultural net income and increased M&I water costs. However, the analysis did not include all restoration fund expenditures as part of the impact assessment, because much of this is spent on construction activities that will be complete by 2020. The expenditure of restoration funds may offset some of the adverse regional effects of restoration fund payments. An analysis of the potential impacts of restoration fund expenditures is provided here to compare the overall impacts during the period of construction.

Restoration fund expenditures will be used for a variety of structures, improvements, land and water. Estimated capital, operating and maintenance costs of CVPIA-mandated actions were developed. These costs include Land Retirement, Level 4 Refuge Water Supplies, and Water Acquisition. The IMPLAN analysis has already included the agricultural losses and water sales income from water acquisition, and the negative effects of land retirement in the San Joaquin Valley have been included. The sale price of land should cover the annual net returns that would have been made from the land in its original use; irrigation, for example, but it is unclear how income from land sales might be spent. In general, it is believed that most income from land sales would leave the region. Therefore, payments for Land Retirement are not included in the

restoration fund expenditure analysis below. These payments are very small relative to other expenditures and costs, so this assumption would not affect the overall conclusions.

Other categories of restoration fund expenditure are Non-Flow Restoration Actions ($60.0 million), Level 2 Refuge Water Supply Conveyance Costs ($5.0 million) and "(b)(1) other program" ($2 million). These costs do not vary by PEIS Alternative, so total expenditure for any PEIS Alternative is $67 million. $15 million of this amount would be provided by the State, but because it is a part of CVPIA implementation, it is included in this analysis.

These expenditures were allocated to the regions using information on specific AFRP actions described in Attachment F of the PEIS. With the Level 2 Refuge Water Supply Conveyance Costs included, it is estimated that 65 percent of restoration fund expenditures would occur in the Sacramento Valley, and 35 percent in the San Joaquin Valley.

Annual expenditures were then allocated to industrial sectors in the IMPLAN database. It was assumed that a third of the fund would be spent on each of New Utility Structures and Water Supply Systems sectors, and the last third would be split between Miscellaneous Retail and Other Business Services sectors. It should be noted that results are not highly sensitive to the selection of industries so long as a representative mix is chosen.

With this information, the regional economic effects of the $67.0 million level of restoration fund expenditure can be estimated. Results are shown in Table III-12 below. First, the impact of the $67.0 million annual restoration fund expenditure is shown. Next, the total regional effects of the alternatives are shown with the $67.0 million expenditure included.

In the Sacramento Valley, total direct and indirect increases in employment, output and income caused by restoration fund expenditure would be 1,530 jobs, $101 million, and $30 million, respectively. These amounts are added to the values from Table III-11 to obtain revised measures of total impacts, as shown in Table III-12. Alternatives 1 and 2 would result in a net increase in employment, output and income in the Sacramento Valley during the period of construction. In Alternatives 3 and 4, employment would increase and output and income decrease by very small amounts relative to the size of the regional economy.

In the San Joaquin Valley, restoration fund expenditure would result in 690 jobs, $45 million in output, and $13 million of POW income. These amounts are much smaller than the negative effects from Table III-11, so overall effects on employment, output and income remain negative.

In California as a whole, results are adjusted for the $15.0 million State contribution included in the $67.0 million total. The $15.0 million would have no net impact on the state economy because it would induce a reduction in final demand elsewhere in the State. Therefore, the statewide gain of 1,730 jobs, $113 million in output and $33 million in income is less than the sum of these impacts for the Sacramento Valley and San Joaquin Valley. Even with the restoration fund expenditure included, overall impacts of the Alternatives on the State economy remain negative.

TABLE III-12

COMPARISON OF TOTAL ECONOMIC IMPACTS BY REGION WITH RESTORATION FUND EXPENDITURES INCLUDED ALTERNATIVES COMPARED TO THE NO-ACTION ALTERNATIVE

Region	Impact of Restoration Fund Expenditure	Alternatives			
		1	2	3	4
		Absolute Change Relative to No-Action Alternative			
Sacramento River					
Employment (#)	1,530	1,270	970	220	220
Output ($MM)	101	81	54	-11	-10
Income ($MM)	30	20	9	-17	-16
San Joaquin River					
Employment (#)	690	-1,760	-2,300	-2,270	-3,170
Output ($MM)	45	-121	-157	-152	-212
Income ($MM)	13	-65	-77	-66	-92
California Total					
Employment (#)	1,730	-1,060	-1,820	-330	-4,810
Output ($MM)	113	-70	-128	-29	-344
Income ($MM)	33	-46	-67	7	-161

LIMITATIONS OF THE INPUT-OUTPUT METHODOLOGY

The key assumptions and limitations of the input-output methodology are discussed in the IMPLAN Methodology/Modeling Technical Appendix. However, three of these assumptions are especially important in the interpretation of impacts estimated for the alternatives. First is the assumption that each industry produces only one commodity. The rice industry produces rice, the cotton industry produces cotton, the furnace blower industry produces furnace blowers, and so on. There are no opportunities for diversification within each industry.

The second assumption is that industries produce commodities using fixed "production functions" or recipes based on fixed proportions of various inputs. Technological relationships are fixed. Changes in the relative prices of inputs are unknown and are not incorporated. The key limitation of this assumption in a long-run analysis, in which the price of an input such as water is expected to increase sharply, is that production processes and technology will likely change over the next 25 years. However, since the extent of the changes is unknown, they cannot be incorporated in the model.

The third assumption is that the model includes no time dimension. Input-output models are "comparative static" in nature, measuring changes from one equilibrium point to another without consideration of the path of adjustment over time. All changes are assumed to be average annual changes.

Arguably the most critical assumption for the use of static input-output models for long-term analyses is that the structure of the economy and technical relationships remain constant.

Short-term predictions are less bothersome, since technical coefficients and industry composition change slowly. Over a longer period, however, the technical coefficients are likely to be affected by technological change and changes in relative prices. Each or all of these conditions can be incorporated into a dynamic input-output model, which allows for changes over time. The conditions also can be incorporated into a static model by changing the technical coefficients and running the model repeatedly for each year of a forecast period.

For any given level of industry detail, dynamic input-output models are considerably more complex than static models. Dynamic models usually incorporate an econometric model that provides the macroeconomic forecasts that define the time paths of the variables of interest in the input-output model, i.e., technical coefficients and relative prices. For a large regional economy with hundreds of sectors, the number of equations linking macroeconomic variables to technical coefficients is very large. Nonetheless, several such models have been developed in the last 15 years. One of the models adaptable to regional analyses is available from Regional Economic Models, Inc. (REMI) in Amherst, Massachusetts. The model is proprietary, and it can be leased on an annual basis or purchased.

Long-term economic forecasts are essential for the use of such a model. However, the uncertainty attached to long-term forecasts increases as the forecast period increases. In addition, it is necessary to make assumptions on the long-term behavior of variables that are exogenous to the macroeconomic model. Such variables might include crop and livestock production, fiscal and monetary policy, and foreign exchange rates. It is also necessary to make assumptions on many of the same variables as those found in static models, such as regional purchase coefficients and commodity disposition (see IMPLAN Methodology/Modeling Technical Appendix). Consequently, while a dynamic model does address the issues of changing technology and relative prices that are not automatically incorporated into static models, it does require large numbers of assumptions or forecasts of relevant exogenous variables.

The input-output models used in this study are static. They are relatively easy to develop using inexpensive software. They are flexible in allowing users to modify the underlying IMPLAN data base with local information on specific sectors or purchasing patterns. Within this analysis, for example, the "Food Grains" sector in IMPLAN which includes both wheat and rice, was disaggregated in the Sacramento River Region model to allow for the estimation of impacts on the rice sector alone. Other changes were incorporated into various models based on data available from a number of sources. These changes are discussed elsewhere in this or the IMPLAN Methodology/Modeling Technical Appendix.

Static models are based on implicit assumptions that arguably are no more subjective than those required for dynamic models. Static models can be modified to allow for changes in technical relationships and relative prices, and the models should be modified if there is sound basis for these changes. Dynamic models explicitly address both of these issues, but at the disadvantages of greater complexity and cost. Given the 30-year horizon of this analysis, there are infinite numbers of changes possible in the relationships in a static model. Unfortunately, it would be impossibly subjective to make such changes, since this analysis did not incorporate a detailed economic outlook for the year 2020. Consequently, it is not possible to conclude whether the assumptions underlying the static model cause a bias that is greater or lesser than that which would result from the use of a dynamic input-output model.

DATA AGGREGATION ISSUES AND ASSUMPTIONS

For this analysis, assumptions are made regarding the distribution among sectors of the direct impacts associated with greater costs for groundwater pumping, CVP water, and irrigation equipment; water sales by irrigators; and changing M&I water costs. Higher water costs for irrigators are assumed to represent, dollar for dollar, a reduction in net income. Reduced net income is assumed to be spread equally between lower capital outlays for farming and lower expenditures for farm households. Water sales by irrigators are treated as an addition to net farm income, and similarly are assumed to be spread equally between capital outlays for farming and expenditures for farm households. While investment in farm capital may seem questionable when water is being sold, the level of aggregation used in estimating direct agricultural impacts (acreages of crops, cost of water, and sales of water) does not permit a sub-regional determination of whether the same irrigators selling water would invest in farm capital.

Finally, changes in M&I water costs are assumed to represent, dollar for dollar, changes in the personal incomes of the affected regions. Existing regional consumption patterns are applied to the income changes, and impacts across sectors are estimated accordingly. All regions except the Central and South Coast are adversely affected by these changes. Greater M&I water availability is estimated to have positive direct impacts on that region for Alternatives 1,2 and 3 and small adverse impacts for Alternative 4.

INCIDENCE OF IMPACTS

It is necessary to make assumptions on the locations of impacts, i.e. where impacts are expected to occur. For example, in Alternatives 2, 3 and 4, varying levels of water are sold by irrigators in the Sacramento River Region, San Joaquin River Region, and Tulare Lake Region. It is assumed that all of the income from those sales remains within the regions in which the irrigators are located. Different assumptions could be made about the proportion of such income that would be "exported," but it is believed that most would not because each region is so large.

These issues potentially are important regarding water transfers from the Sacramento River Region, San Joaquin River Region, and Tulare Lake Region to urban areas. The effects of water transfers depend on many factors, including whether the water is transferred within or outside the region of origin; the economic strength of the area of origin; how the income from water sales is spent, i.e., on what goods and services and in what region(s); and the extent of integration among agriculturally-related sectors within the area of origin (Howe, Lazo, and Weber, 1990). The geographical focus of the analysis, e.g., whether statewide or regional, could influence the significance of the impacts. At the state level, cost savings may offset part or all of the losses due to fallowed land. However, the cost savings are likely to be concentrated in the urban regions, while the losses are likely to be concentrated in the rural areas or within small parts of rural areas. These types of distributional issues are not quantified in this study because of the programmatic nature of the analysis.

OTHER ISSUES

The analysis does not address quantitatively the impacts of implementation on the California dairy industry, in particular the impacts on the price and availability of alfalfa hay. For most of

the alternatives, reductions in acreage of alfalfa hay are small relative to baseline conditions. However, for Alternatives 3 and 4, acreage reductions in the San Joaquin River Region could reduce local supplies and cause higher prices. For Alternative 4, alfalfa hay acreage in the San Joaquin River Region is estimated to fall by 24,300 acres, which would represent about a 2.5 percent decline in total California acreage of the crop (changes in the Sacramento River Region and Tulare Lake Region are very small). Based on previous studies (Northwest Economic Associates, 1994; Konyar and Knapp, 1986), that reduction, other factors unchanged, would be expected to cause a 1.5 to 2.0 percent increase in grower prices throughout the state. Based on 1992 prices (Federal-State Market News Service, 1994), this would amount to about $2.00 per ton.

Dairy producers throughout California would likely be affected to varying degrees. While some supplies could be imported from out of state, delivered costs would be higher because of transportation charges. It is estimated that shipments from the northern San Joaquin Valley to the southern San Joaquin Valley would add about $15 to $20 per ton to delivered hay costs. Shipments from the northern Sacramento Valley to the southern San Joaquin Valley would add an estimated $30 to $50 per ton (Northwest Economic Associates, 1994). However, the San Joaquin River Region is a large region, and it is uncertain where within the region the acreage reductions would occur. Hence, the cost increases estimated above should be considered as maxima; actual cost increases would likely be lower. It should be mentioned, nonetheless, that in critically dry years, the cost impacts could be substantially greater. However, because of the uncertainties mentioned, as well as estimated small reductions in alfalfa acreage in the Sacramento River Region and Tulare Lake Region, this analysis does not include the estimated impacts on the dairy industry.

CHAPTER IV

BIBLIOGRAPHY

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CENTRAL VALLEY PROJECT IMPROVEMENT ACT
PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT

TECHNICAL APPENDIX

Social Analysis

September 1997

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LIST OF ABBREVIATIONS AND ACRONYMS

AFRP	Anadromous Fish Restoration Program
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
DWR	California Department of Water Resources
EDC	Economic Development Corporation
EDD	Employment Development Department
EOC	Economic Opportunities Commission
ESL	English as a second language
FID	Fresno Irrigation District
FLC	farm labor contractors
GCID	Glenn - Colusa Irrigation District
LTRID	Lower Tule River Irrigation District
M&I	municipal and industrial
NEPA	National Environmental Policy Act
OAID	Orland - Artois Irrigation
PEIS	Programmatic Environmental Impact Statement
PFMC	Pacific Fisheries Management
Reclamation	U.S. Bureau of Reclamation
Secretary	Secretary of the Department of Interior
Service	U.S. Fish and Wildlife Service
SJVDP	San Joaquin Valley Drainage Program
SWP	State Water Project
SWRCB	State Water Resources Control Board
USGS	U.S. Geological Survey
WIC	Women, Infants, and Children
WWD	Westlands Water District

CHAPTER I

INTRODUCTION

Chapter I

INTRODUCTION

The Draft Programmatic Environmental Impact Statement (PEIS) summarizes the evaluation of the direct and indirect impacts of implementing a wide range of actions identified in the Central Valley Project Improvement Act (CVPIA). Details of the information used in the definition of the affected environment and analysis of the environmental consequences are presented in the technical appendices of the Draft PEIS.

This technical appendix presents a summary of social analyses, background information that was used during the PEIS preparation, and the results of the impact analyses for conditions that occurred throughout the study area, shown in Figure I-1.

