# Economic Impacts of Reduced Water Availability to Merced Irrigation District

Prepared for:

Merced Irrigation District

MERCED IRRIGATION DISTRICT
WATER & POWER

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# Table of Contents


| Chapter/Section | Description | Page No. |
|---|---|---|
| **EXECUTIVE SUMMARY** | | **1** |
| ES-1 | Background | 1 |
| ES-2 | Estimated Economic Impacts of Reduced Water Availability | 5 |
| ES-3 | Conclusions | 9 |
| **1 INTRODUCTION** | | **1-1** |
| 1.1 | Background | 1-1 |
| 1.2 | Study Objectives | 1-3 |
| 1.3 | Report Organization | 1-4 |
| **2 STUDY AREA** | | **2-1** |
| 2.1 | Demographic and Economic Data about Merced County | 2-2 |
| 2.1.1 | Demographic Data | 2-2 |
| 2.1.2 | Economic Information | 2-3 |
| 2.1.3 | Employment | 2-3 |
| 2.1.3.1 | Major Employers | 2-6 |
| 2.2 | Merced County's Agricultural Economy | 2-8 |
| **3 MERCED RIVER HYDROELECTRIC PROJECT'S CONTRIBUTION TO THE LOCAL ECONOMY** | | **3-1** |
| 3.1 | Water Supply | 3-2 |
| 3.1.1 | Irrigated Agriculture | 3-2 |
| 3.1.1.1 | Crop Commodity Production | 3-2 |
| 3.1.1.2 | Animal Commodity Production | 3-4 |
| 3.1.1.3 | Commodity Processing | 3-5 |
| 3.1.1.4 | Economic "Ripple Effects" | 3-5 |
| 3.1.2 | Municipal and Industrial | 3-6 |
| 3.1.2.1 | M&I Water Valuation | 3-7 |
| 3.2 | Hydro Power | 3-7 |
| 3.2.1 | Hydropower Production | 3-8 |
| 3.2.2 | Economic "Ripple Effects" | 3-8 |
| 3.3 | Recreation | 3-9 |
| 3.4 | Environmental Regulatory Compliance | 3-10 |
| 3.5 | Flood | 3-10 |
| **4 STUDY METHODOLOGY** | | **4-1** |
| 4.1 | Surface water supply | 4-1 |
| 4.1.1 | Canal Deliveries | 4-1 |
| 4.1.2 | Interruptions in Municipal Surface water supply | 4-4 |
| 4.1.3 | Hydro Power Generation | 4-6 |
| 4.2 | Economic Models | 4-6 |
| 4.2.1 | Agricultural Economy | 4-6 |
| 4.2.1.1 | Crop Production | 4-7 |
| 4.2.1.2 | Animal Production | 4-13 |

4.2.1.3 Crop and Animal Processing ..... 4-16
4.2.1.4 Regional Economic Impact Analysis ..... 4-19
4.2.2 Municipal and Industrial Impacts ..... 4-22
4.2.3 Power Impacts ..... 4-23

**5 POTENTIAL ECONOMIC IMPACTS OF REDUCED PROJECT WATER SUPPLIES ..... 5-1**

5.1 Irrigated Agriculture ..... 5-2
5.1.1 Direct Agricultural Impacts ..... 5-4
5.1.1.1 Crop Production ..... 5-4
5.1.1.2 Animal Production ..... 5-6
5.1.1.3 Food Processing Industry ..... 5-7
5.1.2 Regional Economic Impacts ..... 5-9
5.2 Municipal and Industrial Impacts ..... 5-14
5.3 Hydropower Impacts ..... 5-14
5.4 Comparison of Results ..... 5-17

**6 REFERENCES ..... 6-1**

# Tables


| Table No. | Description | Page No. |
|---|---|---|
| Table ES-1 | Summary Estimated Annual Benefits of Merced River Hydroelectric Project (2014 dollars) | 2 |
| Table ES-2 | Estimated Regional Economic Impacts to Agriculture and Power by Water-Year Type (2014 $ millions) | 6 |
| Table 2-1 | Population Growth in Merced County and California 1970-2014 | 2-3 |
| Table 2-2 | Labor Force, Employment and Unemployment in Merced County and California, 2005-2014 | 2-4 |
| Table 2-3 | Total Household Income and Benefits, 2014 | 2-4 |
| Table 2-4 | Percentage of Families and People Whose Income is Below the Poverty Level, Merced County and California, 2014 | 2-5 |
| Table 2-5 | Employment by Industry, 2010-2014 | 2-6 |
| Table 2-6 | Major Employers in Merced County Grouped by Industry Category | 2-7 |
| Table 2-7 | Top 5 California counties by gross value of agricultural production, 2014 ($ millions) | 2-8 |
| Table 2-8 | Top 5 Merced County Commodities by Value of Production, 2009 to 2014 ($ millions). | 2-10 |
| Table 2-9 | Merced County Irrigated Acreage by Commodity 2009 to 2014. | 2-10 |
| Table 2-10 | Top Ten California Counties for Dairy Plants | 2-11 |
| Table 3-1 | Summary Estimated Annual Benefits of Merced River Hydroelectric Project (2014 dollars in millions) | 3-1 |
| Table 3-2 | Estimated Value of the Agricultural Output Supported by Surface Water Supplied by the Project (2014 dollars in millions) | 3-2 |
| Table 3-3 | Crops Acres in Production by Commodity, Merced County and Served by the Merced River Hydroelectric Project, 2009-2014 (Acres in thousands) | 3-3 |
| Table 3-4 | Actual Water Deliveries to Lake Don Pedro Community Service District, 2008 through 2015(acre feet) | 3-7 |
| Table 3-5 | MID's Municipal and Industrial Value Estimate of Annual Contribution to M&I Water (2014 $s 000) | 3-7 |
| Table 3-6 | Actual MID Hydropower Generation, 2015-2010 | 3-8 |
| Table 3-7 | Estimated Hydropower Production Value by Water Year-Type, 2014 dollars | 3-8 |
| Table 3-8 | Estimated Regional Economic Activity of Power Production, 2014 dollars | 3-9 |
| Table 3-9 | MID Environmental Water Delivery | 3-10 |
| Table 4-1 | M&I Water Service Interruption Statistics by Water-Year Type | 4-5 |
| Table 4-2 | Annual Average Estimated Power Generation by Water-Year Type, Baseline versus SWRCB's Plan (MWh) | 4-6 |
| Table 4-3 | District-Level Crop Categorization and Cost and Return Studies Used for SWAP Calibration | 4-8 |
| Table 4-4 | Irrigated Crop Area, Water Use, and Value by Crop Category used in SWAP | 4-10 |

Table 4-5 2012 Irrigation Rates and Allotments for MID ..... 4-11
Table 4-6 Estimated Merced County Crop and Food Processing Sector Relationships: Forward Linkage Analysis. ..... 4-16
Table 4-7 Baseline Value of Commodities Grown with Project Water and Processed in Merced County, by Water-Year Type: Forward Linkage Analysis (2014 $ millions) ..... 4-17
Table 4-8 Baseline Crop Gross Revenues (2014 $ millions) ..... 4-20
Table 4-9 Baseline Animal Production Gross Revenues (2014 $ millions)[1,2] ..... 4-20
Table 5-1 Estimated Regional Economic Policy Impacts to Agriculture and Power by Water-Year Type (2014 $ millions) ..... 5-1
Table 5-2 Estimated Change in Annual Gross Crop Output by Water-Year Type ..... 5-5
Table 5-3 Estimated Change in Annual Gross Crop Revenues by Water-Year Type ..... 5-6
Table 5-4 Estimated Change in County Food Processing by Water-Year type and IMPLAN Processing Sector: Forward Linkage Analysis (2014 $millions) ..... 5-8
Table 5-5 Estimated Change in Annual Employment by Water-Year Type ..... 5-9
Table 5-6 Estimated Change in Annual Labor Income by Water-Year Type ..... 5-10
Table 5-7 Regional Economic Impacts of the SWRCB's Plan by Water-Year Type: Output, Jobs and Labor Income ..... 5-12
Table 5-8 Estimated Policy Impacts to Hydropower: Output, Jobs and Labor Income ..... 5-15
Table 5-9 Comparison of Results to SWRCB SED ..... 5-17

# Figures


| Figure No. | Description | Page No. |
|---|---|---|
| Figure ES-1 | Location of the San Joaquin Tributaries | 3 |
| Figure ES-2 | Annual Canal Deliveries, Existing Operations vs. SWRCB SED | 4 |
| Figure ES-3 | Canal Deliveries by Water Year Type, Existing Operations vs SWRCB's SED | 5 |
| Figure ES-4 | Agricultural Output by Water Year Type, Baseline vs SWRCB's SED | 7 |
| Figure ES-5 | Percent Decline in Agricultural Output by Category and Water Year Type, Baseline vs SWRCB's SED | 8 |
| Figure 1-1 | Location of the San Joaquin Tributaries | 1-3 |
| Figure 1-2 | Merced Irrigation District Watershed Map | 1-4 |
| Figure 2-1 | Merced County Farmlands | 2-2 |
| Figure 2-2 | 2014 Merced County Production Revenue by Commodity Group. | 2-9 |
| Figure 3-1 | Estimated Value of Crop and Animal Production Supported by Water Supplied from the Merced River Hydroelectric Project | 3-4 |
| Figure 4-1 | Annual Canal Deliveries, Existing Operations vs. SWRCB Proposed 40% Plan | 4-2 |
| Figure 4-2 | Average Annual Baseline Canal Deliveries by Water Year Type. | 4-3 |
| Figure 4-3 | Modeled Percent of Canal Delivers by Water Year Type. | 4-4 |
| Figure 4-4 | Estimated Frequency of Interruptions in M&I Water Service to LDPCSD by Year and Number of Months per Year, Baseline versus SWRCB plan. | 4-5 |
| Figure 4-5 | Categories of Agricultural Economic Activity | 4-7 |
| Figure 4-6 | Percent Change in Almond Yield for Variations in Applied Water | 4-12 |
| Figure 4-7 | Average Head per Acre of Feed Crop in Merced County | 4-14 |
| Figure 4-8 | Average Price per Hundredweight (cwt) of Milk in Merced County (2014 dollars) | 4-15 |
| Figure 5-1 | Impact of the SWRCB's SED on Regional Economic Agricultural Output by Water-Year Type, 2014 $ millions | 5-3 |
| Figure 5-2 | Percent Change in Agricultural Output Caused by the SWRCB's SED by Water-Year Type | 5-4 |

# List of Attachments

Attachment A Using IMPLAN to Estimate Impacts to Agricultural Processing (e.g. Forward Linkages)

# Acronyms

| | |
|---|---|
| CDFA | California Department of Food and Agriculture |
| cwt | hundredweight |
| DWR | California Department of Water Resources |
| DPRA | Don Pedro Recreation Agency |
| ENID | El Nido Irrigation District |
| ET | evapotranspiration |
| GIS | geographic information system |
| GWh | gigawatt hour |
| IMPLAN | Impact Analysis for Planning |
| I-O | input-output |
| LDPCSD | Lake Don Pedro Community Services District |
| M&I | municipal and industrial |
| mgd | million gallons per day |
| MID | Merced Irrigation District |
| MRP | monitoring and reporting plan |
| MW | megawatt |
| MWh | megawatt hour |
| NAICS | North America Industrial Classification System |
| Project | 1964 Merced River Hydroelectric Project |
| RDI | regulated deficit irrigation |
| SED | Substitute Environmental Document |
| SWAP | Statewide Agricultural Model |
| SWRCB | State Water Resources Control Board |
| UCCE | University of California Cooperative Extension |
| USACE | U.S. Army Corps of Engineers |
| USDA | U.S. Department of Agriculture |

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# EXECUTIVE SUMMARY

## ES-1 Background

The Merced River Hydroelectric Project (Project) is a surface water supply and flood control facility owned and operated by Merced Irrigation District (MID), providing critical surface water supply for multiple beneficial uses throughout the eastern portion of Merced County. MID's service territory encompasses approximately 164,000 acres in Merced County, with an estimated population of 140,000 (MID 2012a). Project benefits include irrigated agriculture, municipal and industrial (M&I) supply, power, recreation, environmental uses and flood protection. Quantified and qualified benefits are (Table ES-1):

- Irrigated Agriculture
    - Crops grown with irrigation supplied by the Project generate just under **$ 1.0 billion** in annual output in Merced County, both in the production of commodities and in the valued added by processing a portion of those commodities locally (2014 dollars). Agriculture creates **4,888 jobs and generates over $265 million in labor income annually**.
    - A historically reliable surface water supply that supports growers' **considerable investment in permanent crops** (nut and fruit trees) **and dairy and cattle herds**. These investments in permanent crops and animal operations reduce the number of financially viable options for growers should water supply reliability decrease.
    - During naturally occurring droughts growers in the area have **historically relied on groundwater supplies** as a substitute for scarce surface water. Continued use of groundwater at historical extraction rates is less certain as the region works to implement the State's 2014 Sustainable Groundwater Management Act.
    - The high valued agricultural industry in Merced County ($4.4 billion in 2014 as reported by Merced County's Agricultural Commissioner, 2014-15) supports a robust agricultural processing sector. **Of the top 25 major employers in Merced County (measured in number of employees), 13 are directly or indirectly involved in agriculture,** either growing or processing agricultural output (CA EDD, 2013).
- M&I supply:
    - MID makes three small diversions from Lake McClure, each related to raw water supply for rural water systems. The annual M&I supply is valued between **$47,000** and **$99,000**.
    - Urban areas, such as cities and towns, as well as rural communities, rely on groundwater as their source of potable water supply. Urban areas occupy approximately 18,200 acres within the MID. The Merced Groundwater Basin, Groundwater Management Plan reported a total of approximately 43,700 AF of

urban groundwater use in 2014. This total includes both groundwater pumped by urban utilities and groundwater produced by small private residential water systems, commercial businesses and industrial plants not served by the major utilities. Although these water systems are independent of MID, MID's operations have contributed over 1.4 million acre-feet of groundwater recharge between 2010 and 2014 (MID 2015). Without this contribution to groundwater recharge, or with reduced recharge, these urban areas would have experienced water level and water quality issues beyond what they may already be experiencing.

- Power production adds between $13 million and $17 million annually to the regional economy **creating approximately 21 jobs** and generating $**1.2 million in labor revenue**.
- Annual recreation visitation was nearly 1.9 million recreation days (RD) at MID's five developed recreation sites providing opportunities for camping, picnicking, swimming and boating (MID 2012b), where recreation days are defined as each visit by a person to a development for recreation purposes during any portion of a 24-hour period.
- The Project's flood control operations are governed by the USACE flood control manual for New Exchequer dam. In general, the Project attenuates high flows in the winter and spring by storing the water until it can be release for beneficial use. In subsequent wet years, flows may be released for flood management purposes.
- Combining the agriculture and power sectors, **the Project adds just under $1.0 billion in output to the county, just over 4,900 jobs and $268 million in labor income annually to the Merced County economy**.

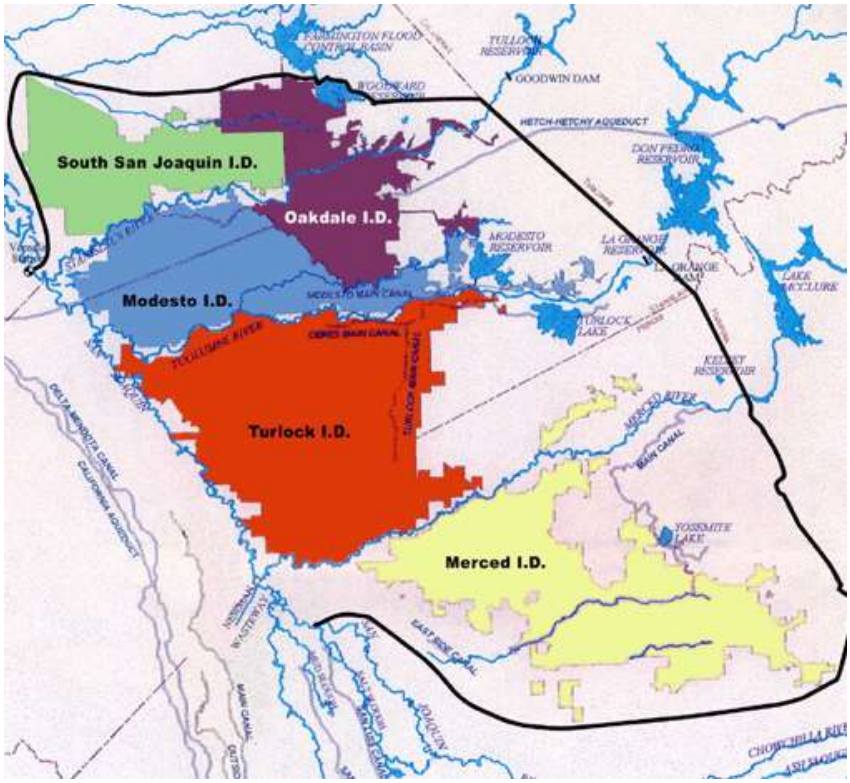
**Table ES-1 Summary Estimated Annual Benefits of Merced River Hydroelectric Project (2014 dollars)**

| Water Use | Impact Measure | Units | Estimated Annual Benefit |
|---|---|---|---|
| Agricultural irrigation supply | Output | $ million | $943 |
| | Labor income | $ million | $267 |
| | Jobs | full and part-time jobs | 4,888 |
| Municipal and industrial surface water supply | Surface water | acre-feet | 785 |
| | Estimated value | $ thousand | $47 to $99 |
| Power | Output | $ million | $13 - $17 |
| | Labor income | $ million | $1 |
| | Jobs | full and part-time jobs | 21 |
| Recreation | Visitation | annual number of recreation days (million) | 1.9 |
| Environmental | Environmental flows, various time periods | acre-feet | 86,000 to 91,000 |
| | Environmental consumptive use | acre-feet (up to) | 15,000 |

| Water Use | Impact Measure | Units | Estimated Annual Benefit |
|---|---|---|---|
| Flood protection | Reserved Flood Control Volume | acre-feet | 400,000 |

Source: Various sources cited in the text that follows.

A controversial proposal by the State Water Resources Control Board (SWRCB) is considering amendments to the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (2006 Bay-Delta Plan). These amendments would establish new flow objectives on the Lower San Joaquin River (LSJR) and its three eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers) for the protection of fish and wildlife beneficial uses, new water quality (salinity) objectives for the protection of agricultural beneficial uses in the southern portion of the Sacramento–San Joaquin Delta (Delta), and a program of implementation to achieve those objectives (**Figure ES-1**). The new LSJR flow objectives include a requirement to dedicate 25 to 65 percent of unimpaired flows in the Merced, Tuolumne, and Stanislaus rivers, to fish and wildlife from February to June each year. If approved, SWRCB's Substitute Environmental Document (SED) would have adverse economic consequences for Stanislaus, San Joaquin, and Merced counties, a region beset by high unemployment and other impacts of a lingering recession and drought.




Source: Merced Irrigation District (http://www.sjwatershed.org/about_frame.html)

**Figure ES-1 Location of the San Joaquin Tributaries**

MID utilized a hydrologic model of the region to estimate both baseline canal deliveries and canal deliveries under the SWRCB's SED, assuming a requirement to release 40 percent of unimpaired flows. Baseline canal deliveries assumed existing operations by MID. 93 years of hydrology were used to develop the model, from 1922 through 2014, including the droughts of 1929 through 1931, 1976 through 1977, 1988 through 1994 and 2012 through 2014. Under the SWRCB's SED, Project water availability, measured as a difference in canal deliveries relative to existing operations, would fall short of baseline deliveries in nearly one out of two years (**Figure ES-2**). Under existing operations, shortages would occur in 11 of the 93 years, while under the SWRCB's plan shortages occur in 41 years out of the 93 year analysis period.

Annual estimates of canal deliveries under the baseline and under the SWRCB's proposed plan were aggregated into water-year types[1]: wet; occurring 29 percent of the 93 years, above normal, occurring 18 percent of the 93 years; below normal, occurring 15 percent of the 93 years; dry, occurring 16 percent of the 93 years; and critical occurring 22 percent of the 93 years (**Figure ES-3**). Canal deliveries to the Project under existing conditions were used as the baseline for water availability in the economic models used to estimate economic impact of the SWRCB's SED on Merced County.

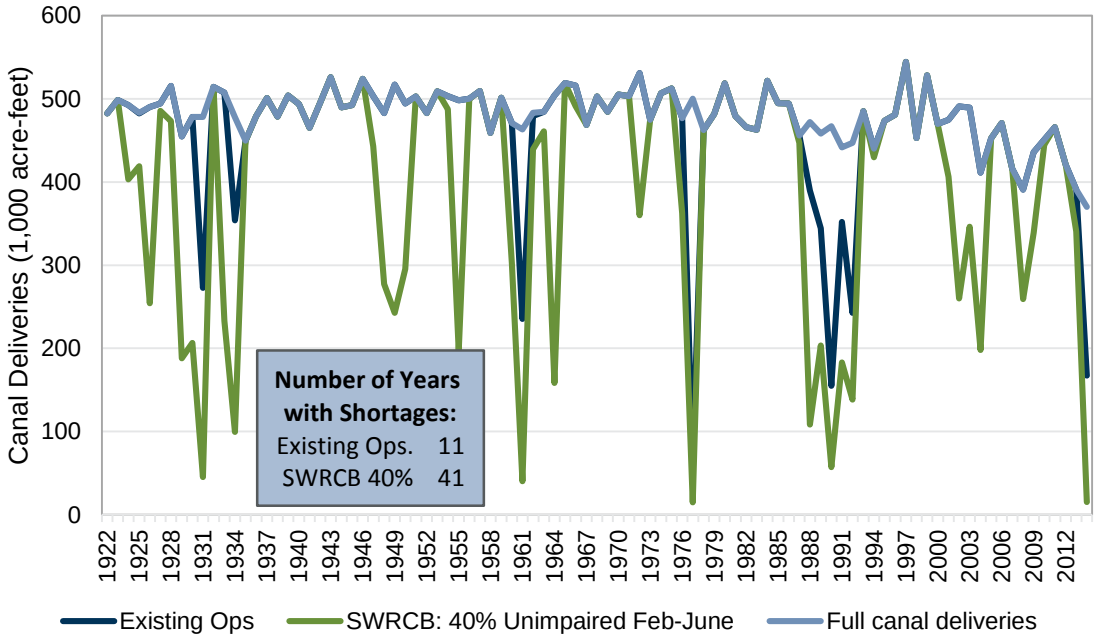



**Figure ES-2 Annual Canal Deliveries, Existing Operations vs. SWRCB SED**

The SWRCB's proposed plan would reduce canal deliveries by between 15 and 25 percent of baseline in half of the 93 years modeled (**Figure ES-3**). Under the baseline water deliveries full canal demands are met in each water-year type except for critical water-years when canal deliveries were estimated to be 75 percent of full canal deliveries. Under the SWRCB SED, canal deliveries in

[1] The San Joaquin Valley 60-20-20 index was used to categorize years into water-year types.

wet and above normal years are 100 percent of baseline. In below normal years, canal deliveries are 85 percent of baseline. In dry years, canal deliveries are 75 percent of baseline. In critical years, canal deliveries are 55 percent of full canal deliveries, 20 percent lower than the critical-year baseline of 75 percent of full canal deliveries.

Although not included in the analysis, MID provided zero water allocation to its growers during the 2015 irrigation season due to the 4th year of the ongoing drought and Lake McClure being at or below its regulatory minimum pool. Although dire, MID's Project operations allowed for increasingly limited surface water supplies for 3 of the 4 years prior to the first 0 allocation year in MID's history. Although the drought is not over, the 2016 water year is an improvement over the last several years and surface water supplies are once again available to MID's growers. If the SWRCB's proposed plan were in place since 2011, MID would likely have had more than one year of 0 allocations.

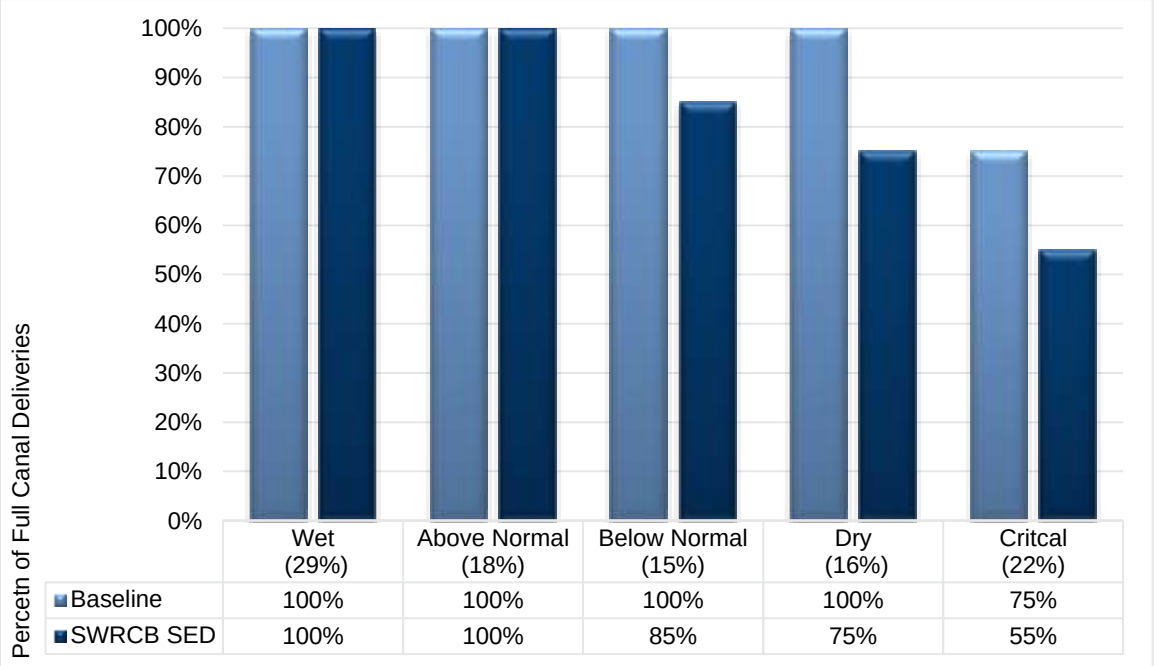



**Figure ES-3 Canal Deliveries by Water Year Type, Existing Operations vs SWRCB's SED**

## ES-2 Estimated Economic Impacts of Reduced Water Availability

The reduction in available surface water supplies caused to the SWRCB's proposal reduces agricultural and hydropower output, employment, and labor income below baseline in nearly every water-year type (**Table ES-2**). Impacts are greatest in below normal, dry and critical water-year types. Total estimated annual output losses range between $1 million (in wet water-year types) to $234 million (in dry years). Full- and part-time jobs would likely not be impacted in wet and above normal water-year types. However, in all other water-year types the annual number of jobs lost is estimated to range between 587 and 970, with the subsequent reduction in labor income ranging between $37 million and $59 million.

**Table ES-2 Estimated Regional Economic Impacts to Agriculture and Power by Water-Year Type (2014 $ millions)**

| Impact Category | Unit of Measure | Water Year Type (Percent of Years Impacted) | | | | |
|---|---|---|---|---|---|---|
| | | Wet (29%) | Above Normal (18%) | Below Normal (15%) | Dry (16%) | Critical (22%) |
| **Total** | | | | | | |
| Canal diversions | Percent of baseline | 0% | 0% | -15% | -25% | -20% |
| Output | $000,000s | -$1 | -$0 | -$129 | -$234 | -$151 |
| Employment | Full and part-time jobs | 0 | 0 | -587 | -970 | -855 |
| Labor Income | $000,000s | $0 | $0 | -$37 | -$59 | -$43 |
| **Agriculture** | | | | | | |
| Output | $000,000s | $0 | $0 | -$127 | -$231 | -$147 |
| Employment | Full and part-time jobs | 0 | 0 | -587 | -970 | -855 |
| Labor Income | $000,000s | $0 | $0 | -$37 | -$59 | -$43 |
| **Hydropower** | | | | | | |
| Power | MWh | -39 | -9 | -37 | -50 | -57 |
| Output | $000,000s | -$1 | -$0 | -$2 | -$3 | -$4 |
| Employment | Full and part-time jobs | 0 | 0 | 0 | 0 | 0 |
| Labor Income | $000,000s | $0 | $0 | $0 | $0 | $0 |

Source: Cardno

Impacts by category of water use are summarized below.

- Agriculture
  - The decline in annual production and processing **output is estimated to range from $127 million to $231 million** in below normal, dry and critical water year types, depending on year type (see **Figure ES-4**).
  - **Employment declines in those years between 587 and 970 full and part-time** jobs, approximately 0.5 to 1 percent of the total workforce in Merced County. With commensurate reduction in labor income ranging from **$37 million to $59 million.**
  - Impacts were estimated **using industry standard models**:
    - The Statewide Agricultural Production Model was used to estimate impacts on crop production.
    - Spreadsheet models were used to estimate impact on animal production (milk and beef).

- IMPLAN was used to estimate the impact in the processing sector as well as regional economic impacts (indirect and induced) from all production and processing.

- These economic models estimate annual impacts on the economy that would result from an annual change in surface water supply availability. The models **do not estimate structural changes** that could result from a long-term change in surface water supply. For example, under the SWRCB's SED crop and animal production is estimated to decline by over 20 percent in 38 percent of the years (dry and critical) Structural changes to the agricultural economy that could result from this magnitude of change in surface water supply reliability, and not accounted for in the impact assessment include:

  - Permanent changes in cropping patterns, away from either perennial crops (fruit and nut trees and vines) and/or away from feed crops. If feed crops are permanently removed from crop production and cannot be replaced, as may be the case with corn silage, a reduction in the herd size of dairy cows could result.

  - Reductions in processing inputs of this magnitude and with this frequency may force processing plants to relocate out of the area or close entirely.