The social analysis was primarily based upon changes in demographics, changes in fisheries, and changes in crop patterns. Information from the Agricultural Economics and Land Use, Regional Economics, and Municipal and Industrial Land Use and Demographics technical appendices was used in the social analyses.

FIGURE I-1
STUDY AREA

CHAPTER II

AFFECTED ENVIRONMENT

Chapter II

AFFECTED ENVIRONMENT

This chapter summarizes the recent social conditions in the Programmatic Environmental Impact Statement (PEIS) study area. Social conditions can be measured in terms of employment opportunity or unemployment levels; educational opportunities; the social structure of a community; opportunities to participate in private social or religious institutions; and the need for public social assistance programs to meet medical, housing, and nutritional needs. This technical appendix discusses unemployment, housing and rental costs, and the need for and ability of communities to provide social service support as indicators of social well being withing the study area. This technical appendix does not address demographics as a measure of social conditions.

DATA SOURCES

Data from 1992 and 1990 were used as the basis for the social analysis. Data from the 1980s was used for social groups, institutions and communities. Historical data about social perceptions for the study area are not consistent among most regions or is not available for some regions. Information presented in this technical appendix for changes in agricultural communities is based on reports of recent drought conditions in the Central Valley and the 1990 San Joaquin Valley Drainage Program (SJVDP). Information for coastal areas specific to fishermen and fishing communities and Native American Tribes was collected from the 1995 U.S. Fish and Wildlife Service Final Report to Congress on the Central Valley Project Impacts to the Anadromous Fish Resource, Fisheries, and Associated Economic, Social, and Cultural Interests.

Recent and historical demographic and economic indicator data were collected at the regional county level and aggregated into the PEIS regions. The major information sources for the demographic and economic indicator data are U.S. census data from the U.S. Department of Commerce, and other data from the California Department of Finance and the California Employment Development Department (EDD). Additional demographic and economic data were collected by reviewing past sociological studies for the study area. This information is summarized in the social well-being sections of this chapter as it pertains to specific social groups, communities, and institutions. Economic indicator data in this technical appendix are based on information presented in the Agricultural Economics and Land Use, Regional Economics, and Municipal and Industrial Land Use and Demographics technical appendices.

Additional demographic and economic information was collected through interviews with members of each social group to support the social well-being study. Each community has a different set of resources. These include economic resources, experience, cultural and demographic characteristics, and leadership. Each of these resources could either increase or decrease the impact. The social organization of the community can also mitigate the effect of actions. Examples of social organization include the ability of the community to draw upon outside resources when faced with a crisis, the community's ability to cooperate to solve problems, or the patterns or personal interactions within the community. The degrees of impacts experienced by a community are based upon the community's values and perceptions. If the

project inputs are seen as desirable, the community may respond very differently than if the impacts are seen as negative or even a violation of community values. In fact, the impact upon a community's values, or the values of a social group within the community, is itself considered a social impact.

The social researcher is interested in how impacts are experienced by the communities and by various social groups. These social groups may be defined by occupation (farmers, agribusiness workers, and commercial fishermen), ethnicity or heritage (American Indian tribes), or by common lifestyle, values, and beliefs (recreationists).

The impact on a community may be very different if it affects everybody in a community or is experienced by only few social groups within the community. Interviews were held with members of each social group and resident of several communities to determine the existing conditions and potential impacts of CVPIA implementation. Other information for the impact assessment came from the Regional Economics Technical Appendix and output from regional economic models.

RECENT CONDITIONS

REGIONAL ECONOMIC INDICATORS OF SOCIAL WELL-BEING

This section summarizes regional economic indicators of social well-being in the study area as they apply to all social groups and communities. Some general conclusions derived from review of the economic data presented in Table II-1 are as follows:

- Within the study area, people living in predominantly rural areas have lower incomes, higher poverty rates and higher unemployment rates, than those living in the urban regions. However, San Francisco and Los Angeles counties experience high income levels and some of the highest poverty rates in the state.

- Within all regions except the Sacramento River and Tulare Lake regions, there are pockets of prosperity that have an "averaging effect" of raising average personal income levels and lowering average poverty and unemployment rates, as shown in Table II-2.

Personal Income

Personal income is measured as family and/or per capita income, as shown in Table II-1. Median family income is a measure of the annual income received by families living together in the same household. The median is a statistical term for the midpoint of a data set. There is a wide range of median family income in the study area.

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TABLE II-1

REGIONAL DEMOGRAPHICS AND ECONOMIC INDICATORS OF SOCIAL WELL-BEING

Issues	North Coast Region	Trinity River Basin Region	Sacramento River Region	San Joaquin River Region	Tulare Lake Region	San Francisco Bay Region	Central Coast Region	South Coast Region	California
Demographics									
Population in 1992 (1)	646,000	13,000	2,397,000	2,022,000	1,031,000	5,359,000	855,000	18,049,000	31,043,000
Economic Indicators									
Median Family Income in 1990 (2)	$27,000 to $42,000	$25,000	$24,000 to $43,000	$29,000 to $35,000	$27,000 to $32,000	$41,000 to $59,000	$37,000 to $43,000	$38,000 to $51,000	$41,000
Per Capita Income in 1990 (2)	$11,000 to $17,000	$11,000	$10,000 to $18,000	$11,000 to $13,000	$10,000 to $12,000	$18,000 to $28,000	$14,000 to $17,000	$13,000 to $20,000	$16,000
Poverty Rate in 1990 (3)	8 to 18%	19%	7 to 20%	9 to 21%	17 to 23%	5 to 13%	10 to 13%	7 to 15%	13%
Median House Costs in 1990 (4)	$100,000	$80,000	$100,000	$100,000	$80,000	$250,000	$200,000	$200,000	N/A
Unemployment Rate in 1992 (5)	7 to 16%	17%	8 to 19%	11 to 17%	15%	5 to 7%	7 to 18%	6 to 12%	9%

NOTES AND SOURCES:
1. Source: California Department of Finance
2. Median family and per capita income in 1990 dollars. Source: California Department of Finance and 1990 U.S. Census.
3. Percentage of persons below the poverty line for whom poverty status is defined. Source: California Department of Finance and 1990 U.S. Census.
4. Source: U.S. Census California General Housing Characteristics, Financial Characteristics 1990, Table 51.
5. Percentage of the labor force in 1992 that was not employed; data are not seasonally adjusted.

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TABLE II-2

AREAS OF INCREASED PROSPERITY IN THE STUDY AREA

Region	Area of Increased Prosperity
South Coast	Orange County
San Francisco Bay	San Mateo County and Marin County
North Coast	Sonoma County
Central Coast	Santa Cruz County
Sacramento River	Napa County
San Joaquin River	San Joaquin County

Per capita income is a measure of the income received by individuals and does not include indirect income such as employee health benefits, food stamps, and other indirect payments. The regions and counties with the highest and lowest per capita incomes are the same as those with the highest and lowest median family incomes. The ranking of regions by family income is shown in Table II-3.

TABLE II-3

REGIONS WITH HIGHEST AND LOWEST MEDIAN FAMILY INCOME

Regions with Low Median Family Income	Regions with High Median Family Income
Sacramento River Region (only Yuba County)	San Francisco Bay Region
North Coast (except Sonoma County)	South Coast Region
Tulare Lake Region	Central Coast Region
Trinity River Basin	

Per capita income in the study area ranges from $10,000 in the Tulare Lake Region and Yuba County (Sacramento River Region) to $28,000 in Marin County in the San Francisco Bay Region.

Ethnicity

The Sacramento River Region population is largely white with only about 28 percent of the total population representing black, Asian, and Hispanic races. The San Joaquin River Region population is mainly white with Hispanic peoples nearly 30 percent of the total population. A large portion of the farmworker population is represented by Hispanics. The population base of the Tulare Lake Region is similar to that of the San Joaquin River Region. The ethnic makeup is approximately 60 percent of the population white and 33 percent of the population Hispanic. Ethnicity for the study area is shown for the Sacramento, San Joaquin, Tulare Lake, and San Francisco Bay regions in Table II-4.

TABLE II-4

ETHNICITY BY REGION

Region	Ethnicity (percentage)			
	White	Black	Asian	Hispanic
Sacramento River	73	7	7	13
San Joaquin River	58	4	8	29
Tulare Lake	60	4	3	33
San Francisco Bay	59	9	16	16
REFERENCE: California Department of Finance, 1990				

Poverty Rates

There is a wide range of poverty rates within the study area. The highest poverty rates in the study area occur in predominantly rural areas. Within the study area, poverty rates are higher among minority ethnic groups. A 1986 study by the EDD (Ong et al., 1986) estimated the poverty rates among races in California during 1980 as summarized in Table II-5.

TABLE II-5

POVERTY RATE BY ETHNICITY

Ethnicity	Poverty Rate (Percentage)
White	6
Black	21
Hispanic	18
Asian and Other	11

Unemployment Rates

As shown in Table II-1, existing unemployment rates are lowest in the San Francisco Bay Region and the South Coast Region where more employment opportunities are available. Unemployment rates are presented as a range in areas with diverse economies such as fishing, logging, and tourism in the North Coast and urban and agricultural areas in the Sacramento Valley and San Joaquin Valley.

Unemployment rates in the study area are higher among minority ethnic groups. The EDD (Ong et al., 1986) estimated statewide unemployment rates among races in California during 1980, as summarized in Table II-6.

TABLE II-6

UNEMPLOYMENT RATE BY ETHNICITY

Ethnicity	Unemployment Rate (Percentage)
White	4
Black	7
Hispanic	7
Asian and Other	4

Employment Opportunities

Employment opportunities vary within the study area regions. Urban centers offer the greatest employment opportunities for all skill levels. Employment opportunities exist in a greater number of industrial sectors than those found in the rural portions of the study area, thus providing a better employment base. Employment opportunities in rural areas involve predominant industries, such as agriculture, logging, and fishing. When economic downturns or other influencing factors occur that affect these predominant industries, workers have limited opportunities for finding new work. Changes in employment opportunities are important economic indicators of social well-being. Employment opportunities generally increase as worker education and technical skill levels increase. However, agricultural employment has been available for less technically skilled workers. Agricultural production for many crops requires trained workers for pruning, thinning, sorting, and harvesting.

Agricultural Employment. Average annual agricultural employment was about 400,000 to 435,000 jobs during the period 1987 to 1992. Approximately 420,000 people were employed in the agriculture industry in 1992 (EDD, 1993). The relationship between the agricultural sector and the larger economy of the Central Valley is important in assessment of social factors. Agricultural employment is becoming a less significant factor in measuring the viability of the local economy in all areas of the Central Valley than it once was historically. The economy of the Central Valley has grown and diversified, and non-agricultural employment opportunities are increasing. This general trend does not hold true for some communities. Agriculture remains the dominant industry and economic force in many smaller communities like Willows and Mendota.

Agricultural employment also may indirectly affect local economies. This effect is usually expressed in the form of a "multiplier," to reflect the revenues or jobs created for each agricultural employment opportunity. The multiplier effects reflect purchase of production supplies and equipment, processing industry needs, increases in retail sales, and demand for services. Multipliers are not the same throughout the Central Valley because of regional market

and production differences. Regional differences include interaction between agriculture and support industries, and interaction between cropping patterns and the labor requirements. In general, agricultural employment is highly labor intensive in the San Joaquin Valley and therefore this region has higher multiplier effects.

Urban Employment. Urban employment opportunities are predominantly within the water transfer service areas and the areas served by municipal and industrial (M&I) contractors. Employment opportunities for the people living within the service areas of major M&I contractors are diverse and more numerous than those found in predominantly rural areas. In California urban areas, service industries generally provide the greatest employment opportunities.

REGIONAL COMMUNITY STRUCTURE AND SERVICES

Regional social programs are administered by county and city governments. Funding for these programs may be available from the federal government, state government, or local agencies or interest groups.

Counties

Counties provide support through a variety of services. Services administered through county offices include worker education and training programs, job placement services, aid for families and children, and welfare programs. These services are available from the following types of agencies.

Private Industry Council. This agency provides worker education, training, relocation, and job placement. Funding for the agency is provided by the federal government under the Job Partnership and Training Act.

Employment Development Department. This agency is funded by the State of California and administers the unemployment insurance, payments programs, and worker disability payments programs.

Economic Opportunities Commission. This is a non-profit community action agency serving residents of the county. The Economic Opportunities Commission (EOC) receives funding from federal, state, and local grants, foundations, the United Way, donations and fund-raising. Programs administered by the agency may include: Homeless Employment and Training; Mature Workers program to assist workers age 55 and older to enter or reenter the work force; Urban Adult/Youth Employment and Training; and the Women, Infants, and Children's (WIC) program, which provides food vouchers and counseling for persons at risk for nutritional deficiencies.

Employment Development Corporation (EDC). This is a private agency formed to bring new economic development to an area. There area several EDCs throughout the state, usually based within a county. This agency does not provide worker training or job placement services; however, industries relocating to an area under its programs can provide new employment opportunities for a community or region.

Services Provided. County expenditures are provided for the uses shown in Table II-7.

TABLE II-7

EXPENDITURES FOR SERVICES OF CALIFORNIA COUNTIES

Service	Percent of County Expenditures
Public Assistance	41
Public Protection	28
Public Health Care	13
Sanitation Services	<1
General Programs	11
Public Ways and Facilities Maintenance	4
Education, Recreation, Cultural and Debt Service	3
SOURCE: Office of California State Controller, County Cost-of-Government Financing Uses 1990-1992.	

Public assistance expenditures increased 12 percent and public protection expenditures increased 11 percent from 1991 to 1992.

Cities

Cities provide public protection services and health services to residents. Employment and job training programs are not administered by cities, except under special circumstances in which a city may promote economic development and employment opportunities, or provide funding to other local agencies for worker placement.

Services Provided. Total expenditures by California cities in 1991 and 1992 are shown in Table II-8. Public safety expenditures are an important part of the total expenditures in many cities.

School Districts

School districts can sponsor worker education programs such as English as a second language (ESL) or basic technical skills. School districts generally are considered to provide education for grades 1 through 12. However, local community colleges also assist the workers by improving education and labor skills. The local Private Industry Councils and Employment Opportunities Commissions can work with the schools to provide worker training.

TABLE II-8

EXPENDITURES FOR SERVICES OF CALIFORNIA CITIES

Service	Percent of California Cities' Expenditures
Public Safety	26
Public Utilities	22
Community Development and Health	20
Transportation	14
Culture and Leisure	9
General Government	8
Other	1

SOURCE:
Office of California State Controller, City Expenditures, Expenditures by Function, Fiscal year Ending June 30, 1992.

The schools also can provide after-school child care and subsidized meals to assist working families and disadvantaged children. In areas with low family income, these programs can be valuable.

SOCIAL WELL BEING

Social well-being is a measure of community standards and attitudes or contentment. High levels of employment, income, and opportunities for satisfaction, such as cultural or recreation opportunities, generally contribute to high levels of social well-being. In contrast, high levels of unemployment and poverty and few opportunities for satisfaction can contribute to lower feelings of contentment and social well-being. These attitudes may be reflected in the community by higher crime rates, increased alcoholism or other dependencies, and other adverse social conditions. Social groups can assist community members in dealing with adverse economic conditions by providing financial support, counseling, and family services.

Factors affecting social well-being include not only employment opportunities but also job guarantees. Job guarantees are affected by seasonal employment trends and economic trends, and in some cases natural occurrences. Seasonal employment affects agricultural workers, fishermen, loggers, recreation workers, and other industries. Economic trends also may affect these industries and highly technical industries such as communications, computers, and electronics, and public service industries such as transportation, infrastructure, and building. Natural occurrences such as weather conditions can shorten or lengthen seasonal employment opportunities. For example, water shortages can reduce the number of acres farmed and the value of recreation opportunities such as boating or skiing. Natural occurrences such as drought and flood conditions and economic conditions are not under the control of the Central Valley Project (CVP) and, although they are not addressed further in this chapter, are important to consider in the assessment of existing conditions.

For the PEIS study area, the largest sectors of workers affected by the reduced job guarantees are seasonal farmers and agricultural workers. Seasonal unemployment among farmers and agricultural workers usually occurs during the winter months following harvest and summer vacation periods. Changes in seasonal employment can affect the demand for social services. The demand for social services increases during periods of unemployment, such as requests for unemployment payments, health services, and other family support programs. The need to utilize family, health, and income support services can decrease social well being among persons who are employed during much of the year, but are seasonally unemployed.

Social Groups

There are several important social groups within the study area: farmers, farm workers and agribusiness workers, commercial fishermen and fishing businesses, recreationists, and Indian tribes.

Farmers. Farmers are those individuals who own land and/or manage farm operations for lands receiving CVP water supplies. These individuals could be affected by changes in agricultural water supply quantities or reliability. They must determine the crops to plant and related farm production expenditures. They rely on long- term and firm water supplies to manage farm production. About half of all farm operators list their principal occupations as farming. Others are employed in other jobs to supplement their income.

Farmers who own and operate family-owned corporations or farms are important and differ from corporate farm owners because family members typically have been raised in the valley, and/or live in the community and are actively involved in operating the farms. Management remains an integral and usually very influential part of the community. Owners of corporate farms frequently reside outside the valley and hire professional managers to run the farms. The farm manager is an employee, not an owner, with allegiances to the corporate owners that may exceed those to the community. Archibald (1990) found that, when family-owned corporations are excluded, corporations operate less than 1 percent of the farms, but that these farms account for 8 percent of the acreage in the San Joaquin Valley.

Dinar (1990) also examined characteristics of farm operators in the San Joaquin Valley. Conclusions from that study are listed below.

- Approximately two-thirds of the land farmed is owned by the farmer, with about one-third leased for periods ranging from 3.8 to 5.2 years.
- Farmers spend 87 percent of farm production costs locally.
- Eighty percent of the farm managers live less than 15 miles from the farm.

Lack of stability in the CVP water supplies could affect the ability of land owners and farm managers to obtain loans for farming operations, and to plan for future equipment needs and farm inputs such as seed and fertilizer; it could also affect decisions for long-term investments in irrigation systems and cropping such as fruits, nuts, and vineyard crops. Many farmers have commented that supply reliability is key to making farm operating decisions and protecting farm

investments, particularly investments in long-term cropping systems such as fruit trees and vineyards that require water in all years. Reduced irrigation supplies for long-term crops can affect crop productivity in future seasons, causing economic hardship in more than one water year or total loss of a crop. In general, the economy of the rural communities relies on the success of farming for its livelihood. When farming conditions are good, farmers can support local community businesses. However, when farming conditions are poor, local communities also can suffer economic losses due to lack of expenditures from farmers. Farmers would like to see increased water supply reliability so that they can plan for long-term production goals, obtain funding, and maintain a trained work force.

Farm Workers and Agribusiness Workers. Farm workers are those persons employed to work on farms; farm managers are not included. Farm workers are irrigation technicians, machine operators, and seasonal workers. California agriculture is highly dependent on seasonal and skilled farm workers to assist with crops. Seasonal workers work for several farmers within the same county. Migrant workers move from county to county to find work. Crop production in the San Joaquin River Region is the most labor-intensive within the study area. Crops grown within the region that require intensive labor are orchard, vineyard, and vegetable crops. Cotton, alfalfa, grain, sugar beet, and pasture crops are the least labor-intensive and do not require seasonal labor for planting, thinning, pruning, harvesting, sorting, or packing as do labor-intensive crops.

In 1989, the EDD conducted an analysis of agricultural employment (Special Projects Unit - EDD, 1989). The information below is drawn from EDD's analysis of agricultural employment in the Sacramento Valley and the San Joaquin Valley.

Sacramento River Region. In 1989, 77,408 farm workers were employed in 118,189 jobs, with earnings of just over $342 million. This is approximately 9 percent of the state's agricultural workers, and about 7 percent of agricultural earnings. Fifty-eight percent of these workers received their primary earnings in agriculture. Thirty-eight percent of the workers were seasonal, and 38 percent were migrant.

San Joaquin River Region. In 1989, agricultural employers reported that 405,469 farm workers were employed in 779,749 jobs with total earnings in excess of $1.5 billion. The San Joaquin Valley employs 46 percent of all farm workers, provides 50 percent of all jobs, and pays 32 percent of all earnings in California agriculture.

Thirty-six percent of workers in the region and statewide have agricultural income with non-farm earnings. Forty-one percent of all agricultural workers and 51 percent of all agricultural jobs in the region are seasonal. Thirty-five percent of all California's agricultural employees are seasonal workers as are 41 percent in the San Joaquin River Region. Sixteen percent of workers in the region were migrant workers and they held 24 percent of all agricultural jobs. Only 25 percent of all agricultural workers in the San Joaquin River Region have total earnings of $7,500 or more. Only 13 percent of workers who received their primary earnings from farm labor contractors (FLCs) earned $7,500 or more from one source.

An EDD study of agricultural workers in the San Joaquin Valley (Alvarado, et al., 1990) reported the following worker characteristics:

- Approximately 70 percent of farm laborers are men.
- The average age of laborers in 35 years.
- Eighty-seven percent of the workers were born in Mexico, 6 percent were born in the United States, and 7% were born in other countries.
- The average laborer has completed about 6 years of schooling.
- Over 80 percent of workers are legal U.S. residents, of which 50 percent hold temporary resident status and 33 percent are permanent or naturalized U.S. citizens.
- Fifty percent of laborers who immigrated to the U.S. have been residents for 10 or more years.
- Eighty percent and 22 percent of the laborers surveyed had fathers and mothers, respectively, also employed as laborers.
- Most of laborers, 84 percent, reported annual periods of unemployment. Financial support during these was provided by unemployment insurance and savings.
- Eighty-eight percent of those surveyed would prefer to continue working as farm laborers and 63 to 87 percent believed they still would be employed as laborers for the next three years.

The average hourly wages paid to farm laborers range between $4 and $10, depending upon the type of work performed. The studies also found that there is a surplus of available workers in the San Joaquin Valley according to the EDD and La Cooperative (1990-1991 publication *Voice of the Fields).* These conditions have led to conditions where workers were living in open fields or in cars, increased use of Farm Labor Contract services, and shorter periods of employment. In addition, it was reported that FLCs pay lower wages and piece contracts and workers would prefer to work directly with the grower. Farm workers, although skilled in the services that they provide, may not have the language skills or educational training to allow them to enter other areas of employment.

Agribusiness workers are those individuals that are indirectly involved in farm production and are employed in agricultural or service industries. These workers include providers of seed, fertilizer, and pesticides; equipment and irrigation technology sales; and farm processors such as cotton gins, packing and shipping companies, olive processors, and tomato processors. Agricultural workers may have the language, education, and business skills to allow them to enter other areas of employment, however studies are not available to indicate the potential for this to occur.

Farm workers and agribusiness workers could be indirectly affected by changes in water supplies and farm production. Unlike farm owners and operators who also could be affected by changes in water supply, these individuals are further removed from control of the production process and must rely on information gathered from farmers and ranchers to determine needs for services and products.

Lack of stability in CVP supplies can directly affect farm production, including acres planted and types of crops produced, and the need for farm labor. Similarly, changes in CVP supplies and cropping patterns will affect the need for farm supplies, equipment and repair needs, and packaging and processing needs. In recent years the Central Valley has experienced losses of olive and melon packing plants, tomato processors, and cotton gins as plants have been consolidated, moved to other regions, or gone out of business. Seasonal workers also can face economic hardship due to lack of work when farming conditions are poor and farmers plant fewer acres or change to less labor intensive crops. Farm workers and agribusiness workers would like to see farmers receive reliable water supplies so that they could have job assurance and a steady income.

Commercial Fishermen and Fishing Businesses. Commercial fishermen and fishing businesses are those individuals that rely on fishing for their income. Fishermen rely on available fish quantities for their income. Changes in water supplies in inland streams and rivers could affect water quality, temperature, or quantities in streams where fish migrate and spawn. The changes in fish numbers directly affect the quantity of fish available for ocean commercial harvest and sport fishing, and thus could directly affect the livelihood of fishermen and supporting businesses. Supporting businesses include boat sales and repair, boat fuel and service, fishing equipment sales, and fish packing and processing plants. Commercial fishermen and fishing businesses are located along the California coast extending from San Luis Obispo to the Oregon border, but are concentrated along the northern coastal towns.

The fishing industry experienced an expansion in the 1980s, but has since experienced declines with numerous businesses and processing plants closing due to declines in fish harvest numbers, particularly salmon. Similarly income for commercial fishermen has decreased while costs have continued to rise with increased regulation of the fishing industry, including increased safety requirements for fishing boats and crew members. Reduced harvest numbers and shortened season limitations have further affected both commercial and sport fishermen. Commercial fishermen would like to see more water dedicated to fishery resource needs to maintain the fishery resource. The fishermen would like to see reduced exports south of the Delta that they feel jeopardize fish migration and loss of spawning and rearing areas result in an overall decrease in fishery populations. The fishermen are not opposed to all water exports or to farming, but would like to see a greater equity in who absorbs the effects of drought and water reductions. For example, fishermen believe that during drought conditions, water diversions are maintained to the maximum extent possible resulting in an unfair balance in favor of farming rather than fishing. The fishermen would like to see more equity in allocation of the limited water resource.

A study completed by the Service in 1995 (Final Report to Congress on the Central Valley Project Impacts to the Anadromous Fish Resource, Fisheries, and Associated Economic, Social, or Cultural Interests) provided a social analysis of the commercial fishing industry. The findings of that study are discussed below.

The identity and lifestyles of many coastal communities have been defined by the commercial fishing industry. Many coastal communities supported canneries, fish processing plants, boat manufacturers and repair shops, and other fishing related service businesses. Historically, fishing in California has not been a major economic industry when compared to gross state output and

revenues. However fishing has been an important economic factor for the fishing communities and has a unique culture and way of life.

Factors affecting the fishermen include the recent decline in the salmon prices and market share of California-Oregon salmon and changes in salmon production. The fishermen reported increased market competition from hatchery raised fish imported from Norway and Chile.

Several conditions have resulted in the production and harvest of smaller salmon. In the past fishermen could harvest larger salmon, but now the salmon are smaller and more must be caught to achieve the same amount of pounds of harvested. However, drought conditions, the decline of fishery habitat quality, potential over-fishing and predation, and losses from the use of unscreened diversions and pumping plant operations have been factors in the decline in the numbers of fish and fish size. Fishermen have had to fish increasingly longer days and extended areas, sometimes traveling to the San Francisco Bay, Oregon, Washington, or Alaska to fish.

Fishermen also noted that the State of Washington allows fishermen to collect unemployment, but California does not. If fishermen were allowed to collect these payments, the hardships from reduced harvests and lower market prices may not be as significant. Fishermen usually do not have the skills to enter other labor markets without retraining, especially the older fishermen, and do not want retraining at age 50 and older. The fishermen used to have access to dental and medical coverage benefits available from fishing license funds. However, these benefits have not been available for the past 10 years. Other benefits that are lacking for some self-employed fishermen are health insurance and workmen's compensation because those fishermen cannot afford to carry the coverage. Retirement funds also may be lacking for some people because of the decline in the fishing industry and markets. When fishing opportunities and harvests are poor, the fishermen turn to the food bank for assistance.

Fishermen also have been required to install additional safety equipment on their boats, or to fish alone to meet regulatory requirements. This has increased concern from family members over the safety of the fishermen who cannot afford the additional safety equipment required for additional crew members. Other fishermen are concerned about the need to fish for other species such as crab, urchin, and albacore. However, the urchin harvest also has declined about 20 percent over the past 10 years. Historically, fishermen could make a living by fishing for salmon. Fishing for other species may require additional or special equipment that adds an additional production cost to fishing from new equipment needs. Nearly all fishing vessels are owner-operated with very few absentee boat owners.

North Coast Region. The North Coast Region was important to the commercial salmon fishing industry, accounting for 25 to 60 percent total salmon revenues for California ports during the 1940s and 1950s. Salmon landings increased during the 1960s and 1970s representing more than 50 percent of salmon revenues statewide. However, the region began to decline in the mid-1980s and the decline continued. While the fishing business has suffered cyclical declines and abundance of fish harvest numbers, the more recent decline in revenues has led to increased unemployment and the demand for social services in the region. Many fishermen suffering from economic losses left the industry for employment elsewhere. In addition, nearly 70 percent of the fish processors have closed or left the region.