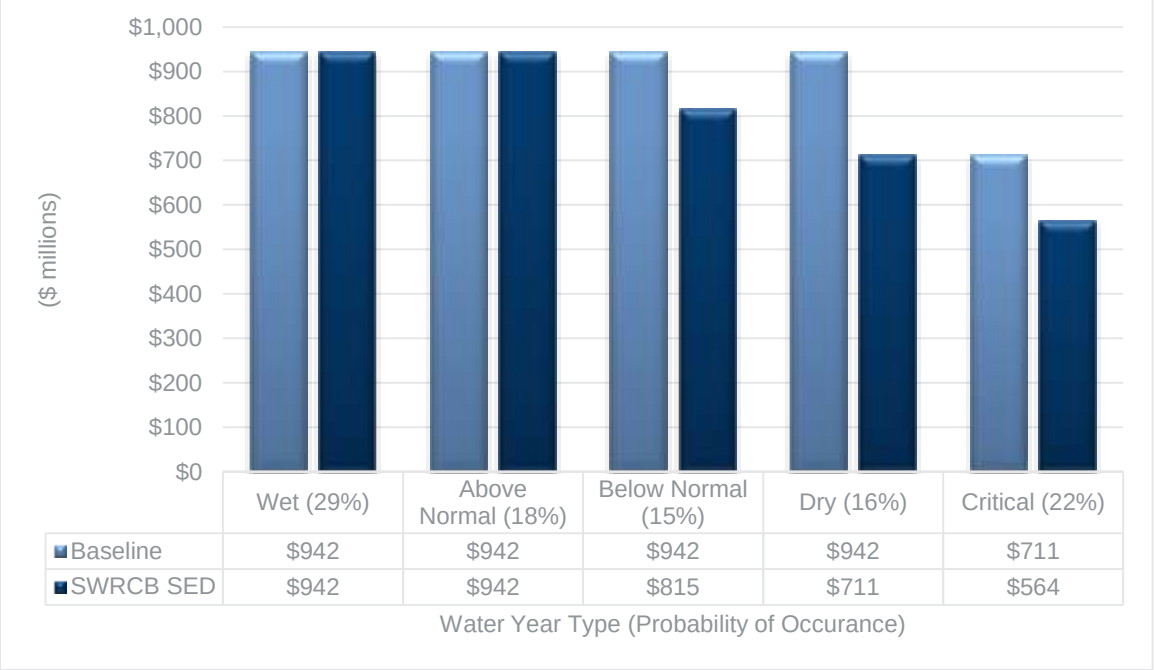



**Figure ES-4 Agricultural Output by Water Year Type, Baseline vs SWRCB's SED**

- As irrigation supplies decline across water year types **animal production declines at a faster rate than crop production** (**Figure ES-5**). This reflects the modeling

assumption, that **high valued crop such as fruit and net trees and vegetables remain in production longer through the voluntary transfers of irrigation water** from lower valued crops. In critical years the baseline for comparison is 75 percent of full canal deliveries, so the impact is 20 percent of baseline. Critical water year type canal deliveries are 55 percent of full canal deliveries, so the estimated impact of a critical year can be understood to already have had a significant reduction in animal crop production.

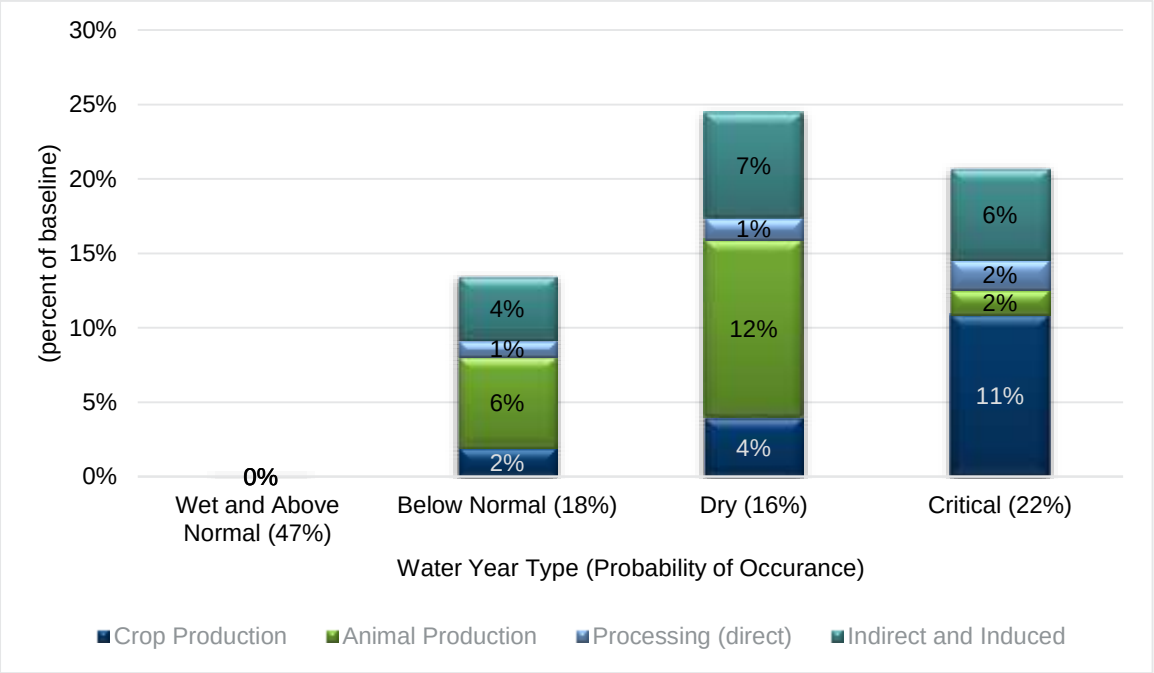



**Figure ES-5 Percent Decline in Agricultural Output by Category and Water Year Type, Baseline vs SWRCB's SED**

- Municipal and Industrial Impacts
    - M&I surface water supply impacts are primarily to the Lake Don Pedro Community Service District (LDPCSD). LDPSCD is a relatively small district that provides water to a population of approximately 3,200 people (LDPCSD 2016a), with total assets valued at $5.1 million (LPDCSD, 2014). The LDPCSD's intake is at elevation 700 feet. When water levels in the lake are below 700 feet there is an interruption in the water supply. Under the SWRCB's SED, the total number of months of interruption over the 93-year planning horizon increases from 11 months to 39 months, **a 355 percent increase in frequency of interruptions**. The annual cost of pumping groundwater during those periods of time would range from just over $6,300 up to $75,000 depending on the length of the interruption. Although the cost may seem modest, for a small district, with only $5 million in assets, a $75,000 annual expense is likely to create a substantial hardship.

- Although not quantified, reduced surface water supplies will likely result in less groundwater recharge resulting from MID's operations. Less recharge will result in water quality and quantity impacts to urban suppliers.

- Hydropower Impacts
  - Power generation is effected in every year type ranging from a reduction of **9 GWh** (above normal water-year types) to **57 GWh** (critical water-year types).
  - Output (measured as gross revenue dollars) would decline **$1 million** (above normal water-year types) to **$4 million** (critical water-year types).

## ES-3 Conclusions

The SWRCB SED would reduce surface water supply to the Project between 15 percent and 25 percent of baseline conditions in more than half of years. Measured as a percent of baseline, estimated agricultural output, employment and labor income decline, in general, just slightly less than canal deliveries, e.g. when canal deliveries decline by 15 percent output declines by 13 percent. These impacts are estimated using models that predict annual changes in output in response to an annual change in irrigation supply.

These models are somewhat limited when estimating the long-term impacts of a change in surface water supply reliability as large as the SWRCB's SED. For example, in critical water year types the baseline canal deliveries are 75 percent of full canal deliveries, so the impact of the SWRCB SED is an *additional 20 percent* reduction from full canal deliveries. Therefore canal deliveries in a critical year would be 55 percent lower than full canal deliveries. Critical years occur in 22 percent of years and have occurred in the past in consecutive, multi-year periods. This magnitude of change in long-term surface water supply reliability could lead to a structural change in the agricultural sector.

The Project's historically reliable surface water supply has contributed to the significant investment in the current structure, and infrastructure, in Merced County's agricultural industry. This investment is exemplified by perennial crops, like trees and vines in the ground, as Merced County ranked 4$^{th}$ in the list of California counties almond production. The investment is exemplified by dairy and cattle operations, as Merced County also ranked 4$^{th}$ in milk production and tied for 6$^{th}$ in the number of dairy operations located in California counties. And the county ranked 2$^{nd}$ in the list of the number of all cattle in the state (550,000 head, 10 percent the state total). In addition to these investments in production, Merced County supports an intensive processing sector as well. 13 of the top 25 employers in the county are in the agriculture sector.

This type of investment in production and processing may decline if surface water supply reliability declines. Growers are resilient, and able to cope with relatively shorter terms droughts, but a county-wide contraction in the agriculture sector is a possible response to the long-term surface water supply reduction of the magnitude that is being considered by the SWRCB, particularly of the type estimated in a critical water year type (22 percent of years). Whether viewed as a 55 percent reduction from full surface water supply, or as presented here, as a further 20 percent reduction from a 75 percent supply reduction, such a drastic reduction could likely result in a county-wide contraction in the agricultural sector.

The county is already facing economic pressures, exemplified by relatively high unemployment in the county. Out of the last 10 years the county unemployment rate has been in double digits in all but one year (2006), ranging between 9.4 percent and 18.0 percent, between 50 percent and 93 percent higher than the state's unemployment rate. In 2014 there were an estimated 115,000 people in the County's labor force, of which 15,000 were unemployed, a 12.8 percent unemployment rate–- if an additional 1,841 jobs were lost, as estimated in this impact report using annual models, the unemployment rate in 2014, a critically dry year, would have been 1.6 percent higher, at 14.4 percent. The long-term impact of a structural change in the agriculture sector could be higher.

# 1 INTRODUCTION

## 1.1 Background

MID provides a number of benefits to the County through the operation of the Merced River Hydroelectric Project (Project), which consists of New Exchequer and McSwain dams, Lake McClure and McSwain Reservoirs, and associated hydroelectric facilities. The Project is operated primarily for flood control and water supply operations, as well as recreation and environmental purposes.

- Project operations are licensed by the Federal Energy Regulatory Commission (FERC). The existing FERC license contains numerous environmental and recreation "terms" that MID implements as license conditions.
- MID historically provides reliable irrigation water supplies to approximately 15 to 20 percent of the irrigated acres in Merced County. In 2014, the estimated value of agricultural production in Merced County was $4.4 billion, ranking 5th among California counties (California Department of Food and Agriculture 2014). Because of the historically high reliability of irrigation water supplies throughout the county, the local agricultural industry has invested heavily in permanent crops, such as high value trees and vines, and animal feed crops that support dairy operations and cattle and calf herds.
- MID contributes to regional M&I surface water supply through three small diversions from Lake McClure, each related to water supply. MID anticipates that the diversions will continue unchanged for the foreseeable future. These are:
    - The Lake Don Pedro Community Service District (LDPCSD) withdraws from a location just north of Barrett Cove Marina up to about 700 AF of water annually for water supply. LDPCSD diverts pursuant to a water purchase agreement with the District, and is subject to the same rules as MID for water out of storage from New Exchequer Reservoir. For example, LDPCSD cannot make withdrawals when the reservoir is below the minimum regulatory pool of 115,000 AF.
    - Less than 1,000 AF of water is withdrawn annually by the MID recreation facilities at three locations along Lake McClure and McSwain Reservoirs.
    - The McClure Boat Club, a small development adjacent to the Project, diverts about 25 AF at a point near the development. The boat club withdraws water from a pump on a float that rises and falls with the reservoir elevation and has an intake 10 feet below the float.

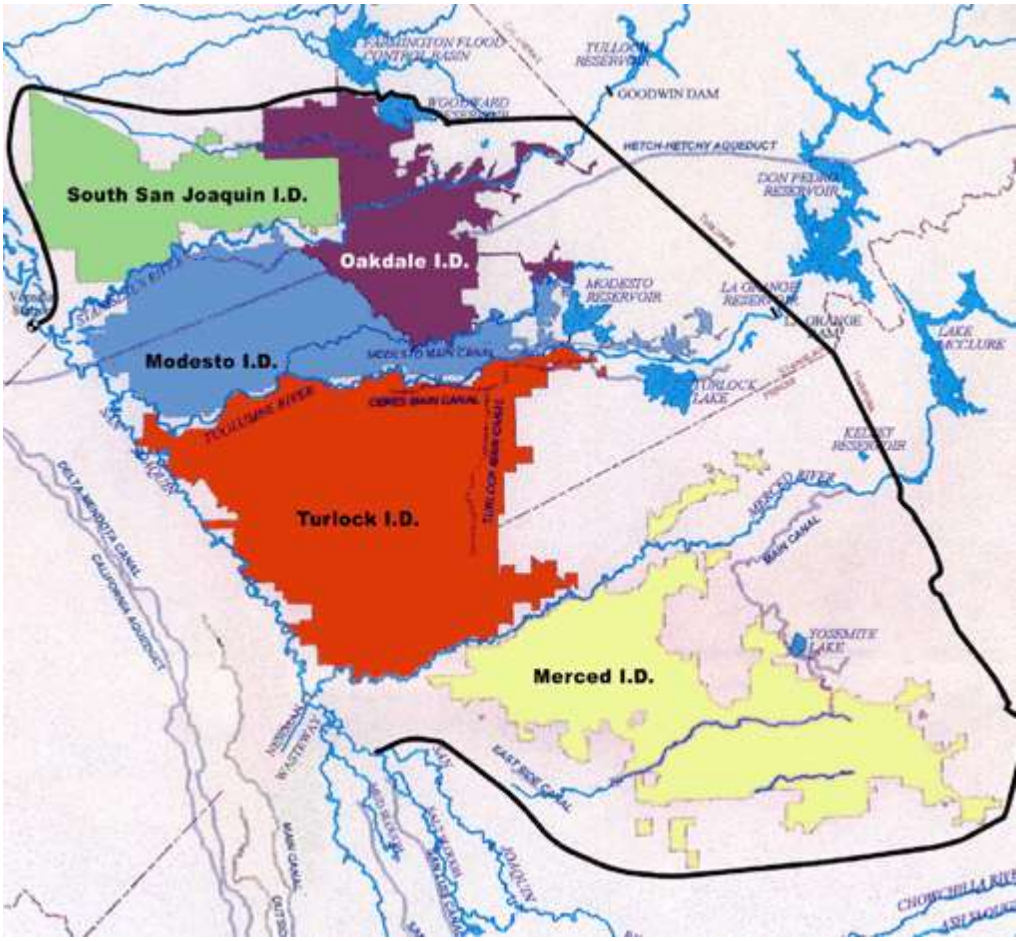
  - Urban areas, such as cities and towns, as well as rural communities, rely on groundwater as their source of potable water supply. Urban areas occupy approximately 18,200 acres within the MID. The Merced Groundwater Basin, Groundwater Management Plan reported a total of approximately 43,700 AF of urban groundwater use in 2014. Although these water systems are independent of MID, MID's operations have contributed over 1.4 million acre-feet of groundwater recharge between 2010 and 2014 (MID's 2015 AWMP). Without this contribution, or with a reduced recharge contribution, these urban areas would have experienced water level and water quality issues beyond what they may already be experiencing.

- The Project's flood control operations are governed by the USACE flood control manual for New Exchequer dam. In general, the Project attenuates high flows in the winter and spring by storing the water until it can be released for beneficial use. In subsequent years, flows may be released for flood management purposes.

- Water releases from the Project are used to generate hydroelectricity at both New Exchequer and McSwain Dams.

- MID owns, operates and maintains five recreation areas adjacent to the lakes behind New Exchequer and McSwain Dams. Six boat launch facilities and over 600 campsites are available to the public year-round. Floating marinas are located on Lake McSwain and Lake McClure for the boating public. Activities enjoyed in the recreation areas include fishing, boating, swimming, camping, hiking and bicycling.

A controversial proposal by the State Water Resources Control Board (SWRCB) is considering amendments to the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento–San Joaquin Delta Estuary (2006 Bay-Delta Plan). The amendments would establish new flow objectives on the Lower San Joaquin River (LSJR) and its three eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers) for the protection of fish and wildlife beneficial uses, new water quality (salinity) objectives for the protection of agricultural beneficial uses in the southern portion of the Sacramento–San Joaquin Delta (Delta), and a program of implementation to achieve those objectives. The new LSJR flow objectives includes a requirement to manage flows in the Merced, Tuolumne, and Stanislaus rivers to 25 to 65 percent of unimpaired flows for fish and wildlife from February to June each year (**Figure 1-1**). If approved, SWRCB's Substitute Environmental Document (SED) would have adverse economic consequences for Stanislaus, San Joaquin, and Merced counties, a region beset by high unemployment and other impacts of a lingering recession and drought.




Source: Merced Irrigation District (http://www.sjwatershed.org/about_frame.html)

**Figure 1-1 Location of the San Joaquin Tributaries**

## 1.2 Study Objectives

This study estimates the potential economic impact to Merced County from changes in surface water supply availability caused by the SWRCB's SED potential changes in the Lower San Joaquin River flow requirements. The location of MID within Merced County and its primary facilities is shown in **Figure 1-2**.

The study objectives are as follows:

- Qualitatively and quantitatively describe local economic conditions in the regions that are directly and indirectly affected by the existing Project operations.
- Estimate the economic benefit generated by the Project's existing operations in various uses, both consumptive (agriculture and urban) and non-consumptive (hydropower and reservoir recreation).
- Estimate the economic impacts on affected groups and industries resulting from changes in Project operations.

Specifically, the models and analytical framework developed in this study allow parties to understand potential changes to Merced County's economy, community, and industries reliant on Project water supplies that result from a change in Project operations.

Source: Merced Irrigation District

**Figure 1-2 Merced Irrigation District Watershed Map**

## 1.3 Report Organization

The balance of this report is presented in four chapters:

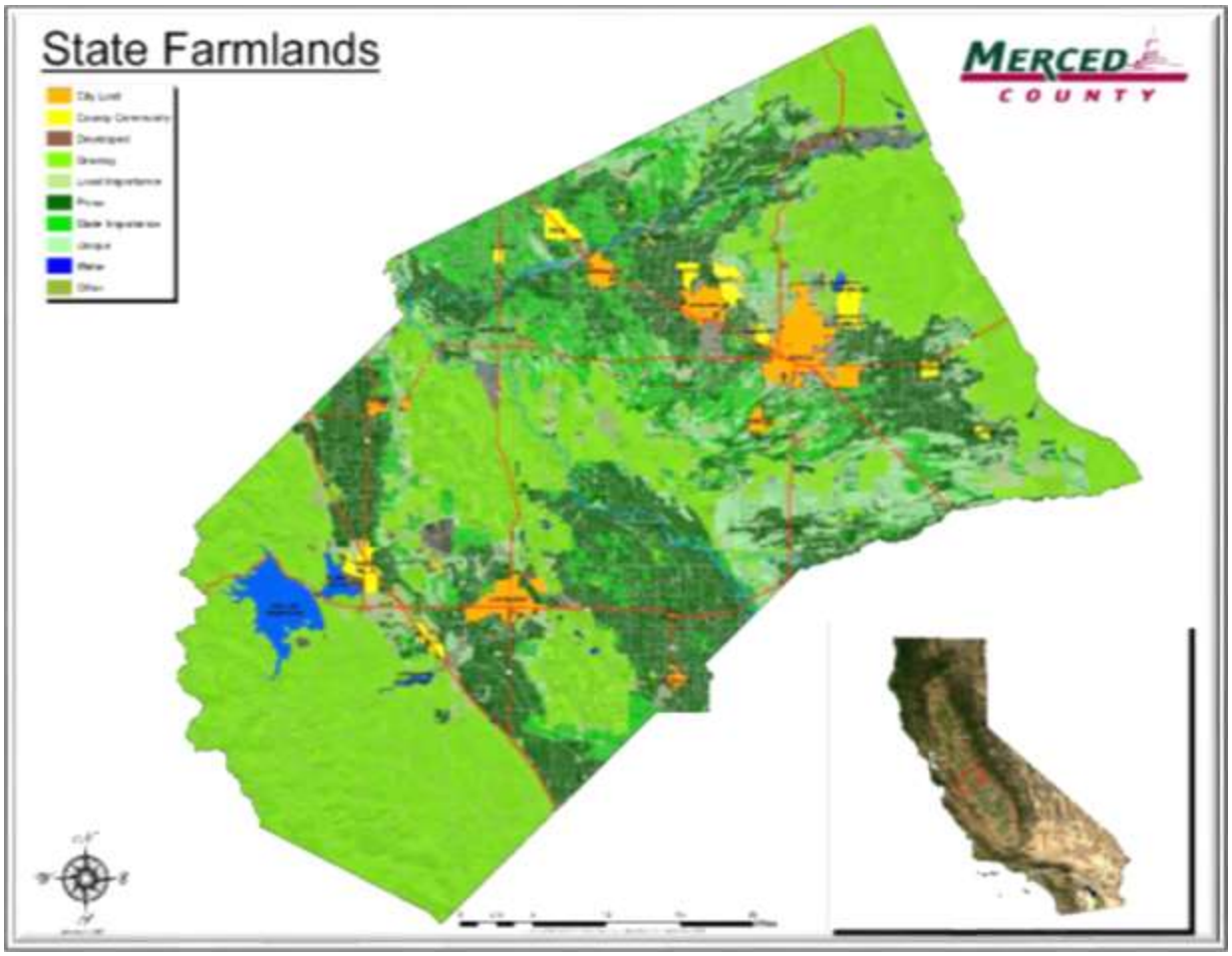
- **Study Area –** Provides demographic and economic background information about Merced County.
- **Merced River Hydroelectric Project's Beneficial Uses** – Presents the Project's contribution to the local area and establishes the baseline for the impact analysis.
- **Study Methodology** – Describes the hydrologic and economic models used for the analysis, including the data sources and model limitations.
- **Potential Economic Impacts** – Presents the estimated impacts of the proposed change in available surface water diversions.

# 2 STUDY AREA

The study area for this report is Merced County (**Figure 2-1**). Located in the Central Valley, Merced County is primarily rural with an economy highly dependent on irrigated agriculture. The county's demographic data tell a story of a rural, agricultural community with relatively lower household income, higher unemployment, and a higher percentage of people living in poverty compared to California state averages. The agricultural industry supports nearly a third of the county's jobs. A little over half of those (approximately 18 percent) are on-farm jobs, compared to 3 percent of the state's jobs. Most importantly, the agricultural industry is heavily invested in either high-valued permanent crops (trees and vines) or feed crops for the county's billion dollar dairy herd and cattle and calf operations. Only 10 percent of the land is devoted to annual crops (primarily high value vegetables) that are not devoted to animal feed.

Merced County consistently ranks as one of the top five counties in agricultural production value in the state (U.S. Department of Agriculture 2012). In 2014, farms in Merced County produced just under $4 billion (7 percent) of California's total market value of $42.6 billion. In addition to producing crops, Merced County is also home to 13 large (more than 100 employees) agricultural processing facilities, supporting between 4,450 and 11,500 jobs.

The strength of the agricultural industry in Merced County is due in large part to the Merced River Hydroelectric Project, owned and operated by Merced Irrigation District (MID). The Project provides a reliable surface water supply to MID's service territory and beyond and generates an annual average of 385 gigawatt-hours (GWh) of clean power.




Source: Merced County 2015

**Figure 2-1 Merced County Farmlands**

The following discussion summarizes demographic and economic data, measured in terms of economic output, jobs and labor income, that describe Merced County and highlights the importance of irrigated agriculture to the county's economy.

## 2.1 Demographic and Economic Data about Merced County

Demographic characteristics (population, races, ethnicity, etc.) of the region provides insight into the local population. Economic information (employment, income, key industries and employers) provides insight into what drives economic activity. And since agriculture is the principle industry in the region, data such as number of acres in production, production values, type of crops and dairy operations are included.

### 2.1.1 Demographic Data

The population in Merced County has grown and is projected to continue to grow faster than the population in the rest of the state. Between 1970 and 2010, the population in Merced County grew at an annual average 2.1 percent, 43.7 percent faster than the state's annual average growth rate of 1.5 percent (**Table 2-1**). Population projections between 2020 and 2060 show that growth rates in

Merced County are expected to continue to outpace the state by 116.6 percent. County population is projected to grow at an annual average rate of 1.3 percent from 2020 to 2060, compared to the state's 0.6 percent average annual growth rate for the same period of time.

**Table 2-1 Population Growth in Merced County and California 1970-2014**

| Year | Merced County | | California | | County Growth Rate Higher than state's Rate (Percent) |
|---|---|---|---|---|---|
| | (population) | (average annual percent change each 10-year period and in total) | (population) | (average annual percent change each 10-year period and in total) | |
| **U.S. Census Estimates** | | | | | |
| 1970 | 104,629 | NA | 19,953,134 | NA | |
| 1980 | 134,558 | 2.5% | 23,667,902 | 1.7% | 47.9% |
| 1990 | 178,403 | 2.9% | 29,758,213 | 2.3% | 23.5% |
| 2000 | 210,554 | 1.7% | 33,873,086 | 1.3% | 28.2% |
| 2010 | 255,793 | 2.0% | 37,254,503 | 1.0% | 105.6% |
| 1970 to 2010 | NA | 2.1% | NA | 1.5% | 43.7% |
| **California Department of Finance Projections** | | | | | |
| 2020 | 288,991 | 3.1% | 40,619,346 | 0.9% | 256.6% |
| 2030 | 337,798 | 4.0% | 44,085,600 | 0.8% | 383.8% |
| 2040 | 389,934 | 3.7% | 47,233,240 | 0.7% | 427.9% |
| 2050 | 439,075 | 3.0% | 49,779,362 | 0.5% | 472.1% |
| 2060 | 485,712 | 2.6% | 51,663,711 | 0.4% | 586.6% |
| 2020-2060 | NA | 1.3% | NA | 0.6% | 116.6% |

Sources: U.S. Census Bureau n.d.; California Department of Finance.

### 2.1.2 Economic Information

Economic information presented below demonstrates Merced County's agricultural community with relatively lower household income, higher unemployment, and a higher percentage of people living in poverty compared to California state averages.

### 2.1.3 Employment

For the last 10 years (2005 through 2014) Merced County's unemployment rate has been significantly higher (between 50 percent and 93 percent) than the state's unemployment rate (**Table 2-2**). In every year but 2006, the county unemployment rate has been in double digits, ranging between 9.4 percent (in 2006) and 18.0 percent (in 2009 and 2010). For example, in 2014 there were an estimated 115,000 people in the County's labor force, of which 15,000 were unemployed, a 12.8 percent unemployment rate—over 71 percent higher than the state's unemployment rate of 7.5 percent.

**Table 2-2 Labor Force, Employment and Unemployment in Merced County and California, 2005-2014**

| Year | Merced County | | | | California | | | | County Unemployment Rate Higher than State's Rate |
|---|---|---|---|---|---|---|---|---|---|
| | Labor Force (a) (000s) | Employ-ment (000s) | Unem-ployment (000s) | Unem-ployment Rate (%) | Labor Force (a) (000s) | Employ-ment (000s) | Unem-ployment (000s) | Unem-ployment rate (%) | (%) |
| 2014 | 115 | 100 | 15 | 12.8% | 18,827 | 17,418 | 2,085 | 7.5% | 71% |
| 2013 | 115 | 98 | 17 | 14.5% | 18,607 | 17,001 | 2,169 | 8.9% | 63% |
| 2012 | 115 | 96 | 19 | 16.3% | 18,551 | 16,628 | 2,059 | 10.4% | 54% |
| 2011 | 115 | 95 | 20 | 17.6% | 18,415 | 16,258 | 1,869 | 11.7% | 50% |
| 2010 | 114 | 93 | 20 | 18.0% | 18,336 | 16,092 | 1,642 | 12.2% | 47% |
| 2009 | 105 | 88 | 18 | 16.6% | 18,215 | 16,183 | 2,190 | 11.2% | 67% |
| 2008 | 102 | 90 | 13 | 12.6% | 18,178 | 16,855 | 1,711 | 7.3% | 73% |
| 2007 | 100 | 90 | 10 | 10.1% | 17,893 | 16,932 | 1,076 | 5.4% | 93% |
| 2006 | 98 | 89 | 9 | 9.4% | 17,654 | 16,789 | 873 | 4.9% | 92% |
| 2005 | 99 | 89 | 10 | 10.0% | 17,530 | 16,583 | 893 | 5.4% | 54% |

(a) Civilian labor force

Source: California Employment Development Department (EDD) n.d.

Total median personal income and benefits in Merced County in 2014 were approximately 30 percent lower than the state (**Table 2-3**). California's median income in 2014 was $61,489 compared to the County's median income of $43,066. More than half of the households in Merced County (56.0 percent) received less than $50,000 in 2014 in income and benefits, compared to more than half the households in California (58.2 percent) that received less than $75,000 in 2014 in income and benefits.

**Table 2-3 Total Household Income and Benefits, 2014**

| Income and Benefits | Merced County | | | California | | |
|---|---|---|---|---|---|---|
| | Number (households) | Percent | Cumulative Percent | Number (households) | Percent | Cumulative Percent |
| Less than $10,000 | 5,278 | 6.9% | 7% | 732,367 | 5.8% | 5.8% |
| $10,000 to $14,999 | 5,747 | 7.5% | 14% | 645,041 | 5.1% | 10.9% |
| $15,000 to $24,999 | 10,617 | 13.9% | 28% | 1,202,447 | 9.5% | 20.4% |
| $25,000 to $34,999 | 9,957 | 13.0% | 41% | 1,138,708 | 9.0% | 29.4% |
| $35,000 to $49,999 | 11,236 | 14.7% | 56% | 1,531,281 | 12.1% | 41.5% |
| $50,000 to $74,999 | 13,956 | 18.2% | 74% | 2,111,201 | 16.7% | 58.2% |
| $75,000 to $99,999 | 7,947 | 10.4% | 85% | 1,544,981 | 12.2% | 70.4% |
| $100,000 to $149,999 | 7,394 | 9.7% | 94% | 1,881,400 | 14.9% | 85.3% |

| Income and Benefits | Merced County | | | California | | |
|---|---|---|---|---|---|---|
| | Number (households) | Percent | Cumulative Percent | Number (households) | Percent | Cumulative Percent |
| $150,000 to $199,999 | 2,234 | 2.9% | 97% | 870,522 | 6.9% | 92.2% |
| $200,000 or more | 2,150 | 2.8% | 100% | 959,332 | 7.6% | 99.8% |
| Median household income (dollars) | 43,066 | NA | NA | 61,489 | NA | NA |
| Mean household income (dollars) | 59,868 | NA | NA | 86,704 | NA | NA |

Source: U.S. Department of Labor, Bureau of Labor Statistics (BLS) , n.d.