The decline of the fishery in North Coast Region has been coupled with declines in the timber harvest industry. In the 1940s, the agriculture, forestry, and agriculture industries of Mendocino County accounted for 42 percent of employment. However, in 1990, these industries accounted for only 19 percent of employment for the county. This reduction in fishing and forestry jobs has been typical of other north coast counties. Many persons consulted for the Service Study indicated that fishermen and the port communities would work together during times when harvests were poor. With the combined forestry and fishery declines, community services and the ability of the community to respond have been stretched. Workers have been forced to leave jobs in these industries for jobs in the tourism and services businesses, which are sometimes lower paying. Within the City of Fort Bragg of Mendocino County, employment in the services and tourism industries has increased from 43 percent in 1950 to 65 percent in 1990. In contrast, employment in the commercial fishing and processing industries have declined by 23 percent.

Central Coast Region. One major port in the Central Coast Region is Monterey. However, this port contributed less than 10 percent of total salmon revenues for the state. In the 1970s, the proportion the salmon harvest rose to 20 percent of total state salmon revenues, but this increase has not been sustained. The Monterey area supported herring and sardine fisheries and a large canning industry until the industry closed. While fishermen in the area have experienced reductions in harvest and market outlets for their catch, the Monterey community and south coast region experienced economic growth in the agriculture and tourism industries.

Native American Tribes. Two Native American tribes, the Hoopa Valley Tribe and the Yurok Tribe, are discussed in this technical appendix because they have been affected by CVP actions in the past and there is potential for project actions to affect the Trinity River and coastal fishery. The tribes rely on Trinity River water supplies and fishery for subsistence living and ceremonial uses. Changes or diversion of Trinity River flows could affect the lifestyle of these individuals. Poverty and unemployment rates for tribal members living on the Hoopa and Yurok reservations are high. Declines in fishery numbers, primarily salmon, and the timber industry have affected the tribal economies resulting in changes to tribal community interaction. Of these resources, only the fishery may be affected by changes to CVP supplies. The Yurok tribe also may be affected by changes to coastal fishery populations. The Yurok have first rights to fish the coastal fishery for salmon above those of commercial fishermen. The Yurok depend on the coastal salmon fishery and inland fisheries for their livelihood.

Declines in fishery resources can affect the ability of tribal members to provide for their families at a subsistence level, perform important tribal ceremonies, and provide for trade between tribal members and other tribes for services and other supplies. The Hoopa and Yurok tribes would like to see greater flows maintained in the Trinity River. If less water were diverted to the Sacramento Valley, instream flows would be greater and may contribute to an increase in the salmon fishery necessary for subsistence living and ceremonial uses, such as the Boat Dance in the fall.

Under treaty and under the protection of the Secretary of Interior, the tribes have rights to instream fisheries for the Trinity River and the Klamath River. These rights recently were defined by the Department of the Interior as equivalent to 50 percent of the annual instream harvest for these rivers. Recently, low salmon stocks have resulted in tribal claims to the fishery harvest, for subsistence and ceremonial uses, that exceed the 50 percent fishery rights.

High unemployment rates and poor access to jobs also are major concerns of tribal members. The nearest significant job market is Eureka/Arcata, a round trip of 120 miles. However, the Eureka/Arcata area also is experiencing high unemployment due to job losses in the fishing and timber industries.

The total Hoopa Valley Tribe labor force is 1,967. Of that number, 369 are categorized as unable to work; 1,071 are not employed, and 527 are employed, with 447 earning an income of $7,000 or higher annually. The lack of jobs and income for tribal members has resulted in an annual per capita income of about $5,900 for the reservation based on 1990 Census data. This is only about 29 percent of the average per capita income for California residents. (Bureau of Indian Affairs, 1991).

The Bureau of Indian Affairs estimates that 2,400 Yurok live on or near the Yurok Reservation. Of that number, 960 are unable to work, 369 are employed, and 1,108 are not employed. (Bureau of Indian Affairs, 1991)

Recreationists and Recreation Workers. Recreationists are boaters, sport fishermen, hunters, and bird watchers that use reservoirs, rivers and streams, and wildlife refuges that store, convey, or use CVP water supplies. Sport fishing also occurs along the coastal area and these individuals also are included in the recreationists groups. Recreation workers are those persons employed by service industries such as river guides; marina operators, boat repair businesses, and recreation supply businesses that provide gear and equipment for hunters, boaters, and fishermen. Members of this group generally are located in Central Valley towns near CVP facilities, wildlife refuges, and rivers, and in coastal fishing communities.

Recreation in CVP reservoirs can be affected by seasonal variations in reservoir levels. During recent drought conditions when reservoir levels dropped significantly, marinas often had to relocate facilities or were unable to use facilities. Reservoir recreation businesses also commented that business can drop substantially when reservoir levels are low, because of increased boating hazards created by reduced lake area and exposed hazards, and loss of scenic values. Sport fishing also has declined as fish numbers have dropped, resulting in decreased needs for river guides and fishing supplies in inland and coastal areas. These businesses have had to reduce staff in recent water-short years. These reductions can affect the local community, particularly reservoir and coastal communities whose economies are based on activities related to fishing and boating.

Recreationists would like to see more water dedicated to recreation uses. Marina owners at CVP reservoirs would like to see the reservoir levels maintained at higher levels during critical vacation times. Unfortunately the interests of the recreation business often conflict with downstream water needs for urban and irrigation uses.

Recreationists represent varied interests and diverse educational, economic, age, and ethnic backgrounds. It is not clear that recreationists are a cohesive social group or have homogenous attitudes about issues related to water, fisheries, and management of natural resources for recreation uses. For this chapter, recreationists have been divided into the following social groups: boaters, sport fishermen, waterfowl hunters, and others based on their recreation interests.

Boaters. Boaters include people who enjoy using the CVP reservoirs and lakes for houseboating, pleasure boating, and water skiing. Data for boating enthusiasts is limited to studies performed by the U.S. Forest Service and the California Department of Recreation. However interviews conducted for the PEIS with marina owners at Shasta Lake and Trinity Reservoir provide insight into the concerns facing boaters as lake levels rise and fall. These discussions also are addressed later in the document for Recreation Communities. Boaters have expressed concern that as lake levels fall to meet water supply and flood control needs, the scenic quality of the reservoir areas also decreases and boating is less enjoyable. Boaters also are faced with more water hazards that normally would be submerged. In addition there are safety concerns with emergency and lake patrol staff that there are more accidents occur as reservoir levels fall and the available boating area is reduced.

Sport Fishermen. Persons interested in sport fishing are present throughout the Central Valley and coastal areas. Sport fishermen represent a varied group of interests depending on the type of fish harvested.

In coastal regions fishing interest is greatest for salmon harvest with recreationists renting ocean-going party boats for day or weekend fishing trips. Sport fishermen that fish coastal waters are not governed by the same rules that limit the commercial salmon harvest. Therefore, this industry has not been affected as significantly. In addition, sport fishing is a recreational activity often conducted for relaxation and social interaction. Therefore, large harvests are not necessarily a measure of the success of the trip. Bait and tackle shop owners expressed concern that the increase in sport fishing has not compensated for recent declines in the commercial fishing industry. This is because the sport fishermen can purchase supplies on the party boats. In addition, large retailers have lower prices and have reduced sales at the smaller specialty stores.

In the Delta region, fishing interests center on striped bass and large mouth bass harvest. Fishermen generally do not rent party boats or hire guides, but fish independently. Fishermen in the area are concerned with other recreation uses in the Delta and the operation of the Delta system affecting fishing opportunities. Businesses in the Delta include marinas and tackle shops, but cater more to recreational boaters than fishermen. This is partly due to concerns about the safety of eating fish caught from Delta waters and the presence of toxins in the fish.

Inland fishermen fish the rivers and tributaries of the Central Valley. Discussions with Sacramento River fishermen indicate interest in the harvest of salmon and steelhead. Sport fishing on the Sacramento River and its tributaries was once a large business. However recent declines in salmon and steelhead numbers have led to a decline in this activity. River guides were once used by the fishermen to locate fishing areas and access the river. However decreased interest in fishing has resulted in some guides leaving the business or having to take other jobs to support themselves. Before, the guides could make a living without supplemental income. Bait and tackle shops in the Redding and Sacramento areas also have gone out of business. Groups interested in the restoration and preservation of inland fishery habitat include several fly-fishing organizations.

Waterfowl Hunters. Waterfowl hunters are primarily concerned with the preservation of habitat and refuge lands. Groups included in this category are the California Waterfowl Association and Ducks Unlimited. These groups support efforts to restore or improve both

waterfowl and fishery habitats. Members hunt on private and public refuge and wildlife habitat lands. Waterfowl hunters contribute to the local communities near hunting areas by purchasing supplies which provide seasonal employment in these communities. This is particularly evident in the San Joaquin Valley where refuge lands are clustered near the towns of Los Banos, Mendota, Volta, Newman, and Merced.

Members of the fishing and waterfowl hunting groups generally believe that environmental considerations should play a larger role in water resources decision making. They also believe that those undertaking actions for economic gain should pay the full costs of the resources they use and the by-products or related impacts of actions taken to use those resources.

Other Recreationists. Other recreationists include hikers, rafters, and birders that utilize reservoir areas, river corridors, and refuges for relaxing, bird watching, and hiking. Rafters and businesses promoting rafting have been affected by controlled river flows. These recreationists may not have the same strong beliefs of the other groups, and may not be represented by specific groups because of their varied interests.

Trinity River Basin and Sacramento River Regions. The U.S. Forest Service conducted surveys of users of the Trinity National Forest, Shasta National Forest, and Whiskeytown National Recreation Area. The users of these areas were identified to have the following characteristics.

- Most people using these recreation areas were 25 to 44 years of age, followed by those age 45 to 64.
- More than 90 percent of the users were White.
- Nearly half the users held college degrees and 50 to 78 percent were employed. with household incomes of $25,000 to $50,000. Houseboaters had higher incomes, ranging from $50,000 to $75,000.
- Most of the users were local residents and nearly all were from California and knew about the area from personal experience.

State of California. In 1987, the California Department of Parks and Recreation sponsored a study of public attitudes. For the survey, 2,142 California households were interviewed using a random sample. The results indicate the value and importance of recreation and outdoor areas to the general public. Values differentiating how much people were willing spend per household or per activity for the improvement or preservation of natural lands and recreation opportunities were not evaluated. The findings are summarized as follows.

- About 75 percent believed spending should be increased for the protection and management of natural and cultural resources, scenery and the natural environment (however spending needed to fulfill these goals was not quantified).
- Seventy five percent of those surveyed believed protection of the natural environment is important for outdoor recreation and natural areas should be preserved for future generations.

- Fifty seven percent considered themselves outdoor enthusiasts and conservatively, Californians spent $1 billion on outdoor recreation during 1986.

- Over 60 percent considered public parks and recreation areas important or very important to their life styles and were satisfied with the public parks and outdoor recreation opportunities available to them.

Communities

Local communities provide a social base for people to access assistance and support during times of need. The social structure of a community may provide job training, educational opportunities, family support services, religious and cultural outlets for support and counseling, recreational opportunities, and monetary assistance. These services may be available through community or county agencies or from cultural and religious institutions within the community. The local community also provides an identifying factor for all residents and a sense of belonging. When economic changes occur within an area, such as the loss or gain of a major employer or drought or flood conditions, the local community can be affected significantly. This is especially true if the local economy is centered around one industry type, such as the forestry, agriculture, fishing, or mining, or defense industries.

The community is a crucial level of social organization. It is at this level that most social services are delivered, social networks formed, and values and beliefs confirmed.

Agricultural Communities. Much of the research on social conditions within agriculture has concentrated on the westside of the San Joaquin Valley. The social analysis for agricultural communities is not intended to focus on one community. Rather, information has been collected for each region through interviews with community leaders, farmers, processing and packing industries, and staff of social service agencies. Presented below is a summary of a 1993 study of social conditions for five irrigation and water districts in the Central Valley. This summary presents an overview of socioeconomic conditions in the valley. These communities have been selected because of the extent that they have been affected by recent water supply and agricultural production conditions. These communities support a large farm labor work force and several processing industries. The residents of these communities have limited employment opportunities and the demand for social services within the region has been increasing.

A 1993 study of the implementation of the Reclamation Reform Act provides a perspective of the social characteristics of eight irrigation districts in the Central Valley. Two of the districts are located within the study area but do not receive water from the CVP. Three of the districts are located in the San Joaquin Valley and receive CVP water: Fresno Irrigation District (FID), Lower Tule River Irrigation District (LTRID), and Westlands Water District (WWD). The remaining districts are located in the Sacramento Valley and receive CVP supplies include Glenn-Colusa Irrigation District (GCID) and Orland-Artois Irrigation District (OAID).

A 1977 study conducted by the University of California (Community Services Task Force, 1977) examined the link between the size of farms and 130 communities in the San Joaquin Valley. The studies showed that as the size of farm operations decrease, the quality of surrounding

communities improve. Similar studies in other parts of the country show the same result (Flora and Flora, 1988). Flora and Flora report that medium size farms contribute to community vitality because families with medium-sized farms generate a higher local multiplier from their income than do either the hired workers, owners, or managers of large farms. This means more retail firms and sales in the local community. This also may be associated with more local ownership of retail firms than is true in large-farm communities.

However this finding may not be true in areas, such as the west side of the San Joaquin Valley where regional data about social conditions do not appear to be significantly different than in other San Joaquin Valley communities. In fact, in the Sacramento Valley, where smaller farms are more prevalent, median family income is significantly lower and the poverty rate is higher.

The Sacramento Valley has been affected recently by drought conditions, job losses in the timber industry, and plant closings. Discussions with social service agencies serving the Yuba, Sutter, Glenn, and Colusa county areas indicated that a ripple effect has led to major economic changes. There have been seven major plant closings in the area in the past 10 years. Poverty rates for the area are approaching 20 percent for some communities according to 1990 Census data. There also is concern that seed companies are moving out of the area and retail businesses are failing because the community can no longer support them.

Processing plants employ several thousand workers during the harvest and processing seasons, however this employment is short term and temporary. One olive processor in the Corning area employs at least 5,000 workers during the olive harvest and processing season. Many workers migrate to the area to harvest up to 4,000 acres of olives. This industry is critical to the area. Another major employer for the area is the Dole Nut Company.

During drought conditions many farmers allow their orchards to go dormant by providing very little water. This allows the trees to survive, but they produce poor quality fruit, and can have reduced yields in future years. Other growers construct new groundwater wells to supply the orchards, but this is an added expense that reduces farm revenues. Recent conditions have resulted in a 33 percent reduction in the olive processing industry.