It follows that with a lower median household income there are also more people in poverty in Merced County than California. In 2014, 16.4 percent of Californians were below the poverty level compared to 25.6 percent of Merced County residents (**Table 2-4**) or 56 percent higher than the state.

**Table 2-4 Percentage of Families and People Whose Income is Below the Poverty Level, Merced County and California, 2014**

| Families and Individuals | Merced | California | Difference |
|---|---|---|---|
| | Percent | Percent | Percent |
| All families | 21.4% | 12.3% | 9.1% |
| Married couple families | 13.2% | 7.4% | 5.8% |
| Families with female householder, no husband present | 43.9% | 27.9% | 16.0% |
| All people | 25.6% | 16.4% | 9.2% |

Source: U.S. Department of Labor, Bureau of Labor Statistics (BLS) n.d.

The agriculture and manufacturing industries in Merced County comprise a larger relative share of employment compared to the state (**Table 2-5**). Total farm employment in Merced County was between 16 percent and 18 percent of total employment between 2005 and 2014 compared to 3 percent of state employment.

The agricultural industry in Merced County supported 14,000 jobs in 2014. Manufacturing, much of which is the processing of crops (e.g., food snacks, canned food, wine, cheese), supported another 10,000 jobs—combined these account for approximately one third (31 percent) of the jobs in Merced County.

**Table 2-5 Employment by Industry, 2010-2014**

| Industry | Merced County | | | | | California | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2012 | 2013 | 2014 | 2010 | 2011 | 2012 | 2013 | 2014 |
| Total, All Industries[1] | 69 | 70 | 72 | 74 | 76 | 14,665 | 14,823 | 15,161 | 15,567 | 16,002 |
| Total farm[1] | 11 | 11 | 13 | 14 | 14 | 383 | 390 | 400 | 412 | 416 |
| Percent of total | 16% | 16% | 17% | 18% | 18% | 3% | 3% | 3% | 3% | 3% |
| Total nonfarm[1] | 58 | 59 | 59 | 60 | 62 | 14,283 | 14,434 | 14,761 | 15,154 | 15,586 |
| Percent of total | 84% | 84% | 82% | 82% | 82% | 97% | 97% | 97% | 97% | 97% |
| Manufacturing[1] | 8 | 8 | 8 | 9 | 10 | 1,244 | 1,250 | 1,255 | 1,256 | 1,274 |
| Percent of total | 12% | 12% | 12% | 12% | 13% | 8% | 8% | 8% | 8% | 8% |
| All other[1,2] | 51 | 51 | 50 | 52 | 52 | 13,039 | 13,185 | 13,507 | 13,898 | 14,313 |
| Percent of total | 74% | 73% | 69% | 70% | 68% | 89% | 89% | 89% | 89% | 89% |

1 Number of jobs (thousands)

2 Industry categories include: Mining, logging and construction; Trade, transportation and utilities, Information, financial activities, Professional & business services; Educational & health services, Leisure & hospitality, Other services and Government.

Source: California Employment Development Department (EDD) 2010-2014.

### 2.1.3.1 Major Employers

Of the top 25 major employers in Merced County (measured in terms of number of employees), 13 are directly or indirectly involved in agriculture, either growing or processing agricultural output (**Table 2-6**). Foster Farms, a poultry processing plant, employs between 1,000 and 4,999 employees. Three firms employ between 500 and 999 employees: Hilmar Cheese, a cheese processor (see box), and two farms, Marchini & Sons and Western Marketing and Sales[2]. Seven other

**Hilmar Cheese Processing Facility**

Hilmar Cheese Company specializes in the production of natural cheeses utilized by private label and national brand, retail and food service companies across America. Hilmar Cheese Company...

- Was founded in 1984 and began production in 1985.
- Annually produces more cheese and whey from one site (Hilmar, CA) than any other manufacturer in the world.
- Production facility in Hilmar, California and Dalhart, Texas
- Employs more than 1,200 people.
- Processes more than 21 million pounds of milk (9.5 million liters) each day received from more than 230 dairies.
- Produces more than 2.4 million pounds (more than 1,100 metric tons) of cheese each day.
- Makes natural cheeses like Cheddar, Monterey Jack, Pepper Jack, Colby, Colby-Jack, flavored Jacks, Mozzarella and Hispanic cheeses for use in food service, ingredients, retail and the restaurant/fast food trade.

In 2014, Hilmar Cheese Co. announced plans to invest $75 to $100 million to build a milk powder processing plant in Turlock, located in neighboring Stanislaus County. The plant is expected to create 40 full-time jobs, plus expand related industries in Stanislaus and Merced counties.

Sources:
Hilmar Cheese Company webpage: https://www.hilmarcheese.com ;
Modesto Bee, 2014: http://www.modbee.com/latest-news/article3159327.html#storylink=cpy

[2] The estimated number of employees at Hilmar Cheese Company reported by the California Employment Development Department in Table 3-7 (between 500 and 999) differs from the number of employees reported on Hilmar Cheese Companies web page (1,200).

employers employ between 250 and 499 people; these include Bianchi & Sons Packing Co., Gallo Cattle Co., Liberty Packing Co., Live Oak Farms, McLane Pacific, Nor Cal Nursery, and Sensient Natural Ingredients. Gallo Winery, located in Livingston employs between 100 and 249 people.

Together, these top 13 agricultural employers alone provide between 4,450 and 11,500 jobs to Merced County.

**Table 2-6 Major Employers in Merced County Grouped by Industry Category**

| Employer | Location | Industry | Sector | Employment Range |
|---|---|---|---|---|
| Foster Farms | Livingston | Agriculture | Poultry Processing Plants (mfrs) | 1,000-4,999 |
| Hilmar Cheese Co | Hilmar | Agriculture | Cheese Processors (mfrs) | 500-999 |
| J Marchini & Son | Le Grand | Agriculture | Farms | 500-999 |
| Western Marketing & Sales | Atwater | Agriculture | Farms | 500-999 |
| Bianchi & Sons Packing Co | Merced | Agriculture | Fruits & Vegetables-Growers & Shippers | 250-499 |
| Gallo Cattle Co | Atwater | Agriculture | Cheese Processors (mfrs) | 250-499 |
| Liberty Packing Co | Los Banos | Agriculture | Packing & Crating Service | 250-499 |
| Live Oak Farms | Le Grand | Agriculture | Fruits & Vegetables-Growers & Shippers | 250-499 |
| Mc Lane Pacific | Merced | Agriculture | Food Service-Distributors (whls) | 250-499 |
| Nor Cal Nursery | Turlock | Agriculture | Fruits & Vegetables-Wholesale | 250-499 |
| Sensient Natural Ingredients | Livingston | Agriculture | Flavoring Extracts (whls) | 250-499 |
| E & J Gallo Winery | Livingston | Agriculture | Wineries (mfrs) | 100-249 |
| Yosemite Wholesale Warehouse | Merced | Agriculture | Warehouses | 100-249 |
| University of California, Merced | Merced | Education | Schools-Universities & Colleges Academic | 500-999 |
| Livingston Union School District | Livingston | Education | School Districts | 250-499 |
| Atwater Elementary Teachers | Not Available | Education | Professional Organizations | 100-249 |
| Merced County Human Services | Merced | Government | Government Offices-County | 500-999 |
| Mercy Medical Center Merced | Merced | Health Services | Hospitals | 1,000-4,999 |

| Employer | Location | Industry | Sector | Employment Range |
|---|---|---|---|---|
| Golden Valley Health Center | Merced | Health Services | Clinics | 500-999 |
| Quad/Graphics Inc. | Merced | Manufacturing | Printers (mfrs) | 500-999 |
| Malibu Boats West Inc. | Merced | Manufacturing | Boat Dealers Sales & Service | 250-499 |
| Werner Co | Merced | Manufacturing | Ladders-Manufacturers | 250-499 |
| Pacific Gas & Electric Co. | Merced | Manufacturing | Electric Companies | 100-249 |
| Walmart | Merced | Retail | Department Stores | 250-499 |
| Walmart Supercenter | Atwater | Retail | Department Stores | 250-499 |

Source: California Employment Development Department (EDD) n.d.
Note: Shaded rows are directly or indirectly involved in agriculture.

## 2.2 Merced County's Agricultural Economy

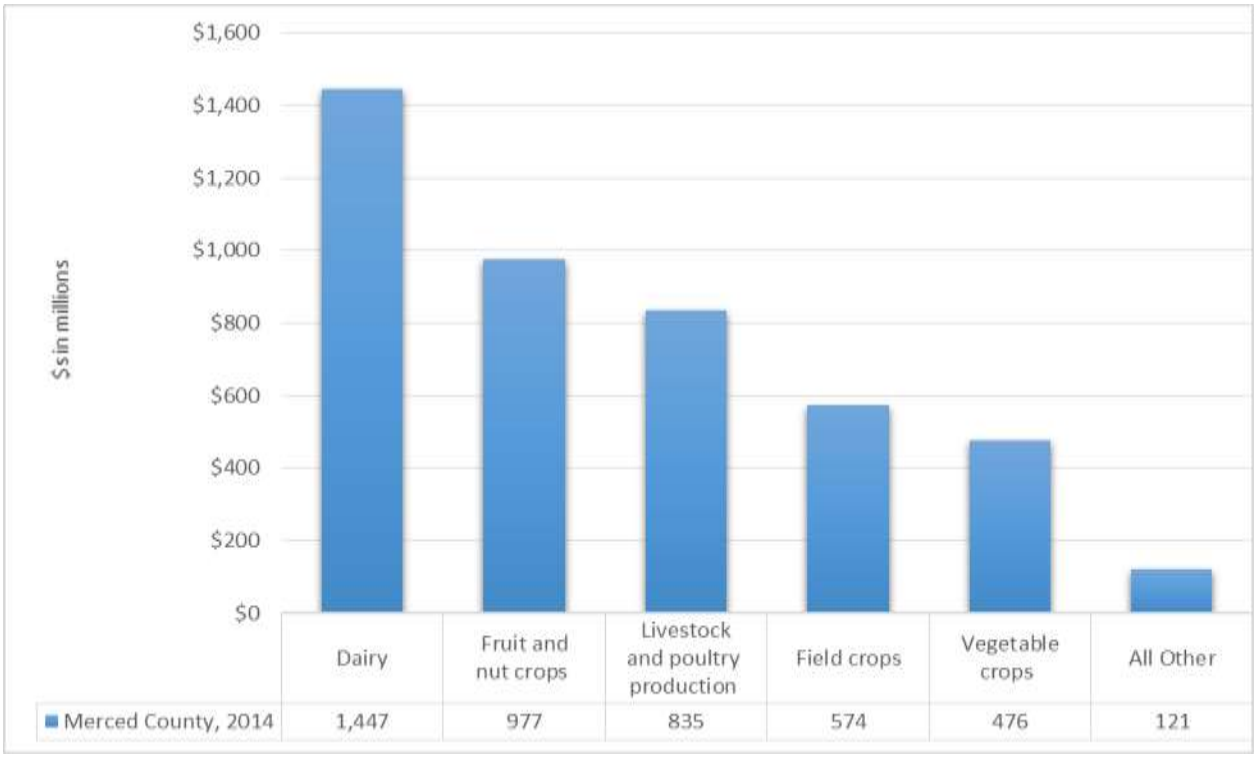
The value of agricultural production in Merced County in 2014 ranked fifth among all California counties (**Table 2-7**) (California Department of Agriculture 2014). Merced County contributed $4.4 billion in gross value, or 8.3 percent of total gross value for the state. Nearly all (99.7 percent) of the acres under production were irrigated.

**Table 2-7 Top 5 California counties by gross value of agricultural production, 2014 ($ millions)**

| Rank | County | Production Value | Percent of state Total |
|---|---|---|---|
| 1 | Tulare | $8,084.5 | 15.1% |
| 2 | Kern | $7,552.2 | 14.1% |
| 3 | Fresno | $7,037.2 | 13.2% |
| 4 | Monterey | $4,493.4 | 8.4% |
| 5 | Merced | $4,430.0 | 8.3% |
| -- | California | $53,492.1 | 100.0% |

Source: California Department of Food and Agriculture 2014

Dairy accounted for the largest portion of Merced County's 2014 production revenue ($1,447 million, or 33 percent) followed by fruit and nut crops ($977 million, or 22 percent), livestock ($835 million or 19%), field crops ($574 million or 13 percent) and vegetable crops ($476 million or 11 percent) (**Figure 2-2**).




Source: Merced County Agricultural Commissioner, 2014 Annual Report on Agriculture

**Figure 2-2 2014 Merced County Production Revenue by Commodity Group.**

Despite the 4-year drought, the value of Merced County agriculture has increased from previous years. This increase is due in part to the following factors:

- Pumping of groundwater to mitigate for the reduction in surface water supplies.
- Relatively high milk prices compared to previous years. For example, in 2014, the price of milk per hundredweight (cwt) ranged between $22/cwt and over $23/cwt. Compared to a low in 2009 of $11.5/cwt (Merced County 2014a, 2009).
- Relatively high almond prices compared to previous years. For example, in 2014, average almond prices in Merced County were $8,020/ton, a 27 percent increase from 2013 prices and a 254 percent increase from 2009. (Merced County 2014a, 2009). High almond prices are a result of the increase in demand of the tree nut driven by changing tastes. Protein-rich Paleo diets, peanut-butter allergies, and evolving tastes have increased American's consumption of almonds to 2 pounds per person annually, double the amount consumed just 7 years ago (Bloomberg 2015).

Historically, the top five individual commodities by value in the county are consistently cow's milk, almonds, cattle and calves, chickens, and sweet potatoes (**Table 2-8**). In 2014 these five commodities accounted for over 70 percent of the total production value for the entire county. These commodities are high value and require significant capital investments making them relatively fixed in the short run (one to twenty five years).

**Table 2-8 Top 5 Merced County Commodities by Value of Production, 2009 to 2014 ($ millions).**

| Commodity | 2014 Production Value | Percent of 2014 Total | Rank | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | 2014 | 2013 | 2012 | 2011 | 2010 | 2009 |
| Milk | $1,442.7 | 32.6% | 1 | 1 | 1 | 1 | 1 | 1 |
| Almonds | $790.7 | 17.8% | 2 | 2 | 2 | 2 | 2 | 3 |
| Cattle and Calves | $350.1 | 7.9% | 3 | 3 | 3 | 3 | 4 | 4 |
| Chickens | $309.1 | 7.0% | 4 | 4 | 4 | 4 | 3 | 2 |
| Sweet Potatoes | $217.0 | 4.9% | 5 | 5 | 5 | 5 | 5 | 5 |
| Subtotal of top five | 3,109.6 | 70.2% | | | | | | |
| Total of all commodities | $4,430.0 | 100.0% | | | | | | |

Source: Merced County Agricultural Commissioner, Annual Reports on Agriculture: 2009-2014

The capital investment required to establish an almond orchard is over $5,000 per acre. The establishment cost is the sum of the costs for land, planting, trees, etc., as well as the production expenses for growing the trees until almonds are harvested and revenue is generated in approximately 3 years (UCCE 2011). For a 40-acre orchard, that equates to over a $200,000 investment before revenue is generated. These establishment costs are recovered over the remaining 22 of the 25 years the orchard is in production.

In the dairy industry the cash costs of dairy operations only represent 78 percent of the total annual costs. Depreciation and interest costs for the investments in items including the milking barn, free stall, manure pit, bulk tank, hay barn, silage pit, maternity pens, etc., represent 22 percent of total costs (UCCE 1986).

As a result of the relatively high capital investment required to produce Merced County's high-value commodities, there is little change in the number of acres dedicated to production of these commodities (**Table 2-9**). Field crops comprise the largest percent of irrigated acreage in Merced County, at just under 70 percent of total acres for each of the last 6 years. The majority of field crops are feed crops (between 55 and 61 percent of total acres) grown to support the billion dollar plus dairy and livestock and poultry production industries. Fruit and nut crops comprise a steady 21 to 23 percent of all irrigated acreage between 2009 and 2014, primarily almonds (16 to 17 percent of all irrigated acres). Vegetable crops comprise approximately 10 percent of total acres in production over the past 6 years, primarily tomatoes and sweet potatoes.

**Table 2-9 Merced County Irrigated Acreage by Commodity 2009 to 2014.**

| Commodity Category<br>Commodity | Irrigated Acres (thousands) | | | | | | Percent of Annual Total Acres (percent) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| **Feed crops (alfalfa, silage, pasture, etc.)** | **359** | **334** | **316** | **333** | **372** | **361** | 56 | 55 | 56 | 59 | 58 | 56 |
| **Field Crops (not animal feed)** | **46** | **63** | **80** | **74** | **65** | **63** | 11 | 14 | 13 | 10 | 10 | 11 |
| Cotton | 23 | 39 | 56 | 52 | 36 | 36 | 7 | 10 | 9 | 6 | 6 | 7 |

| Commodity Category<br>Commodity | Irrigated Acres (thousands) | | | | | | Percent of Annual Total Acres (percent) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
| All other | 22 | 24 | 25 | 22 | 29 | 27 | 4% | 4% | 4% | 5% | 4% | 4% |
| **Fruit and Nut Crops** | **127** | **130** | **130** | **131** | **131** | **132** | **21** | **22** | **23** | **22** | **21** | **21** |
| Almonds | 95 | 99 | 99 | 98 | 99 | 100 | 16 | 17 | 17 | 17 | 16 | 16 |
| Grapes (wine and raisin) | 12 | 12 | 12 | 13 | 13 | 13 | 2 | 2 | 2 | 2 | 2 | 2 |
| Peaches | 5 | 5 | 4 | 4 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 |
| Pistachios | 4 | 4 | 5 | 5 | 5 | 5 | 1 | 1 | 1 | 1 | 1 | 1 |
| All other | 12 | 11 | 10 | 12 | 10 | 11 | 2 | 2 | 2 | 2 | 2 | 2 |
| **Vegetable Crops** | **61** | **60** | **46** | **45** | **54** | **62** | **10** | **10** | **8** | **8** | **9** | **10** |
| Sweet potatoes | 16 | 17 | 17 | 15 | 17 | 18 | 3 | 3 | 3 | 3 | 3 | 3 |
| Melons | 8 | 10 | 7 | 4 | 5 | 8 | 1 | 2 | 1 | 1 | 1 | 1 |
| Tomatoes | 32 | 29 | 20 | 23 | 26 | 32 | 5 | 5 | 3 | 4 | 4 | 5 |
| All other | 5 | 4 | 3 | 4 | 5 | 5 | 1 | 1 | 1 | 1 | 1 | 1 |
| **Misc other** | **7** | **6** | **5** | **6** | **9** | **5** | **1** | **1** | **1** | **1** | **1** | **1** |
| **Total** | **600** | **593** | **578** | **590** | **630** | **623** | **100** | **100** | **100** | **100** | **100** | **100** |

Source: Merced County Agricultural Commissioner, Annual Reports on Agriculture: 2009-2014.

Merced County's high-value agricultural industry contributes more to the economy than the commodities' production value. The agricultural industry supports a significant agricultural processing sector as well. For example, approximately 34 percent of the dairy milk produced in Merced County is also processed in the county at one of the 6 processing plants (**Table 2-10**). An additional $1.66 in production value is added to Merced County economy when the milk is processed locally. Another example of value-added to commodities occurs with sweet potatoes, where 22 packing facilities operate year-round to fill orders from clients for sweet potatoes (UCCE undated).

In summary, when compared to the state's demographic and economic data, Merced County is characterized by higher projected population growth, lower household income, higher unemployment, and a higher percentage of people living in poverty. The agricultural industry supports nearly one third of the county's jobs. Approximately 18 percent of county's agricultural jobs are on-farm jobs, compared to 3 percent for the state. Most importantly the agricultural industry is heavily invested in either high-valued permanent crops (trees and vines) or feed crops for the county's billion dollar dairy herd and cattle and calf operations. Only ten percent of the land is devoted to annual crops (primarily vegetables) that are not devoted to animal feed.

**Table 2-10 Top Ten California Counties for Dairy Plants**

| County | Number of Dairy Plants | Percent of state |
|---|---|---|
| Los Angeles | 25 | 18% |
| Sonoma | 15 | 11% |

| County | Number of Dairy Plants | Percent of state |
|---|---|---|
| Tulare | 14 | 10% |
| Stanislaus | 11 | 8% |
| Alameda | 8 | 6% |
| Fresno | 6 | 4% |
| Kings | 6 | 4% |
| **Merced** | **6** | **4%** |
| Marin | 5 | 4% |
| Orange | 5 | 4% |
| California | 136 | 100% |

Source: California Department of Food and Agriculture, February 2015.

# 3 MERCED RIVER HYDROELECTRIC PROJECT'S CONTRIBUTION TO THE LOCAL ECONOMY

Annually, the Project generates an estimated $943 million in agricultural output both in the production of commodities and in the valued added by processing those commodities, creating 4,888 agriculturally-related jobs and generating $267 million in labor income (**Table 3-1**). The Project contributes slightly under 1,000 acre-feet M&I surface water supply annually to three rural water systems located near Lake McClure, valued at between $47 thousand and $99 thousand per year. Urban areas as well as rural communities, rely on groundwater as their source of potable water supply. The Merced Groundwater Basin, Groundwater Management Plan reported a total of approximately 43,700 AF of urban groundwater use in 2014. Although these water systems are independent of MID, MID's operations have contributed over 1.4 million acre-feet of groundwater recharge between 2010 and 2014 (MID 2015a). Without this contribution, or with a reduced recharge contribution, these urban areas would have experienced water level and water quality issues beyond what they may already be experiencing. Power production adds another $13 million to $17 million to the economy creating 21 jobs that generate $1 million in labor revenue. Combining the **agriculture and power sectors, on an annual basis the Project adds just under $1.0 billion in output, 4,909 jobs and $268 million in labor income to the Merced County economy**.

The estimates of output include the economic "ripple" effects (e.g. indirect and induced effects) of direct agricultural and power production. Details of these estimates follows below.

**Table 3-1 Summary Estimated Annual Benefits of Merced River Hydroelectric Project (2014 dollars in millions)**

| Water Use | Impact Measure | Units | Estimated Annual Benefit |
|---|---|---|---|
| Agricultural irrigation supply | Output | $ million | $943 |
| | Labor income | $ million | $267 |
| | Jobs | full and part-time jobs | 4,888 |
| Municipal and industrial surface water supply | Surface water | acre-feet | 785 |
| | Estimated value | $ thousand | $47 to $99 |
| Power | Output | $ million | $04 to $4.3 |
| | Labor income | $ million | $1 |
| | Jobs | full and part-time jobs | 21 |
| Recreation | Visitation (annual recreation days) | days (million) | 1.9 |
| Environmental | Environmental flows, various time periods | acre-feet | 86,000 to 91,000 |
| | Environmental consumptive use | acre-feet (up to) | 22,000 |
| Flood protection | Reserved flood control volume | Acre-feet | 400,000 |

Source: Various sources cited in the text that follows.

## 3.1 Water Supply

MID is a conjunctive use district that relies on surface water supplies delivered by the Project to supply its irrigated agriculture and supplements this supply with conjunctively managed groundwater when surface water supplies are limited

### 3.1.1 Irrigated Agriculture

MID provides water to over 2,200 customers (MID 2012a) to irrigate approximately 100,000 acres annually (MID 2015a). Those 100,000 acres constitute 14 to 20 percent of all irrigated acres in Merced County, depending upon the year. Some of those crops, corn-silage, alfalfa hay, irrigated pasture, etc., are inputs to the production of animal commodities. And a portion of both crop and animal commodities are processed locally. Combined, this crop and animal commodity production as well as the processing comprise the Project's economic benefit to irrigated agriculture in Merced County.

The value of the crop and animal commodity production, the processing of that production, plus all the economic ripple effects (indirect and induced) generated by those 100,000 irrigated acres is estimated to be just under $1 billion dollars annually (**Table 3-2**). This estimate is used as the baseline for the estimated economic impacts presented in Chapter 5, Potential Economic Impacts of Reduced Project Water Supplies. Estimates of the baselines of the crop and animal commodity production as well as the processing estimates and direct and induced impacts follow. Details of the methods used to estimate these baselines as well as the potential impacts of reduced water supplies is found in Chapter 4, Study Methodology.

**Table 3-2 Estimated Value of the Agricultural Output Supported by Surface Water Supplied by the Project (2014 dollars in millions)**

| Economic Activity Name | Value ($ million) | Percent of Total |
|---|---|---|
| Crop Production (nuts, fruit, animal feed, vegetables, etc.) | $348 | 37% |
| Animal Production (milk and beef) | $249 | 26% |
| Crop and Animal Processing (direct) | $71 | 8% |
| Indirect and Induced Effects | $275 | 29% |
| **Grand Total** | **$943** | **100%** |

Source: Cardno 2015; Highland Economics 2015

#### 3.1.1.1 Crop Commodity Production

The number of irrigated acres that receive surface water supplies from the Project remained relatively constant from 2009 through 2013 at just over 100,000 acres (**Table 3-3**). In 2014, the number of irrigated acres dropped by approximately 20 percent, to a low of 88, 700 acres. The reduction in irrigation acres in 2014 was due to the ongoing drought and a reduced surface water allocation. The 2014 reduction in irrigated acres correspondence with a reduction in all crop commodity types except vegetables, with the largest absolute reduction in animal feed crops. The largest percent reduction was in the field crops (rice, cotton and grain).

**Table 3-3 Crops Acres in Production by Commodity, Merced County and Served by the Merced River Hydroelectric Project, 2009-2014 (Acres in thousands)**

| Crop Commodity | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 |
|---|---|---|---|---|---|---|
| **Merced County** | | | | | | |
| Animal Feed Crops | 359 | 334 | 316 | 333 | 372 | 361 |
| Field Crops | 46 | 63 | 80 | 74 | 65 | 63 |
| Fruit and Nut Crops | 127 | 130 | 130 | 131 | 131 | 132 |
| Vegetable Crops | 61 | 60 | 46 | 45 | 54 | 62 |
| Miscellaneous other | 7 | 6 | 5 | 6 | 9 | 5 |
| Total Acres | 600 | 593 | 578 | 590 | 630 | 623 |
| **Acres served by the Project (within the service area and the MID sphere of influence)** | | | | | | |
| Animal Feed Crops | 48 | 44 | 49 | 52 | 41 | 32 |
| Field Crops | 6 | 6 | 6 | 5 | 4 | 2 |
| Fruit and Nut Crops | 43 | 42 | 45 | 47 | 44 | 41 |
| Vegetable Crops | 14 | 18 | 12 | 14 | 13 | 14 |
| Miscellaneous other[1] | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Acres | 111 | 109 | 112 | 116 | 102 | 89 |
| **Acres served by MID as a percent of the County** | | | | | | |
| Animal Feed Crops | 13% | 13% | 16% | 16% | 11% | 9% |
| Field Crops | 13% | 6% | 8% | 4% | 3% | 3% |
| Fruit and Nut Crops | 34% | 32% | 34% | 36% | 33% | 31% |
| Vegetable Crops | 23% | 30% | 26% | 31% | 24% | 23% |
| Miscellaneous other[1] | 0% | 0% | 0% | 0% | 0% | 0% |
| Total Acres | 18% | 18% | 19% | 20% | 16% | 14% |

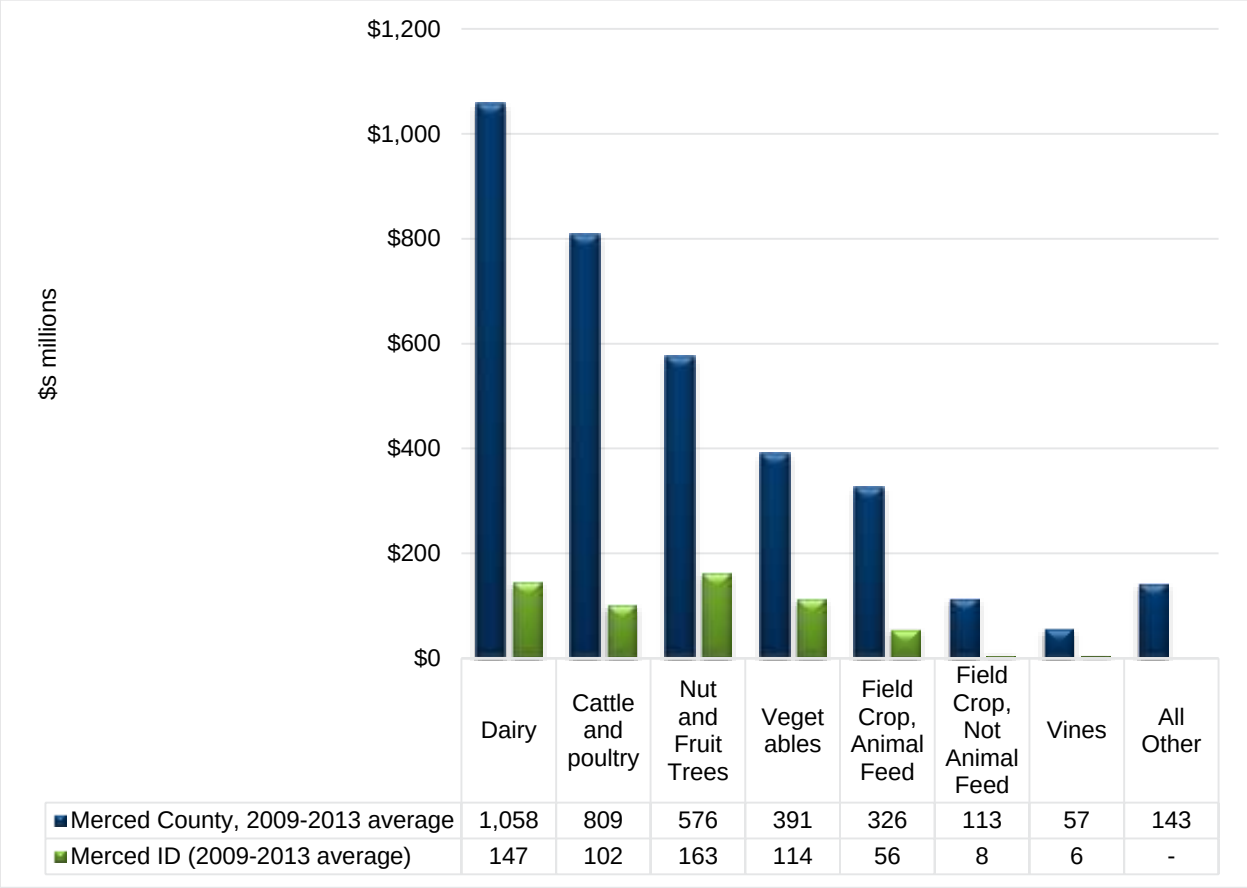
Notes:

[1] See Chapter 4, Study Methodology, for the aggregation of crops into these crop categories. In the aggregation process there were no 'miscellaneous other' crops.