About 60 percent of the growers in the area supplement their income with other employment. This is a recent condition, in the past the farmers could support themselves without the need for supplemental income. For the area it was estimated that 90 percent of the people are employed in agriculture-related businesses.

One community in the San Joaquin Valley has been affected significantly from changes in CVP supplies. Mendota is located in Fresno County and supports a large Hispanic community of farm laborers. Reductions in CVP water allocations to contractors in the San Joaquin Valley have created significant social changes in the community. Much of the labor force is seasonally employed in the agricultural production. The labor force includes skilled farm laborers. However these workers lack the language and technical skills to become employed in other industries. According to a 1994 EDD study, of male workers in the Mendota area, only forty percent of those who usually work 35 hours per week or more were employed for more than 39 weeks of the year. In addition, 30 percent of the workers worked six months of the year or less.

Unemployment for the community has ranged from about 30 to 40 percent since 1986. This is above the state average.

The major employers in the Mendota area are centered around the food processing and packaging industries. Employment within these industries also is seasonal with the number of employees per employer increasing from 50 to 500 employees during the melon packing season. The community supports four produce and packing plants. Local business leaders and social service providers are working with these plants to expand production to include other products to reduce the number of seasonal employees and by providing more year-around job opportunities.

Another large employer in the Mendota area is the school district which provides year-around and stable employment at higher compensation than the packing plants and farm employment. The school district employs about 175 people. However the school system is becoming burdened and tax base for the Mendota area has not been increasing. Ninety percent of the children attending schools in Mendota are from farm worker families.

Families in the Mendota area often turn to social service programs during the winter months and periods farm labor needs are reduced. Social service programs provide medical assistance, unemployment payments, food stamps, and programs for women and children. Farm laborers also may have house payments to make for housing that became available under a federal subsidized housing program. The program made housing available to the workers but also requires that they keep the home for 20 years. Because of this requirement, leaving the area for other employment opportunities is difficult. Nearly 40 percent of Mendota residents live at or below the poverty level according to the 1990 Census.

Commercial Fishing Communities. Historically the fishing season was viewed as an uplifting time for fishing communities. The communities would celebrate the beginning or the end of the fishing season and entire families would be involved in fish harvest, processing, or packing. In this manner everyone in the town was affected by the fishing industry and there was a sense of caring and participation for everyone. As the fishing industry has declined and processing and packing plants have closed or relocated, the townspeople are not as involved with fishing as a community identity. Therefore fishermen believe that an important culture lifestyle, sense of independence, and community interdependence have been lost.

A fish processing plant noted that recent declines in the fishing harvest and markets have reduced the labor force at the plant. The plant once employed up to 50 people, but now employs only 20 to 25 workers. The plant also has experienced significant losses recently and due to market and harvest uncertainties the processor has not purchased any new equipment in the past three years.

In Fort Bragg boat docks are becoming empty as fishermen leave the business. They are allowing the federal government to buy their boats and to get out of debt. A dock in Fort Bragg once housed 60 boats but is now empty. Reasons for the reduction in boats are the increased safety requirements for boats. Safety equipment requirements for boats have increased and therefore fishermen are not taking crew members to help with the harvest. Now fewer people are employed in fishing. The fishermen used to hire teachers and local youth to assist with the harvest, but now the seasons are shorter and revenues are decreasing, and fewer people are involved in fishing. The fishermen discourage the younger people from entering the industry.

Recent conditions have made it difficult for new fishermen to enter the industry because of the high cost of equipment and license fees. Because of the insecurity of the market and harvest conditions, loans to enter the industry are difficult to secure. This also has made it difficult for the older fishermen who desire to retire and wish to sell their equipment. There are no new fishermen to purchase the equipment and the fishermen often are forced to accept large losses on their investment.

For several coastal communities, such as Fort Bragg, Bodega Bay, and Monterey, tourism has helped to alleviate the economic losses of the fishing industry. People of the communities are now involved in the service industry to cater to tourists. Hotels and restaurants provide employment opportunities. The coastal fishing communities also have been affected by timber industry cutbacks. This has created an increased demand for social services and has led to business closures.

The Pacific Fisheries Management Council (PFMC) estimates that for coastal county residents dependent on income from the ocean commercial salmon fishery, 1991 was a "poor" year with estimated total revenues declining by 32 percent from $31.8 million for 1990 to the $22.3 million estimated for 1991. (PFMC, 1992)

Tribal Communities. The Yurok and Hoopa were considered a single tribe until an act of Congress completed their separation in 1988. Beginning in 1990-1991, members were to register their tribal affiliation.

Hoopa Valley Tribe. Thirty five percent of the residents on the Hoopa Valley Tribe reservation are Hoopa. The remaining population includes persons of other Indian heritage, 50 percent of residents, and non-Indians, 14 percent of residents. Timber production is the main economic contributor to the tribal economy and supports 31 jobs. The tribal government provides services similar to a city government and is a major employer.

There have been six new service industry businesses on the reservation since employing 20 persons. There are also tribal enterprises including: the Tsemeta Forest Regeneration Complex, which provides seedlings for reforestation of tribal lands and for sale to the U.S. Forest Service and private organizations; a hotel; a service station and mini-mart; the Hoopa Forest Industries; a rural hospital, and the reservation water system. These enterprises provide about 70 jobs to residents of the reservation.

The salmon harvest is important to the celebrations and ceremonies of the Hoopa Valley Tribe. Salmon is harvested and shared with other tribal members. The Trinity River also is important to tribal ceremonies, such as the boat dance. It is also tradition that all members who participate in tribal ceremonies are served from the salmon harvest. If salmon are not available from the harvest, other tribal commodities are traded to provide enough salmon to feed everyone. Historically, the tribe also used salmon for trading with other tribes and among the tribe for other goods and services. In a 1995 Fish and Wildlife Service report tribal members reported that the reduction in salmon population has led to increased depression among tribal members and changes in the traditional diet. There is concern that increased disease is beginning to occur among members because of the increased diet of processed food and less dependence on salmon and natural foods in the diet. If salmon harvests were adequate to meet tribal needs members

could return to traditional ways and diets. This could lead to decreased unemployment and increased self-esteem among members.

Yurok Tribe. The Yurok Tribe cultural identity is centered around salmon fishing and the Klamath River. The tribe has rights to harvest up to 50 percent of the annual salmon harvest of the Trinity and Klamath Rivers. In addition tribal ceremonial and subsistence needs may take priority over privileges of other fishing interests and may exceed the 50 percent supply allocation in some years.

Salmon are not only a source of food, but also an integral part of the tradition and ceremonies of the tribe. Several major ceremonies each year use salmon for world renewal, thankfulness, and the feeding of all participants from the salmon harvest. The Yurok is the largest fishing tribe in California. Tribal members that fish, share their harvest with other tribal members and distribute the harvest among the elders. Access to a subsistence level of salmon is an essential component of self-esteem for tribal members. Fishing also allows the fisherman to provide for his family. As with the Hoopa Tribe, the Yurok have used salmon to trade with other tribes and among members. There also is concern that part of the tribal heritage is being lost because the young do not remember the abundant salmon runs and do not have the opportunity to fish in the manner of their ancestors.

Recreation Communities. Historically, lake and reservoir levels have risen and fallen because of water supply operations, flood control operations, and natural weather conditions. As lake levels fall, the distance from the marina facilities to the water increases, vistas are marred by water line changes and lack of vegetation at the water surface, and subsurface water hazards become more pronounced. Marina owners and lodge operators stated that large changes in lake levels affect their business significantly. In the past during drought conditions, when lake levels already were low, water supply releases caused them to move marina docks several times and created a decrease in business. It costs $4,000 to $5,000 to move a marina due to changing water levels. Business also decreases during these times, so any additional costs can create hardship on marina owners and local businesses.

During times when lake levels are low, people reduce their travel to the reservoirs for camping and houseboating. Employment opportunities in towns and with businesses located near the lakes decrease because fewer people are needed to tend to fewer customers. Because employment in the recreation business is seasonal and tied to reservoir use, annual family income can be determined during the spring and summer tourism months lasting from June to August. In Trinity County, 40 to 50 percent of the established businesses, such as RV parks and stores, failed recently due to recent job losses in the logging industry and recreation industry. This caused an increased need for social service assistance in the county. Over a five-year period, following the listing of the spotted owl, requests from social programs providing medical assistance and food stamps increased 86 percent and 13 percent, respectively. Discussions with social services staff indicated that the demand for social services, unemployment payments and medical assistance, in a given year usually increases after the Labor Day holiday for recreation and resort workers.

Summary

Once social groups have been identified, how these groups and their communities are affected by or affect social indicators can be evaluated. The social indicators selected for analysis are: unemployment, housing costs, and the need for and ability of communities to provide social service support programs. Unemployment in Central Valley rural areas, particularly the San Joaquin Valley is higher than in urban areas such as San Francisco, Sacramento, Fresno, and Los Angeles. This is because of the large seasonal labor markets in these areas and the limited availability of other employment opportunities.

Review of literature available for rural areas generally is limited to the San Joaquin Valley and therefore the focus of the environmental analysis will draw heavily from these resources. Seasonal unemployment in some communities, such as Mendota, is very high approaching 40 percent at times. While the average unemployment rate for Fresno County ranged between 10 and 14. 5 percent between 1988 and 1992 (The New United Way, Vision 2020 County Report, 1994). The high level of seasonal unemployment in Mendota may be attributable to the limits of agricultural production. A study by the Giannini Foundation indicated that in 1982-1983 the average farm worker worked 23 weeks or less than half of the year. The lack of work available to these persons results in a low income and the need for supplemental incomes during period of unemployment. The study also indicated that the workers would like to work more but work was not available. The study further states that jobs such as harvesting have a span of 10 to 15 years. This could lead to workers leaving the work force or continuing to work at jobs that are less demanding, but also pay less.

Per capita income in the San Joaquin Valley decreased in Fresno, Madera, Kings, and Merced counties between 1980 and 1990. Per capita income in Fresno County for 1990 was $15,346 while per capita income for the City of Mendota was substantially less at $4,920 (The New United Way, Vision 2020 County Report, 1994). While Stanislaus and San Joaquin County experienced increases slight increases in income, possibly because of their proximity to the San Francisco Bay Area and lack of reliance on CVP water supplies for agricultural production. The need for social services in areas of high unemployment is higher than in other areas. In the western San Joaquin Valley the higher levels of unemployment can be attributed to several factors including a work force with limited skills, lack of formal education, and the need for training in English as a second language. For example, the work force may be very skilled in farm labor operations such as pruning, sorting, packing, and irrigation technology, however these skills do not transfer to other labor markets. Therefore the demand for workers with these skills is limited and training programs may be necessary to bring new employment opportunities to these individuals and the communities where they live (Applied Development Economics, Inc. 1994). It is assumed that similar conditions exist in the Sacramento Valley, but to a lesser extent because fewer acres are dedicated to crops with intensive labor requirements; however data to support these assumptions is lacking.

In coastal areas fishermen were concerned about the lack of fish and declining incomes from previous levels. With declining incomes and increasingly costly safety regulations, the fishermen were not able to hire help for their boats and were required to fish longer periods and at distances further from shore to continue to make a living. Long time fishermen also were concerned with recent changes in the industry affecting their ability to maintain and sell their boats. The

fishermen have put a substantial investment in the boats and often cannot sell the boats for their full value because no one in interested in fishing any more. The fishermen also indicated that they no longer wished for their children to learn the fishing trade because it is getting harder and more dangerous to make a living fishing for salmon.

Housing costs and rental costs were compared for several counties in the Central Valley (Butte, Colusa, Fresno, Merced, Sacramento, San Joaquin, Shasta, and Stanislaus counties surveyed) and for Mendocino County along the coast. Median housing costs for all areas increased substantially from 1980 to 1990, ranging from 26 percent in Fresno County to 55 percent in San Joaquin County. Fresno County has a large rural housing base that may reduce average median housing costs. San Joaquin County has experienced larger increases in housing costs because of its proximity to the San Francisco Bay Area. Housing costs for rural counties experienced smaller increases than more urban counties. Housing costs increased 43 percent from 1980 levels in Mendocino County. While housing costs reflected regional influences, increases in median rental costs increased at a relatively similar rate for all counties from 1980 to 1990. Increases in rental costs ranged from a low of 45 percent in Shasta County to a high of 55 percent in San Joaquin County. Interestingly rental costs increased by 47 percent for the ten year period, a substantially higher rate of increase than housing costs. This finding is significant, particularly in areas with large seasonal employment or where most the population is unable to afford home purchase. The reflected increases indicated that most income is being required for to provide housing, leaving less money available for savings or other expenses, such as transportation, health care, food, clothing, or education.

Studies of the western San Joaquin Valley support a finding that increases in population have led to greater total revenues for the region. However these revenues are supported by a larger population making a lower per capita income. Therefore, although revenues for the region appear to have increased, expenditures to provide social support services to a poorer population also have increased.

Several studies have been prepared focused on the San Joaquin Valley agriculture and the response of agriculture to reductions in water supply. These studies have used data generated by drought conditions that occurred from 1987 to 1992, excluding 1990. One study, *The Impact of Water Supply Reductions on San Joaquin Valley Agriculture*, generally referred to as the Rand Study December 1994, indicated that there was little change in agricultural employment and crop revenue in Fresno County during this period between control counties unaffected by CVP deliveries and study counties that received CVP supplies. It was found that reductions of 7 percent in crop revenue occurred, and greater reductions were offset by changes in cropping to higher value vegetable crops and possibly improvements in irrigation efficiency. The study also indicated that there may farmers may be able to conserve water without substantial hardship or the need to make drastic cropping or land use changes. However the study cautioned that in the long term, changes to vegetable production in response to water cutbacks may be less pronounced, likewise long term water cutbacks could eliminate any existing cushion in water use. This could lead to potential reductions in farm labor needs, expenditures, and revenues, which could affect the ability of a community to provide essential services.

CHAPTER III

ENVIRONMENTAL CONSEQUENCES

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ENVIRONMENTAL CONSEQUENCES

The environmental consequences of implementing Alternatives 1 through 4 are analyzed relative to social well being are difficult to quantify. The consequences of an action as they affect social issues is often intangible and may be a secondary consequence of the action. Social well being is a measure of people's beliefs and attitudes, and the ability of people to cope with the changes in economic and social conditions that may arise as a result of an action.