Sources: Merced County Agricultural Commissioner, Annual Reports on Agriculture: 2009-2014 and personal communication with Bryan Kelly, Merced Irrigation District.

Project water supports a larger share of fruit and nut crop and vegetables acres (primarily almonds and also pistachios, prunes, peaches and grapes) than the rest of the county and a lower share of field crops (primarily animal feed crops, cotton, and rice). For example, the Project delivered water to irrigate between 31 and 36 percent of the fruit and nut crop acres in the county from 2009 to 2014. During the same time the Project water deliveries irrigated between 3 and 13 percent of the field crops. Growers' investments in these higher value crops have been protected by the Project's historically high surface water supply reliability.

The estimated 5-year annual average value of crop commodities produced on land irrigated with Project water supplies is just over $348 million (**Figure 3-1**), with nut trees the largest portion of that ($163 million), approximately 28 percent of the County's production value of almonds ($163 million as a portion of $576 million). Vegetables made up $122 million of the crop commodity value, or 29 percent of the County's vegetable production value.




| | Dairy | Cattle and poultry | Nut and Fruit Trees | Vegetables | Field Crop, Animal Feed | Field Crop, Not Animal Feed | Vines | All Other |
|---|---|---|---|---|---|---|---|---|
| Merced County, 2009-2013 average | 1,058 | 809 | 576 | 391 | 326 | 113 | 57 | 143 |
| Merced ID (2009-2013 average) | 147 | 102 | 163 | 114 | 56 | 8 | 6 | - |

Sources: Merced County: County Agricultural Commissioner, 2014 Annual Report on Agriculture.
Merced ID: Estimated by Cardno based on estimated acres by crop per B. Kelly, MID (Kelly 2015).

**Figure 3-1 Estimated Value of Crop and Animal Production Supported by Water Supplied from the Merced River Hydroelectric Project**

### 3.1.1.2 Animal Commodity Production

The portion of Merced County animal commodity production that is supported by feed crops grown with Project water is estimated to be $249 million. Corn silage and alfalfa hay, the primary component of roughage in dairy cow's diet contribute to the production of $147 million of milk production. Irrigated pasture, the primary roughage component in cattle's diet, contribute to the production of $102 million in beef production (**Figure 3-1**).

The estimates of animal commodity production values were calculated by first estimating the number of head of dairy cows and cattle that can be supported with crops grown with water delivered by the Project. The number of head is then multiplied by the average yield per animal and the average price per unit of yield. The approach is fully described in Chapter 4, Study Methodology.

Chickens and eggs are major livestock and livestock products in Merced County. However, consistent with the U.S. poultry industry as a whole, chickens in the region are fed mainly high protein diets (USDA ERS 2014a). Protein sources in these diets can consist of soybean meal, fishmeal, corn gluten meal, alfalfa meal, minerals; while energy requirements are satisfied mainly by corn-grains (Chiba 2009). Much, if not virtually all of these feed stuffs are imported from other regions of the United States (Pelican 2014, Barry 2014). For these reasons, it is unlikely that MID crop production supports a measurable percentage of the gross value of chicken or egg production in the region.

#### 3.1.1.3 Commodity Processing

Local processing of commodities produced with irrigation water supplied by the Project adds an estimated $71 million annually to Merced County' economy.[3] As discussed in Chapter 2, Study Area, 13 of the top 25 employers in Merced County are in the agriculture sector. Of those 13 employers, 10 are categorized as providing processing (cheese, snacks, wine, etc.), crating and packaging, shipping, distributing, and/or wholesaling of crop and animal products (the remaining 3 employers are farms). In other words, for every $1.00 of crop and animal production value, an additional $0.39 of output is created in processing, crating, shipping, distributing, and/or wholesaling the raw crop and animal product. See Chapter 4, Study Methodology for a description of the assumptions about the estimate.

#### 3.1.1.4 Economic "Ripple Effects"

In addition to the direct economic effects of crop and animal commodity production and related local processing, economic "ripple effects" include indirect, and induced effects. Indirect effects result from industries purchasing from other industries in order to satisfy the demand generated in the directly affected industry. For example, indirect effects are generated in the truck transportation industry due to demand for shipping agricultural inputs and products. The truck transportation industry then increases its demand for such inputs as fuel and labor, which in turn are also indirect effects.

Induced effect result from increased expenditures by households employed by directly and indirectly affected economic sectors. For example, induced effects are generated when a farm laborer spends his or her income at a retail store. Income at the indirectly affected retail store thus also rises, and

[3] In order to combine the value of processing and the value of commodity production without double counting the value of the crop production it is necessary to subtract the value of the crop inputs from the final value of the processed goods. The net value of the commodities processed locally is $71 million.

additional induced effects are generated when the retail store owners and workers spend their income on other goods and services in the local economy.

Indirect and induced effects are estimated to contribute another $275 million to the total economic benefit of Project water delivered into agriculture.

### 3.1.2 Municipal and Industrial

MID makes three small diversions from Lake McClure, each related to raw water supply for rural water systems. Additionally, MID's operations provides substantial groundwater recharge within its service area that benefits the three local cities and rural communities that rely solely on groundwater for potable water supplies.

- MID contributes to regional M&I surface water supply through three small diversions from Lake McClure, each related to water supply. MID anticipates that the diversions will continue unchanged for the foreseeable future. These are:
    - LDPCSD is a relatively small district that provides water to a population of approximately 3,200 people (LDPCSD 2016a), with total assets valued at $5.1 million (LPDCSD, 2014). It can withdraw up to 5,000 acre-feet of water annually directly from Lake McClure for surface water supply (MID, 2013). The LDPCSD's intake is at elevation 700 feet. Since the beginning of the current 4-year drought, Lake McClure levels have been approaching the limits of the LDPCDS pumps, threatening the district's ability to continue to pump water from the lake and provide water to residents. In 2015, water diversions were halted for several weeks due to low lake levels. Water diversions to LDPCSD in 2015 were 93 acre feet, 14 percent of the average volume delivered from 2009 through 2014 (**Table 3-4**). On April 16, 2015, the LDPCSD published a Drought and Emergency Water Supply Information Update stating they were working on plans to increase supply reliability to supplement the surface water from Lake McClure with groundwater wells. Since that time LDPCSD has received $1.6 million in grant funding from various sources, including DWR, SWRCB and the USDA (LDPCSD 2016a). The LPDCSD has invested $0.3 on the dollar of its customer's money to develop the supply (estimated $0.6 million). The wells represent a doubling of LDPCSD's assets, 30 percent of which comes directly from the district's funds.
    - Less than 1,000 AF of water is withdrawn annually by the MID recreation facilities at three locations along Lake McClure and McSwain Reservoirs.
    - The McClure Boat Club, a small development adjacent to the Project, diverts about 25 AF at a point near the development. The boat club withdraws water from a pump on a float that rises and falls with the reservoir elevation and has an intake 10 feet below the float.
- Urban areas, such as cities and towns, as well as rural communities, rely on groundwater as their source of potable water supply. Urban areas occupy approximately 18,200 acres within the MID. The Merced Groundwater Basin, Groundwater Management Plan reported a total of approximately 43,700 AF of urban groundwater use in 2014. Although these water systems are independent of MID, MID's operations have contributed over 1.4 million acre-

feet of groundwater recharge between 2010 and 2014 (MID's 2015 AWMP). Without this contribution, or with a reduced recharge contribution, these urban areas would have experienced water level and water quality issues beyond what they may already be experiencing.

**Table 3-4 Actual Water Deliveries to Lake Don Pedro Community Service District, 2008 through 2015(acre feet)**

| Municipal Purveyor | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|
| Lake Don Pedro Community Services District | 985.7 | 899.8 | 635.0 | 542.7 | 622.3 | 641.3 | 771.0 | 93.2 |

Source: Kelly, B, 2015.

#### 3.1.2.1 M&I Water Valuation

The annual value of M&I water delivered from the three Lake McClure diversions described about is estimated to be between $47 thousand and $99 thousand (**Table 3-5**).

The value of the M&I supplies was estimated by using the cost of replacement wholesale water supply as a proxy. Costs are based on a range of wholesale raw water rates charged by resource management agencies throughout the state (see Chapter 5, Study Methodology). The difficulty in using published wholesale rates as the basis for the valuation estimate is that it may imply water could be purchased and transferred to M&I water purveyors located in Merced County for treatment and delivery. When in fact wholesale supply may not be available and the water purveyors in Merced County very likely could not take delivery from wholesalers without a significant investment in infrastructure. Despite this shortcoming of the method, the water that MID delivers directly from Lake McClure has value and that value will only increase under increasing demand.

**Table 3-5 MID's Municipal and Industrial Value Estimate of Annual Contribution to M&I Water (2014 $s 000)**

| M&I Water Source/Program | Average Annual Volume | Price | | Extended Value | |
|---|---|---|---|---|---|
| | | Low (b) | High (c) | Low | High |
| | (TAF/year) | ($/AF) | ($/AF) | ($000) | ($000) |
| McClure Lake diversions (a) | 0.7 | $70 | $148 | $47 | $99 |

(a) MID 2015
(b) DWR 1994, indexed using BLS 2015
(c) MWD, 2015

## 3.2 Hydro Power

Hydropower is generated at the facility by water flows released for agricultural and other downstream purposes. Hydropower is a valuable, but secondary, purpose of the Project. With an authorized capacity of 103.5 MW the project generated an average of about 467,456 megawatt-hours (MWh) of power annually from 2010 through 2015 (**Table 3-6**) (MID 2015).

### 3.2.1 Hydropower Production

Power is produced at MID's New Exchequer and McSwain Dams on the Merced River and sold to utility companies, which then sell it to consumers. The value of the hydropower produced at the facilities has averaged $8.9 million dollars per year from 2010 to 2014 (MID, 2015), based on generation that has ranged between 88,981 MWh and 535,527 MWh. Note that the power generation in 2015 during the drought (13,250 MWh) was considerably lower than the 5-year average.

**Table 3-6 Actual MID Hydropower Generation, 2015-2010**

| Year | Output (MWh) | Total Revenue ($ million) | Average revenue ($/kWh) |
|---|---|---|---|
| | | | |
| 2014 | 88,981 | $5.3 | $0.06 |
| 2013 | 160,343 | $9.6 | $0.06 |
| 2012 | 230,735 | $9.2 | $0.04 |
| 2011 | 535,527 | $10.7 | $0.02 |
| 2010 | 317,381 | $9.5 | $0.03 |
| **Average (5-Year)** | **266,593** | **$8.9** | **$0.03** |
| *NOTE: 2015* | *12,350* | *$0.7* | *$0.06* |

Source: MID 2015b

The hydrology model's estimate of power generation by water year type ranges from 170,763 MWh to 537,159 MWh, slightly higher than the range of actual power generation. The estimated economic contribution to Merced County's economy from hydropower generation ranges from a low of $10.2 million to a high of $13.4 million, depending on water year type (**Table 3-7**). Water year type impacts the volume of water that can be released to generate power.

**Table 3-7 Estimated Hydropower Production Value by Water Year-Type, 2014 dollars**

| Water-Year Type | Output (MWh) | Total Revenue ($ million) | Average revenue ($/kWh) |
|---|---|---|---|
| Wet | 537,159 | $10.7 | $0.02 |
| Above Normal | 369,041 | $11.1 | $0.03 |
| Below Normal | 285,274 | $11.4 | $0.04 |
| Dry | 268,755 | $13.4 | $0.05 |
| Critical | 170,763 | $10.2 | $0.06 |

Source: Bergfeld. L, 2015 and Cardno

### 3.2.2 Economic "Ripple Effects"

In addition to the direct economic effects of hydropower production the economic "ripple effects" include indirect, and induced effects. Indirect effects result from industries purchasing from other industries. Induced effect result from increased expenditures by households employed by directly and indirectly affected economic sectors.

Indirect and induced effects are estimated to contribute another $2 to $4 million to the total economic benefit of Project water used to generate hydropower. Bringing the total regional economic impacts of hydropower to between $13 million per year to $17 million per year, depending on the year type, supporting over an estimated 21 full and part-time jobs (**Table 3-8**).

**Table 3-8 Estimated Regional Economic Activity of Power Production, 2014 dollars**

| Type of Production | Baseline by Year Type | | | | |
|---|---|---|---|---|---|
| | Wet | Above Normal | Below Normal | Dry | Critical |
| **Power Generation assumptions** | | | | | |
| MWh Gen (000s) (a) | 537,159 | 369,041 | 285,274 | 268,755 | 170,763 |
| Weighted Average Price/Kwh (b) | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 |
| Output ($millions) | | | | | |
| Direct output | $10.7 | $11.1 | $11.4 | $13.4 | $10.2 |
| Indirect | $0.4 | $0.4 | $0.5 | $0.5 | $0.4 |
| Induced | $2.4 | $2.5 | $2.5 | $3.0 | $2.3 |
| Total Output | $13.6 | $14.0 | $14.4 | $17.0 | $12.9 |
| Employment (full and part-time jobs) | | | | | |
| Direct | 7 | 7 | 7 | 7 | 7 |
| Indirect | 2 | 2 | 2 | 2 | 2 |
| Induced | 12 | 12 | 12 | 12 | 12 |
| Total Output | 21 | 21 | 21 | 21 | 21 |
| Labor Income ($millions) | | | | | |
| Direct | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 |
| Indirect | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 |
| Induced | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 |
| Total Output | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 |

Source: (a) Bergfeld, L., 2015. (b) Kelly, B., 2016. All other data from Cardno

## 3.3 Recreation

MID owns, operates and maintains five recreation areas adjacent to the lakes behind New Exchequer and McSwain Dams. Six boat launch facilities and over 600 campsites are available to the public year-round. Floating marinas are located on Lake McSwain and Lake McClure for the boating public. Activities enjoyed in the recreation areas include fishing, boating, swimming, camping, hiking and bicycling. In 2010, the Project's recreational areas supported recreational visitation of nearly 1.9 million recreation days (MID 2012b).