ANALYSIS METHODOLOGY

The analysis of potential impacts to individuals and communities draws from published studies related to reaction of growers, farm workers, and communities resulting from drought conditions and anticipated reaction to implementation of the SJVDP. The analysis also draws from interviews conducted early in the environmental review process and subsequent follow-up interviews. These interviews were with irrigation district staff and representatives of social support organizations such as the EDD and EOC. Summaries of these interviews can be made available upon request. The findings of these interviews have been used in the following analysis. It is important to note that these extensive interviews were conducted during formulation of alternatives and persons were interviewed based on proposed alternatives that restricted CVP deliveries to a much greater extent than the alternatives evaluate in this Draft PEIS.

Many social consequences perceived to occur as a result of Central Valley Improvement Act (CVPIA) actions actually would have occurred as a result of planned water supply actions that would have taken place from 1992 to 2022. The completion of these projects would alter water supply operations for the CVP and redistributing water among the CVP users and environmental uses. Natural actions also have occurred historically and will continue to occur and affect social conditions. Examples of natural and economic conditions that may have adverse direct and secondary social consequences are long term drought, flood, and changes in market demand or prices; disease and pest conditions affecting agricultural crops, fish, and wildlife; and natural population changes. The social consequences of these actions are not addressed because they are not a result of CVPIA actions.

SOCIAL GROUPS

As discussed in Chapter II, implementation of the project alternatives has the potential to affect several social groups. The social groups identified for this analysis are farmers, farm workers and agribusiness workers, commercial fishermen and fishing businesses, recreationists and recreation workers, and Native American tribes. Each of these social groups is discussed in the alternatives analysis.

CVPIA RELATED CHANGES

As discussed in the Affected Environment data for the Sacramento Valley and coastal areas is limited, while data for the San Joaquin Valley, particularly the western side of the valley is more readily available. Studies have been completed within the past ten years focusing on the potential socioeconomic impacts of drought conditions and water supply reductions on this portion of the valley and the potential impacts from implementation of the SJVDP. The impact analysis is based on the findings of these studies in determining the projected impacts of implementation of the CVPIA. However, impacts to social groups are difficult to quantify. Human behavior is difficult to predict and past studies have focused on social, economic, and land use changes resulting from short term drought conditions. The actual effects of implementation of long term water supply programs cannot be predicted with complete assurance, but must be projected based on assumptions of human behavior, primarily the assumed actions of farm managers and land owners implementing long term changes to farm operations. The alternatives evaluation for the social analysis is based on the regional economics analysis and projected changes to regional employment. These findings have been applied to the analysis for the identified social groups.

The initial discussion focuses on each alternative and the relative changes to employment for each identified social group. The discussion continues with potential impacts to communities and how each social group may be affected by changing economic conditions. The discussion also addresses the need for job and language training, the potential needs for displaced workers to relocate to obtain employment opportunities, and how community social and institutional services may be affected or may react to employment changes under each alternative. At the end of the chapter, a brief summary of the alternatives is presented with respect to total agricultural employment, ethnic make up of affected region, and changes in agricultural production.

NO-ACTION ALTERNATIVE

The number of agricultural jobs available may increase in some areas due to projected changes in crop production to higher value and more labor intensive crops. However, agricultural employment would remain seasonal. There could be improvements in mechanization for picking and sorting crops and other improvements that could eliminate some tasks that are currently labor intensive. Changes in irrigation technology also may occur that could change farm labor needs. Changes to the population, crop production, and technology resulting in a decrease in employment opportunities or the duration of employment may create an increased need for social services to provide food, health care, and housing for those facing economic hardship. These needs may be seasonal or could be year-around depending on the extent of the change and the education, training, and technical skills of the population in the area affected.

In a report prepared by the United Way for Fresno County (Vision 2020 Region 5, 1994), the primary concerns of the public were crime, youth problems, poverty and economic development, housing affordability, affordable and accessible health care, transportation needs, and water supply reliability. The area surveyed included all of Fresno County, but focused on the western side of the San Joaquin Valley, extending from Kerman to Coalinga. The survey indicated that

while water is important, water was never listed as a top concern of those community leaders surveyed. Concern for the future of the region stressed greater anxiety about social issues related to health, family welfare and poverty, affordable housing, and youth crime. Many of those surveyed expressed concern for the future of those currently on welfare and the continued reliance of several generations on welfare programs for economic support. The study identified that overcrowding is common in many households in rural Fresno County. In the communities of Mendota, Huron, and Firebaugh overcrowding occurs in 30 to over 50 percent of households, while Fresno County has an average nearly 14 percent of housing in overcrowded conditions. Often overcrowding is largely dependent on the financial capacity of family. Crime rates for the Fresno County area have risen sharply when compared to California as a whole. While California has experienced an eight percent increase in the crime rate from 1983 to 1992, Fresno County has experienced a steady and constant increase in the crime rate approaching 60 percent over that same period according to the New United Way Study.

No similar study has been completed or was available for the Sacramento Valley or coastal areas. Given changing market conditions and economic policy, it is difficult to project future changes in employment for each region. The social analysis for employment is based on the 1991 baseline conditions assumed in the Regional Economic Analysis for this PEIS.

The demand for social services by less technically skilled workers, particularly unemployment insurance and food and welfare programs, may increase as the demand for highly skilled workers in technical fields rises. Less technically skilled workers and those lacking basic education levels and English language skills may find employment more difficult. While seasonal employment may be available, the opportunity to receive income from year-around employment may become more difficult.

ALTERNATIVE 1

Implementation of the actions proposed for each alternative, as compared to No-Action Alternative, with regard to employment is shown on Table III-1. In the Sacramento River Region the total number of jobs lost includes approximately 160 due to changes in the agricultural sector. 20 jobs would be gained from increases in the recreation sector. In the San Joaquin River Region, approximately 2,400 jobs would be lost due to changes in the agricultural sector, while 10 recreation - related jobs would be gained. The Tulare Lake Region would experience losses approaching 940 jobs, of which all would result from changes in the agricultural sector. These losses represent less than one percent reduction in jobs for each region. The projected reduction in agricultural jobs includes not only direct farm labor inputs but also related and secondary declines in manufacturing, service, construction, and retail employment opportunities throughout the region. There is no employment breakdown for the north coastal area or jobs related to fishing.

In the Sacramento Valley job losses in the agricultural sector would be limited to the west side. Recreation employment losses would occur at CVP reservoir facilities and could affect sport fishing and river recreation activities.

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TABLE III-1

CHANGES IN REGIONAL EMPLOYMENT

Region	Total Number of Jobs (1)	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Sacramento River	1,297,260	-260	-560	-1,310	-1310
San Joaquin River	890,220	-2,450	-2,990	-2,960	-3,860
Tulare Lake	468,700	-940	-870	-800	-1,100
San Francisco Bay	3,129,540	-100	-100	-90	-100
South and Central Coast	9,603,010	960	960	3,110	-175
Total	**15,388,730**	**-2,790**	**-3,550**	**-2,060**	**-6,540**

NOTES:
(1) Regional Economic Analysis Baseline Data, 1991.

In the San Joaquin River and Tulare Lake regions agriculture job losses would occur mainly on the west side due to reductions in irrigated agricultural acreage. This would affect the areas near the communities of Mendota, Firebaugh, Huron, and Coalinga the greatest. Because these areas already are experiencing high levels of unemployment and the labor force is primarily farm workers, the social and economic structure of these communities could be affected further when compared to No-Action Alternative. Examples may include higher demand for social services, loss of community-specific fire and police protection services in favor of less expensive area-wide services merged with one or more other communities, increased crime such as shoplifting, and loss of local small businesses such that customers may have to travel further to purchase supplies.

There would be no other adverse impacts resulting from job losses in other regions, except the San Francisco Bay Region, where a loss of less than 100 jobs could occur due to increased water costs. Given the size of the employment base for the region, employment losses would not create an increase the need for social services.

In the South Coast and Central Coast regions, jobs would increase due to increased availability of water. While this would be a benefit to the regions, the changes would be very small given the size and large population of the affected areas.

It was assumed that no discernable changes to population would occur in the regions due to the large populations in each region.

Further discussion of changes to employment is provided in the Regional Economics and Agricultural Economics and Land Use technical appendices. Changes in employment were not considered due to changes in electricity costs.

LAND OWNERS AND FARM OPERATORS SOCIAL GROUP

For the agricultural sector job losses in all regions would most likely affect farm owners and operators the most. In the San Joaquin Valley changes to agricultural production would result from land fallowing and land retirement on the west side. Crops most likely affected do not require intensive labor inputs for production, therefore secondary impacts to farm workers are limited. Discussions with irrigation district staff on the west side of the San Joaquin Valley have indicated that farm managers displaced by land retirement would likely find employment elsewhere in the agricultural sector. However, other less skilled managers may become displaced or underemployed as these skilled managers gain employment.

Per capita income for displaced farmers and families may decline and could be replaced by social service and support programs. Farm managers may be required to travel further to their place of employment or move to other areas to gain employment. The need to move or to be away from home and family for longer periods, could add additional burden to other family members.

FARM WORKERS AND AGRIBUSINESSES SOCIAL GROUP

There could be some jobs lost in agribusinesses providing seed, fertilizer, pesticide, and equipment inputs, or markets for products that would have been grown on the lands projected to

be removed from production. These indirect labor losses are documented in the total labor losses projected for the agricultural sector under this alternative. Machinery operators and irrigation technicians employed by landowners participating in the land retirement and management programs would be affected and may seek other employment.

In discussions with the staff of agencies providing social services in all regions, the primary concern was the need for increased social services to accommodate the loss of jobs in the agricultural sector. The Sacramento River Region also is affected by the timber industry and any losses that may occur in this industry, although unaffected by the CVPIA, would stretch the need for social services. When labor reductions in the timber industry occurred following listing of the spotted owl, there were significant increases in the demand for social services, primarily unemployment assistance, medical assistance, and food stamps.

In the San Joaquin River and Tulare Lake Regions the principal concern of social service agencies was the potential for job losses to those with limited skills, such as field laborers. However, because few changes are anticipated to labor intensive farm production under this alternative, the need to provide services for these persons is limited. Rather job losses would most likely be for farm managers and skilled irrigation technicians or machine operators. According to those interviewed involved in farming operations there is a demand for persons with these higher skill levels. It is anticipated that displaced farm managers and technicians could find work in other regions or other jobs related to agriculture. While there may be a temporary increase in the need for social services to provide training or economic assistance for a portion of these displaced workers, this need is not expected to be large.

Per capita income may decrease slightly in the western side of the San Joaquin Valley from implementation of this alternative. However it is assumed that these workers could find other employment because of the demand for workers with these skills. Therefore, changes in per capita income may be temporary.

If all projected job losses were to occur near one community, the total effect to the area could be devastating. For example, the communities of Huron, Kerman, Mendota, and Coalinga have existing (1990) populations ranging from approximately 4,600 to 8,000 respectively. If all jobs lost for the San Joaquin River Region were to affect Huron, Kerman, or Mendota, over half the total population and more than half of the working population of these communities could be affected. It is impossible to determine the exact percentage of these changes in irrigated acres and associated impacts at this time. This information would be determined in subsequent environmental documents for contract renewals.

RECREATIONISTS AND RECREATION WORKERS SOCIAL GROUP

Displaced recreation workers at Shasta Lake and New Melones Reservoir would likely need to receive social service benefits. Interviews with recreation service employers indicate that many recreation workers are seasonal and part-time employees. Many are students who look for seasonal employment. Loss of recreation jobs for these individuals would likely cause them to seek temporary employment elsewhere. However, in towns located adjacent to CVP recreational facilities, where employees are local townspeople, job losses could cause some displaced workers to apply for social assistance. Displaced workers that held permanent seasonal jobs have

indicated a need to utilize social service programs during the off-season months. Therefore it is anticipated that if these workers are displaced they may require year-round assistance until other employment could be found.

A benefit of the reallocation of water supplies from agricultural uses to fish and wildlife habitat uses may result in improved recreation opportunities and the income generated from hunters, birders, and sport fishermen visiting the wildlife refuges and streams. In addition there could be improvements to aesthetic values in rivers and refuge lands and environmental benefits that are difficult to quantify. As discussed in the Chapter II, a survey of California residents by the California Department of Parks and Recreation indicated that most residents expressed interest in the improvement of natural areas and recreation opportunities, including improved habitat for fish and wildlife. These values are discussed in more detail in the Recreation and Visual Resources technical appendices, but are important to social well being with regard to recreation and relaxation opportunities. A benefit of increased water supplies for fish and wildlife habitat uses also would be additional employment opportunities related to environmental restoration and both habitat restoration and structural improvements. This would include such actions as restoration and improvement of refuge facilities and spawning areas in streams. These new jobs could replace some of the jobs lost in the area.

FISHERMEN AND FISHING BUSINESSES SOCIAL GROUP

The lack of data for the north coastal area makes projections of potential impacts to fishermen difficult. However a decrease in water deliveries and subsequent increases in water held in reservoirs, rivers, and streams could benefit fisheries. If improvements to the fishery occur, there may be similar, but lesser benefits to fishermen. The benefits to fishermen would not be as great because it cannot be assumed that the catch of fish would not be equal to increases in fish numbers. Fishing regulations govern catch limits and may remain in place. Therefore, the true potential benefits to fishermen and fishing businesses cannot be quantified. In coastal areas fishermen and fishing businesses could receive higher incomes under implementation of Alternative 1, however this change cannot be quantified because the ability to fish and quantities of harvest are regulated. The Fish, Wildlife and Recreation Economics technical appendix evaluates the economic benefits that may occur in the future for communities in fishing areas.

NATIVE AMERICAN TRIBES SOCIAL GROUP

The Hoopa Valley and Yurok tribes would benefit from the provision of increased flows in the Trinity River. These benefits are currently being evaluated in a separate environmental impact statement (EIS) for the Trinity River operations. Increased flows may improve the fishery of the river and its tributaries. Because the culture of these tribes is dependent on the fishery for subsistence and ceremonial uses, the social value of the increased flow is important. Tribal members believe that increased flows would lead to less unemployment and aid in a return to traditional lifestyles. There would be no change to housing costs or per capita income for tribal members. However, there could be intangible social benefits from the ability to lead a subsistence lifestyle.

ALTERNATIVE 2

Implementation of the actions proposed for Alternative 2, as compared to the No-Action Alternative, would result in a loss of jobs in the Sacramento River Region as shown on Table III-1. Approximately 490 jobs would be lost due to changes in the agricultural sector. There would be an increase of approximately 40 recreation-related jobs. In the San Joaquin River Region nearly all job losses would result from changes in the agricultural sector. There would be an increase of approximately 30 jobs due to increased recreation. The Tulare Lake Region would experience losses approaching 900 jobs, of which all would be related to changes within the agricultural sector. The need for the level of social services to assist agricultural workers displaced due to implementation of Alternative 2 could increase over the level projected for Alternative 1.

Job losses would occur in the San Francisco Bay Region and would be identical to the losses projected to occur under Alternative 1.

In the South Coast and Central Coast regions, jobs would increase due to the availablility of water. While this would be a benefit to the regions, the change would be very small given the size and large population of the affected areas.

It was assumed that no discernable changes to population would occur in the regions due to the large populations in each region.

Further discussion of changes to employment is provided in the Regional Economics and Agricultural Economics and Land Use technical appendices. Changes in employment were not considered due to changes in electricity costs.

LAND OWNERS AND FARM OPERATORS SOCIAL GROUP

In the Sacramento River Region job losses would occur along the west side. Land owners and farm managers may seek other employment opportunities locally or may elect to relocate to other areas for employment. The losses would be spread throughout the west side and would not affect one community more than another.

In the San Joaquin River and Tulare Lake regions agriculture job losses would occur mainly on the west side of the region and could affect the areas near the communities of Mendota, Firebaugh, Huron, and Coalinga the greatest. Because these areas already are experiencing high levels of unemployment and the labor force is primarily farm workers, socio-economic impacts to this area are of concern. The social impacts to these communities would be similar to that described for Alternative 1. Because land use changes are anticipated to occur to lands producing crops with limited labor requirements, impacts to employment opportunities would be limited to farmers, farm managers, and irrigation technicians and machine operators. It is assumed, based on discussions with irrigation district staff, that these workers could find employment elsewhere because the need for skilled agricultural workers is high. However these workers may have to travel further to their place of employment or relocate to other areas where employment is available. The need to relocate families or for family members to spend more

time apart could create additional social burdens on the family and the individual members as new friendships and family structure within a new community may need to be built.

Other job losses could occur on the east side of the region near Oakdale, Modesto, and Turlock. These job losses would not be due to CVP water supply reductions, but due to a reduction in irrigated acreage resulting from the sale of water rights on the Stanislaus, Tuolumne, and Merced rivers by persons with water rights that are willing to sell those rights for other beneficial uses. Per capita income for farmers on the east side of the San Joaquin Valley that could sell water supplies could increase.

FARM WORKERS AND AGRIBUSINESSES SOCIAL GROUP

There could be a secondary impact to persons employed by businesses that supported agriculture production activities on the west side of the Sacramento Valley and the west and east sides of the San Joaquin Valley, such as seed, fertilizer, pesticide, equipment, and labor inputs. The need for social service program to support these individuals would increase unless these workers can find other employment. Support businesses and local retail businesses could be affected by the loss of income generated from farm production. However, on the east side of the San Joaquin River Region these losses could be offset by new economic opportunities generated by the purchasing power of growers receiving income from the sale of water.

Displaced workers would include seasonal farm laborers on the east side that are skilled in pruning, harvesting, irrigation, and other labor intensive activities. However based on studies conducted of farm workers, many workers lack basic training and language skills necessary to obtain other employment. Therefore, compared to Alternative 1, the need for training and social welfare programs would likely be greater under Alternative 2 and greater than under the No-Action Alternative. These workers also may be forced to find employment further away from home. For those workers with homes and developed family and social structures within the communities, the need to travel further for work or to relocate could lead to increased burdens.

As discussed for Alternative 1, if all employment loss impacts were to occur within one community, the total effect to that community could be devastating. The projected changes to agricultural employment for this alternative are greater, but would affect the east and west sides of the San Joaquin River Region and therefore could be dispersed over several communities.

RECREATIONISTS AND RECREATION WORKERS SOCIAL GROUP

A benefit of the reallocation of water supplies from agricultural uses to fish and wildlife habitat uses could be an increase in recreation opportunities and the income generated from hunters, birders, and sport fishermen visiting the wildlife refuges and streams. In addition there may be aesthetic values and environmental benefits that are difficult to quantify for social value. The loss of agricultural employment could be offset slightly by the creation of recreation jobs from increased river flows and improved fish and wildlife habitat. Restoration activities to improve habitat also could provide employment opportunity. Impacts for recreation communities near reservoirs would be similar to those anticipated for Alternative 1.

COMMERCIAL FISHERMEN AND FISHING BUSINESSES SOCIAL GROUP

Improved habitat in eastern streams could benefit fisheries in those streams and the Delta when compared to No-Action Alternative also may have secondary benefits to commercial fishermen who rely on salmon harvest for their living. The benefits to commercial fishermen could be greater than under Alternative 1 because of increased flows in the eastern tributaries of the San Joaquin Valley. This may result in improved fishing conditions leading to increased income and less demand for social services in fishing communities as fishermen and fishing businesses are better able to provide for their families. There may be a slight improvement in per capita income for fishermen and persons with supporting businesses in the north coastal area. However it is difficult if improvements to the social or income conditions of fishermen because fishing catch and harvest season are regulated. If enforcement of the existing regulations continues under implementation of the alternatives, then fishing income could remain unchanged

NATIVE AMERICAN TRIBES SOCIAL GROUP

The Hoopa Valley and Yurok tribes would benefit from the provision of increased flows in the Trinity River. Increased flows would improve the fishery of the river and its tributaries. Because the culture of these tribes is dependent on the fishery for subsistence and ceremonial uses, the social value of the increased flow is significant. Tribal members of have stated that increased flows which would improve fisheries and related activities would lead to less unemployment and aid in a return to traditional lifestyles. This would be an improvement to the Native American lifestyle when compared to No-Action Alternative, but would be similar to the effects experienced under Alternative 1. These benefits are being evaluated in a separate EIS for the Trinity River operations.

ALTERNATIVE 3

Implementation of the actions proposed for Alternative 3, as compared to the No-Action Alternative are shown on Table III-1. In the Sacramento River Region approximately 1,240 jobs would be lost due to changes in the agricultural sector. There would be an increase of 40 recreation related jobs, equivalent to the employment gains under Alternative 2. In the San Joaquin River Region, approximately 3,000 jobs would be lost. There would be a gain of approximately 50 jobs related to the recreation sector. The Tulare Lake Region would experience losses approaching 800 jobs, of which all would be caused by changes within the agricultural sector. The loss of jobs for the Tulare Lake Region under Alternative 3, when compared to that anticipated under Alternatives 1 and 2, would be less. As discussed in the Agricultural Economics and Land Use technical appendix, there would be an increase in more labor intensive crop production in the Tulare Lake Region for areas receiving water from the State Water Project, and therefore a corresponding increase in farm employment opportunities. This increase offsets labor losses for other areas of the Tulare Lake Region that receive CVP supplies and in the San Joaquin River Region anticipated under this Alternative 3.

Job losses occurring in the San Francisco Bay Region would be incidental and nearly identical to the losses projected to occur under Alternative 1. Further discussion of changes to employment

is provided in the Regional Economics and Agricultural Economics and Land Use technical appendices.

In the South Coast and Central Coast regions jobs would increase due to the availability of water. While this would be a benefit to the regions, the changes would be very small given the size and large population of the affected areas.

It was assumed that no discernable changes to population would occur in the regions due to the large populations in each region.

Further discussion of changes to employment is provided in the Regional Economics and Agricultural Economics and Land Use technical appendices. Changes in employment were not considered due to changes in electricity costs.

LAND OWNERS AND FARM OPERATORS SOCIAL GROUP

Communities that lie within the areas that could be affected by the loss of agricultural employment in the Sacramento Valley are Willows, Orland, Colusa, and Chico. Lands in these areas are cultivated for rice production and pasture lands. Job losses would affect farm managers and land owner/operators. Landowners that are willing to sell their water supplies and remove their lands from irrigated production would be compensated and may not require other employment. Per capita income could improve for those farmers able to sell water. However displaced farm managers would likely seek other jobs within the area or relocate to other areas. Families of the farm managers could be affected if they are required to move and leave behind established community connections to schools, family, church and friends.

In the San Joaquin River and Tulare Lake regions agriculture job losses would occur on the west side of the region and would affect areas near the communities of Mendota, Firebaugh, Huron, and Coalinga the greatest. Changes to farm labor needs would be similar to those experienced under Alternative 2 when compared to the No-Action Alternative. Other job losses would occur on the east side of the region near Oakdale, Modesto, and Turlock. These job losses would not be due to CVP water supply reductions, but due to the sale of water rights on the Stanislaus, Tuolumne, and Merced Rivers. Farm managers displaced from the removal off irrigation on some lands may be required to relocate or accept jobs that require less skill and training leading to underemployment of these individuals. Farmers and water rights holders able to sell water could receive higher per capita incomes and may generate new sources of income for other non-agriculture related business, or could use the available income from water sales to make improvements to other agricultural lands not affected by the water sales.

FARM WORKERS AND AGRIBUSINESSES SOCIAL GROUP

Water purchased from persons holding water rights within the eastern watersheds of the Sacramento River Region and San Joaquin River Region would be greater than that purchased under Alternative 2. It is estimated that the land removed from production would include orchards and other labor intensive crops. Purchase of the water would require that lands irrigated with the water rights become fallow and a loss of irrigated agricultural production would occur as

discussed in Agricultural Economics and Land Use technical appendix. However revenue generated within the regions from the water purchases could be used to generate jobs and income in other labor sectors or used for improvements on farmland irrigated with other supplies. It is difficult to determine if the benefits from these revenues would carry-over to the affected communities or fringe communities such as Firebaugh and Mendota, which would already have been affected by reductions in CVP irrigated acres and resulting farm employment losses.

Under this alternative more land in the Delta Mendota Canal CVP service area would be removed from production when compared to the No-Action Alternative. Therefore, the west side communities would most likely be adversely affected by the reduction in farmed acreage and the subsequent loss of income and demand for farm production supplies for the area. Secondary employment losses in businesses such as seed and equipment suppliers, farm services, and retail businesses could occur. These assumed labor losses have been included in the total labor losses per region provided above.

Skilled farm workers and machinery operators would lose employment, but may find other employment because of their skill levels. However, unlike under Alternative 2, these workers may be required to find work at a less pay and a lesser skill level or to travel further or relocate for employment opportunities. This is because more skilled workers would be displaced under Alternative 3 and therefore the potential to find similar employment opportunities could be limited and more difficult.

Some skilled workers and farmworkers displaced by the reduction in irrigated acreage may choose to relocate to the Tulare Lake Region where employment opportunities may be better. Economic and agricultural land use models used for this PEIS analyses indicated that the Tulare Lake Region could experience a net increase in irrigated crop production. Employment opportunities in the Tulare Lake Region would be seasonal, and therefore workers may require social services when seasonal employment is not available. This could stretch the availability of social services to existing residents of the region. The social support groups may include schools, churches, social and support clubs and organizations, and potentially association with family members in other households. If workers from the San Joaquin River Region choose to relocate, additional social burdens could be placed on these workers and their families as the existing social structure and support groups are left behind and new friendships and social support groups are formed in another area.

The need for social services to support displaced farm laborers with limited skills would likely increase under Alternative 3, when compared to Alternative 2 and the No-Action Alternative. The need for training programs and language programs could increase if laborers are unable to find agricultural work elsewhere in the state, such as the Tulare Lake Region or if they are unable to relocate.

The per capita and family income of the displaced workers would probably decrease and could affect the ability of these persons to maintain their current standard of living. If these displaced workers cannot find other employment or are unable or unwilling to relocate to other potential labor markets, the families of displaced workers and potentially their communities could be adversely affected. Examples include the possible inability of displaced workers to meet mortgage payments for homes, less opportunity for the workers or their families to obtain higher

education because of lack of income to support the cost of going to school, and less income for purchases of supplies, clothing, and larger items such as cars and appliances. The lack of income and purchasing power could indirectly affect local businesses that rely on the purchases of persons within the community. If local businesses are lost then all members of a community would need to travel further to obtain supplies. Similar changes could occur to fire and police protection services, churches, schools, and other social institutions if local communities cannot support community specific institutions, mergers may be required to maintain basic social support and protection services. If all employment losses were to affect one or several communities the effects could be devastating to the area. For example the communities of Mendota and Firebaugh have a combined population of approximately 11,000. The loss of nearly 3,000 jobs within the area would likely affect every family and local businesses.

RECREATIONISTS AND RECREATION WORKERS SOCIAL GROUP

More water would be allocated to in-stream fishery uses under Alternative 3 when compared to no action and therefore it is anticipated that recreationists and recreation workers would benefit from implementation of this alternative to a greater extent. For all regions recreation employment opportunities are anticipated to improve when compared to No-Action Alternative. Employment projections for recreation also include indirect benefits to local businesses that support the recreation industry such as food stores, gas stations, and other businesses within a recreation community. Changes to per capita income would be negligible.

FISHERMEN AND FISHING BUSINESSES SOCIAL GROUP

Restoration of watershed and improved habitat in streams may create secondary benefits to commercial fishermen who rely on salmon harvest for their living. In stream flows under Alternative 3 would be greater than under the No-Action Alternative and Alternatives 1 and 2. Therefore fishery numbers could improve as habitat improves. The benefits to commercial fishermen would be increased and potentially less demand for social services in fishing communities. However it is unclear if benefits to fish numbers would benefit fishermen because fishing harvest is regulated. Improvements to the fishery may not affect fishing regulations and harvest regulations may remain unchanged when compared to the No-Action Alternative. It is unclear if per capita income for fishermen and fishing businesses would improve.

NATIVE AMERICAN TRIBES SOCIAL GROUP

The Hoopa Valley and Yurok tribes would benefit from the provision of increased flows in the Trinity River. Increased flows could improve the fishery of the river and its tributaries as compared to the No-Action Alternative. Because the culture of these tribes is dependent on the fishery for subsistence and ceremonial uses, the social value of the increased flow is significant. Tribal members indicated that increased flows and improved fisheries would lead to less unemployment and aid in a return to traditional lifestyles. These benefits are being evaluated in a separate EIS for the Trinity River operations.

ALTERNATIVE 4

Implementation of the actions proposed for Alternative 4, as compared to the No-Action Alternative are shown on Table III-1. In the Sacramento River Region job losses would be nearly identical to those projected under Alternative 3. Of these, nearly all are caused by changes in the agricultural sector. There would be an increase of approximately 40 recreation-related jobs, identical to those projected for Alternatives 2 and 3.

In the San Joaquin River Region, approximately 3,800 jobs would be lost, nearly all due to changes within the agricultural sector. More land would be removed from production on the west side in the CVP Delta-Mendota Canal service area. Farmers and agricultural workers in this area and the communities of Mendota, Firebaugh, Huron, and Coalinga would be adversely affected by the reduction in irrigated lands. As discussed under Alternative 3, these communities may not be able to support local businesses, fire and police protection services, schools, and churches because of the employment and income losses. Therefore, the small communities may be required to merge social and institutional services to provide for local residents. This could lead to a declining social support structure as people have to drive further to participate in social events, church, and schools. Family income would decline for displaced workers and additional burdens could be placed on family members if additional members are required to work to support the family, or relocation is necessary to find other employment. If workers are unable to find other employment or are unwilling or unable to relocate to other jobs, the demand for social services such as welfare, food, and health programs would be expected to increase.

The Tulare Lake Region would experience losses approaching 1,100 jobs, of which all would be caused by changes in the agricultural sector. The need for social assistance for farmers, agricultural workers, and workers in supporting businesses displaced due to implementation of Alternative 4 would be more extensive but similar to that projected for Alternatives 2 and 3.

The San Francisco Bay Region would experience a loss of less than 100 jobs due to increased water costs. Impacts from the loss of these jobs would be identical to those anticipated for Alternatives 1, 2, and 3.

Unlike under Alternatives 1, 2, and 3, the South Coast and Central Coast regions would experience job losses under Alternative 4 due to reduction in water supplies. These losses would be due to increases in urban water costs that could adversely affect businesses. However, the loss of jobs is small and negligible when compared to the total employment base for the regions.

LAND OWNERS AND FARM MANAGERS SOCIAL GROUP

In the Sacramento River Region the potential adverse impacts to displaced farmers and farm managers would be identical to those under Alternative 3 and would be greater than under No-Action Alternative.

In the San Joaquin River Region employment losses in the agricultural sector would be greater than under any of the alternatives. Most of these losses would occur on the west side in the Delta-Mendota and San Luis Canal service areas. Water supply reductions to these areas would affect less labor intensive production as anticipated for each of the other alternatives. Cotton,

irrigated pasture, and grains would be removed from production with CVP supplies and land would be fallowed. Because these crops are not labor intensive adverse impacts fall largely to farmers, farm managers, and technically skilled farm workers such as machinery operators and irrigation technicians. Workers with farm management skills are needed throughout the Central Valley. However, given the large number of farm managers displaced under this alternative, it is not likely that each would find similar employment within the affected area. Displaced farm managers may have to relocate to other areas, accept underemployment, or displace other managers that are less skilled. Employment losses on the westside could be greater than the total job losses (3,800 jobs). This is because income from east side water sales is anticipated to generate approximately 1,500 jobs and offset most losses experienced on the westside of the region.

In the Tulare Lake Region, approximately 200 more workers would be displaced than under the Alternatives 1, 2, and 3. These would include farm managers who may be able to find other jobs, but as with the San Joaquin River Region, employment opportunities may be limited. Displaced farm managers may require additional job training or education to be able to enter other employment fields and may have to relocate within the region to major economic centers or to other regions to find employment opportunities. Displaced workers within the Tulare Lake Region represent employment losses withing the Kern County State Water Project service area and the Cross Valley Canal service area. These regions also would experience losses under each alternative, with the Cross Valley service area experiencing identical losses, and the Kern County State Water Project service area experiencing acreage losses of a much higher magnitude, nearly double those anticipated under the other alternatives when compared to the No-Action Alternative. The Agriculture Economics and Land Use technical appendix presents a more detailed discussion of projected land use changes under each alternative.

FARM WORKERS AND AGRIBUSINESSES SOCIAL GROUP

Communities in the Sacramento River Region and San Joaquin River Region adversely affected by the implementation of Alternative 4 would be the same as those affected under implementation of Alternative 3. However, the magnitude of the potential adverse impacts would be much greater under Alternative 4. Because these areas already are experiencing high levels of unemployment and the labor force is primarily farm workers, socio-economic losses to this area are of concern. Water supply reliability under Alternative 4 would decrease and workers and communities may be faced with less income and employment stability than under Alternative 3, particularly on the west side of the San Joaquin River Region. The need for social services under Alternative 4, could therefore be greater than under any of the other alternatives when compared to No-Action Alternative. These needs not only include social support and welfare programs, but also language and skills or technical training. In addition, the communities and supporting businesses within the west side communities of Mendota, Firebaugh, Huron, and Coalinga could be faced with the need to consolidate social support and protection services. The effects to these communities could be devastating if any are singularly affected by implementation of this Alternative 4.

RECREATIONISTS AND RECREATION WORKERS SOCIAL GROUP

There would be no change in recreation employment or the projected need for social services from those anticipated under Alternative 3 when compared to No-Action Alternative.

FISHERMEN AND FISHING BUSINESSES SOCIAL GROUP

There would be no change in fishing anticipated fishing opportunities or related employment and income from those anticipated under Alternative 3 when compared to No-Action Alternative.

NATIVE AMERICAN TRIBES SOCIAL GROUP

There would be no change in Native American fishery or Trinity River flows from Alternative 3 when compared to No-Action Alternative. Therefore, the anticipated impacts to Native Americans are identical to those anticipated under Alternative 3.

SUMMARY OF CHANGES TO EMPLOYMENT AND SOCIAL SERVICES

The findings of the alternatives comparison are presented in this summary and include data developed for the Agricultural Economics and Land Use analysis.

Irrigated agriculture for the regions under each alternative is presented in Table III-2. The greatest reduction in acreage for areas served by CVP water supplies is on the westside of the San Joaquin Valley. This area would experience a reduction of 25,000 acres under Alternatives 1, 2, and 3, and a reduction of 29,000 acres under Alternative 4. The majority of land removed from production under these alternatives is a result of implementation of the Land Retirement Program authorized by CVPIA.

Other large acreages of land are anticipated to be removed from production in the Sacramento River Region and the east side of the San Joaquin River Region as a result of purchase of water from landowners willing to sell their water supplies. The largest reductions of irrigated acreage from implementation of water purchases are anticipated under Alternatives 2, 3, and 4. A reduction of irrigated acreage under these alternatives would occur in areas where land owners are willing to sell water rights on the Yuba, Mokelumne, and Calaveras Rivers in the Sacramento River Region and on the Merced, Stanislaus, and Tuolumne Rivers in the San Joaquin River Region.

Projected changes to total agricultural employment within the affected regions are shown on Table III-1 and are compared to total agricultural employment as assumed for the Regional Economics analysis baseline data. The projected employment data developed for the alternatives analysis is presented in the Regional Economics technical appendix. The employment data developed for the PEIS analyses includes direct and indirect agricultural labor requirements and manufacturing, services, and retail indirect employment generated by agriculture. For the Social Analysis, the data has been compared to baseline conditions to determine the total change in agricultural employment under each alternative. Projected changes in agricultural employment when compared to baseline conditions may indicate a much larger change in employment than may actually occur, primarily because the analysis is not compared to a future No-Action Alternative condition when changes to mechanization and land use may result in unemployment for some workers.

TABLE III-2
IRRIGATED ACREAGE AVERAGE YEAR (1922-1990)
(1,000 acres)

		Changes Compared to No-Action Alternative			
	No-Action Alternative	Alternative 1	Alternative 2	Alternative 3	Alternative 4
			Sacramento River Region		
Pasture and Hay	280	-0.3	0.3	-6.0	-5.6
Rice	473	-1.2	-4.3	-12.7	-12.6
Cotton	0	0.0	0.0	0.0	0.0
Other Field	615	-0.1	-1.8	-4.6	-4.6
Vegetable	250	0.0	-0.2	-0.2	-0.2
Tree and Vine	400	0.0	0.0	-0.3	-0.3
Subtotal	**2020**	**-1.6**	**-6.0**	**-23.8**	**-23.3**
			San Joaquin River Region		
Pasture and Hay	338	-3.9	-22.3	-67.0	-73.5
Rice	14	-0.1	-0.9	-3.0	-3.2
Cotton	465	-18.7	-25.5	-27.7	-37.2
Other Field	479	-5.5	-12.2	-25.8	-27.2
Vegetable	462	-2.4	-3.0	-2.9	-3.9
Tree and Vine	800	-0.2	-1.0	-3.3	-3.4
Subtotal	**2558**	**-30.9**	**-64.9**	**-129.7**	**-148.5**
			Tulare Lake River Region		
Pasture and Hay	191	-2.7	-2.4	-1.3	-3.6
Rice	0	0.0	0.0	0.0	0.0
Cotton	646	-9.7	-9.3	-9.2	-12.7
Other Field	304	-2.7	-1.9	-2.4	-1.9
Vegetable	211	-0.3	-0.3	-0.3	-0.2
Tree and Vine	657	-0.2	-0.2	-0.2	-0.3
Subtotal	**2009**	**-15.6**	**-14.1**	**-13.4**	**-18.8**
			San Felipe Unit		
Pasture and Hay	2	-0.7	-0.7	-0.4	-0.7
Rice	0	0.0	0.0	0.0	0.0
Cotton	0	0.0	0.0	0.0	0.0
Other Field	3	-1.2	-1.2	-0.7	-1.3
Vegetable	12	-4.4	-4.4	-2.4	-4.9
Tree and Vine	8	-2.7	-2.7	-1.5	-2.9
Subtotal	**25**	**-9.0**	**-9.0**	**-5.0**	**-9.8**
Total	**6611**	**-57.1**	**94.0**	**-171.9**	**-200.3**

As shown in the tables and the above discussions the total impacts to agricultural employment and land acreage reductions are rather small when compared to the regions and state as a whole.

ADDITIONAL IMPACTS DURING THE PERIOD OF CONSTRUCTION

The 2020 analysis of alternatives included the impact of restoration fund payments as reduced agricultural net income and increased M&I water costs. However, the analysis did not include all resotration fund expenditures as part of the impact assessment, because much of htis is spent on construction activities that will be complete by 2020. The expenditure of retoration funds between now and 2020 will provide job opportunities that may offset some of the adverse regional effects of CVPIA implementation.

In the Sacramento Valley, about 1,530 jobs would be created by restoration fund expenditure. Alternatives 1 and 2 would result in a net increase in employment in the Sacramento Valley during the period of construction. In Alternatives 3 and 4, employment would also increase, but by very small amount relative to the size of the regional economy. In the San Joaquin Valley, restoration fund expenditure would result in 690 jobs during the period of construction. This amount is much smaller than the negative effects, so overall effects on employment remain negative. These jobs would increase primarily in construction-related sectors, and would not necessarily benefit the same workers displaced from agriculture.

ENVIRONMENTAL JUSTICE

Executive Order 12898 requires that federal agencies analyze the impacts of proposed alternative actions to evaluate disproportionate impacts to minorities or low income populations.

Table III-3 shows the ethnic structure of the Sacramento, San Joaquin, and Tulare Lake Regions. These areas would be affect the greatest by implementation of the alternatives. As discussed in the Affected Environment, the population of the Sacramento River Region is primarily white. The population of the San Joaquin River and Tulare Lake Regions are also primarily white, but there also is a large Hispanic population for the regions, as shown in Table III-4. One reason for the higher percentage of Hispanics in the San Joaquin River and Tulare Lake Regions could be the larger population of farm laborers that support truck and fruit, nut, and vine production in these regions.

TABLE III-3

ETHNICITY BY REGION

Region	Ethnicity			
	White (percent)	Black (percent)	Asian (percent)	Hispanic (percent)
Sacramento River	73	7	7	13
San Joaquin River	58	4	8	29
Tulare Lake	60	4	3	33
San Francisco Bay	59	9	16	16

SOURCE:
California Department of Finance, 1990.

TABLE III-4

ETHNICITY OF POTENTIALLY AFFECTED COMMUNITIES IN THE SAN JOAQUIN RIVER REGION

	Ethnicity			
San Joaquin River Region	**White (percent)**	**Black (percent)**	**Asian (percent)**	**Hispanic (percent)**
Coalinga	66	1	1	33
Firebaugh	31	23	1	67
Huron	13	>1	1	86
Kerman	52	1	4	43
Mendota	15	1	1	83
SOURCE: New United Way, Vision 20/20, May 1994				

Areas where water purchases are proposed have populations that are primarily white, except in Merced County where Hispanics and Asians make up a large portion of the population. In the Tulare Lake Region, acreage reductions would occur in areas within Kern County served by the State Water Project and areas served by the Cross Valley Canal. The Tulare Lake Region, like the San Joaquin River Region is primarily white, but also has a large Hispanic population.

It is difficult to conclude that one social group would be adversely affected to a greater extent by implementation of any of the alternatives. In addition, because the impacts of the alternatives occur throughout the Central Valley area of California no one ethnic group is affected more than another. Moreover, the impacts are more reflective of the type of labor requirements required for agricultural production and the skill and education level of those employees that determines the total impact to any social group.

There could be direct benefits from implementation of the CVPIA to the Native American tribes from increased flows in the Trinity River under all alternatives. These benefits are being evaluated in a separate EIS for Trinity River operations.

There could be indirect adverse impacts to farm laborers, who are generally economically disadvantaged, may lack English language skills and education or training to obtain other employment, and are from minority groups, however it is not the intent of the CVPIA to affect these groups. Potential impacts to these groups are a result of direct and adverse impacts to land owners and farmers that receive CVP supplies. These persons are generally not economically disadvantaged and do not represent minority groups. However, as lands are removed from production either by reductions in CVP deliveries, land retirement programs, or through purchase of water rights from willing sellers, some labor intensive crops would be removed from production. Indirect and adverse effects to farm laborers would occur as result of this action.

Adverse impacts to the social groups identified in this technical appendix would occur throughout the Sacramento River, San Joaquin River, and Tulare Lake regions and specific areas have not been targeted for implementation of the alternatives. The west side of the San Joaquin Valley is especially affected because both the Land Retirement Program and water supply reductions fall disproportionately in this area.

CHAPTER IV

BIBLIOGRAPHY

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BIBLIOGRAPHY

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