The water surface elevation that supports the functional use of the boat ramps on the two lakes ranges from just under 600 feet to approximately 775 feet (MID 2012b).

## 3.4 Environmental Regulatory Compliance

MID takes or has taken several measures to meet environmental regulations. These include consumptive and non-consumptive water uses (**Table 3-9**).

**Table 3-9 MID Environmental Water Delivery**

| Environmental Resources | Average Annual Volumes (acre-feet) |
|---|---|
| **Non-Consumptive Environmental Water Uses** | |
| Federal Energy Regulatory Commission in-stream flow | 33,025 to 43,736 |
| California Department of Water Resources (Davis-Grunsky Agreement) | 53,912 to 65,892 (Nov-Mar) |
| October pulse flow | 12,500 (October) |
| **Consumptive Environmental Water Uses** | |
| Merced National Wildlife Refuge | Up to 15,000 (March – October) |

## 3.5 Flood

The Project's flood control operations are governed by the ACOE flood control manual for New Exchequer Dam. In general, the Project attenuates high flows in the winter and spring by storing the water until it can be release for beneficial use. In subsequent wet years, flows may be released for flood management purposes.

# 4 STUDY METHODOLOGY

The methods and model used to estimate the baseline and impact of the SWRCB's proposed plan on the economy of Merced County are described in this section. The economic impacts of reduced water deliveries to the Project are primarily felt in the agriculture sector. The Statewide Agriculture Production Model (SWAP) was used as the basis for the model to estimate on-farm impacts to crop commodity production. Animal commodities values were estimated using a spreadsheet model. IMPLAN was used to estimate regional economic impacts. Both backward and forward economic linkages were estimated using IMPLAN. Examples of backward linkages include inputs to crop production (seed, fertilizer, pollination services, etc.). Examples of forward linkages are the processing of the production (wine, canned goods, snack food, cheese, etc.). Linkages were measured as the value of output, full and part-time jobs and labor income.

Other categories of impacts, for example M&I water supplies and hydropower output utilized much simpler spreadsheet-based models to estimate the economic impact of the SWRCB's plan. All the models and methodological approaches used to estimate the economic impact analysis are discussed below in detail. Also described is the hydrologic model which provided necessary inputs to the economic models.

## 4.1 Surface water supply

The hydrologic model estimated the change in 1) canal deliveries for irrigation 2) M&I water service interruptions to the LDPCSD and 3) power generation caused by the SWRCB's proposed plan compared to existing operations. The model uses a 93-year hydrologic trace, considering operations from 1922 to 2014. The estimates of the changes are used as input to the economic model, which quantifies and/or qualifies the estimated change in water operations. The hydrologic model was used to simulate operations under the current regulatory requirements and under the SWRCB's proposed plan.

### 4.1.1 Canal Deliveries

Under existing operations, the model estimates shortages in 11 years (**Figure 4-1**). Under the SWRCB's proposed plan the model estimates shortages in 41 of the 93 years represented in the model.

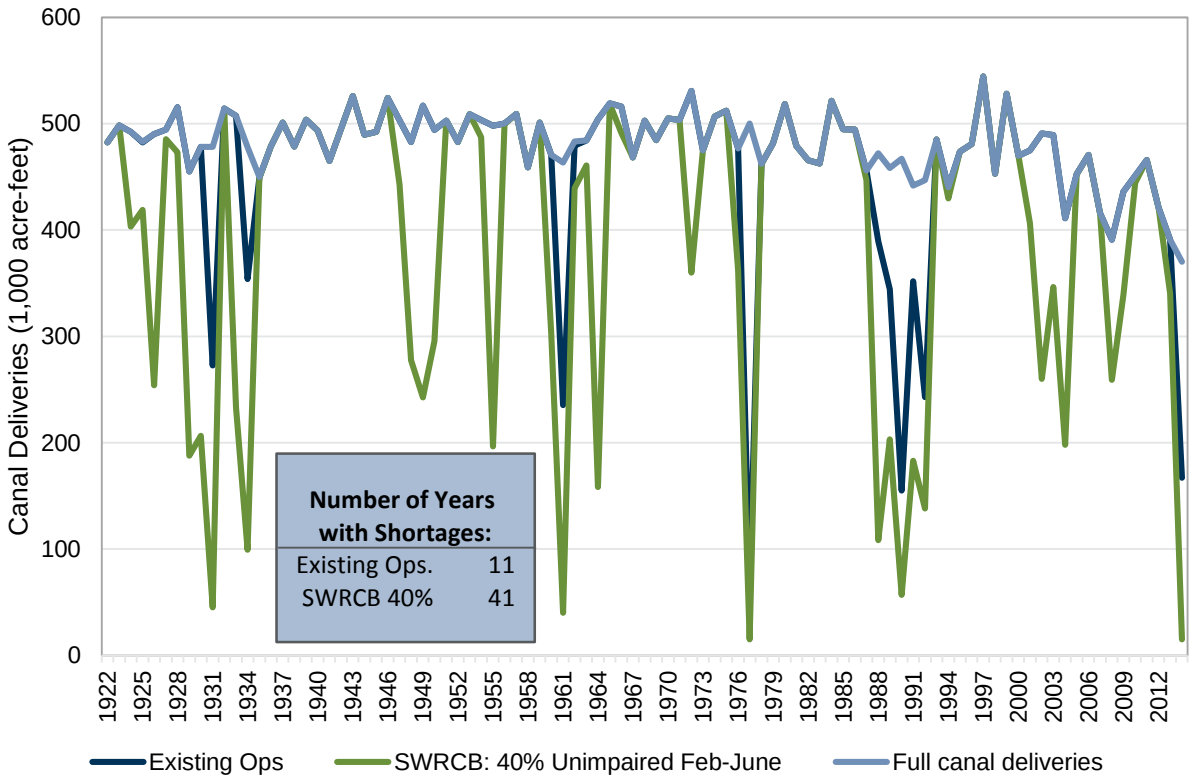
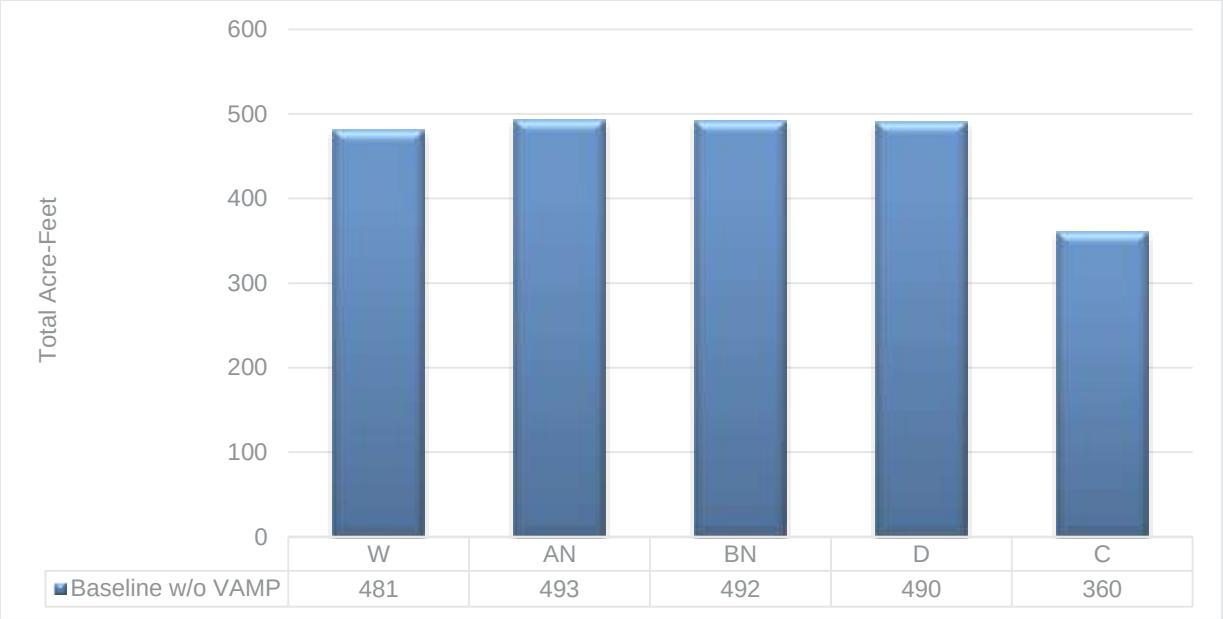



**Figure 4-1 Annual Canal Deliveries, Existing Operations vs. SWRCB Proposed 40% Plan**

Annual estimates of canal deliveries under existing operations and under the SWRCB's proposed plan were aggregated into water-year types (wet, above normal, below normal, dry, and critical) using the San Joaquin Valley 60-20-20 index to categorize years into water-year types. Canal deliveries to the Project under existing conditions were used as the baseline for water availability in the economic models (discussed below). Except for critical water-years, under existing conditions in each water-year type, water deliveries meet full canal demands. The baseline used for critical years was 25 percent below full canal demands (**Figure 4-2**).

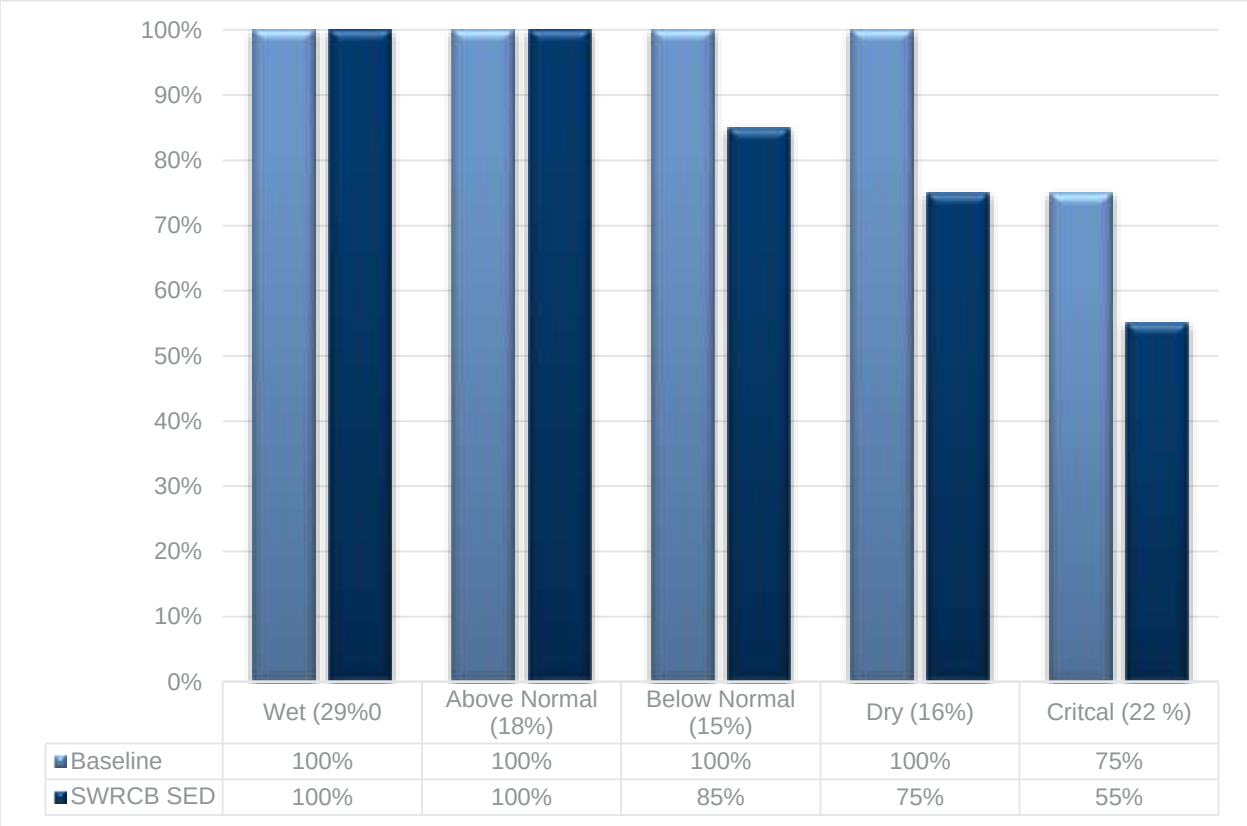



W = wet; AN = above normal; BN = below normal; D = dry; C = critical; VAMP =Vernalis Adaptive Management Plan

**Figure 4-2 Average Annual Baseline Canal Deliveries by Water Year Type.**

Under the SWRCB proposed plan, canal deliveries in wet and above normal years are 100 percent of baseline (**Figure 4-3**). In below normal years, canal deliveries are 85 percent of baseline. In dry years, canal deliveries are 75 percent of baseline. In critical years, canal deliveries are 55 percent of full canal deliveries, 20 percent lower than the critical-year baseline of 75 percent of full canal deliveries.

Generally, the SWRCB's proposed plan would reduce canal deliveries by between 15 and 25 percent of baseline in half of the 93 years modeled. These estimates of canal deliveries were input into the economic models discussed below to estimate the economic impact of available water deliveries by year type. Also, based on the ongoing increased management of groundwater in California, the model did not increase groundwater pumping to offset potential impacts of a reduction in surface water availability. So the reduction in canal deliveries and subsequent reduction in irrigation supplies were not offset with increases in groundwater pumping.




W = wet; AN = above normal; BN = below normal; D = dry; C = critical

**Figure 4-3 Modeled Percent of Canal Delivers by Water Year Type.**

### 4.1.2 Interruptions in Municipal Surface water supply

The Project's contribution to local M&I supplies are generated from surface water diversions from Lake McClure (see Section 3.1.2 for complete description). The hydrologic model did not estimate potential impacts of the SWRCB plan to groundwater recharge; therefore, the impact of the SWRCB plan on groundwater recharge is not known.

The potential impact of the SWRCB's plan on surface water diversions was estimated by the model as the number of months per year that water deliveries to LDPCSD would have been interrupted. Service to LDPCSD is interrupted when lake levels at McClure fall below the intake of the pumps that serve LDPCSD or Lake McClure falls below 115,000 acre-feet. Under the baseline conditions the hydrologic model estimates 7 years out of 93 years in in which there would have been at least 1 month that LDPCSD would experience interrupted deliveries (**Figure 4-4**). For example, the two-year period (1961 and 1962) of the drought in the early 1960's and a 5-year period (1988-1992) of the late 1980's drought. In general, service interruptions during those two periods occurred for 1 to 3 months.

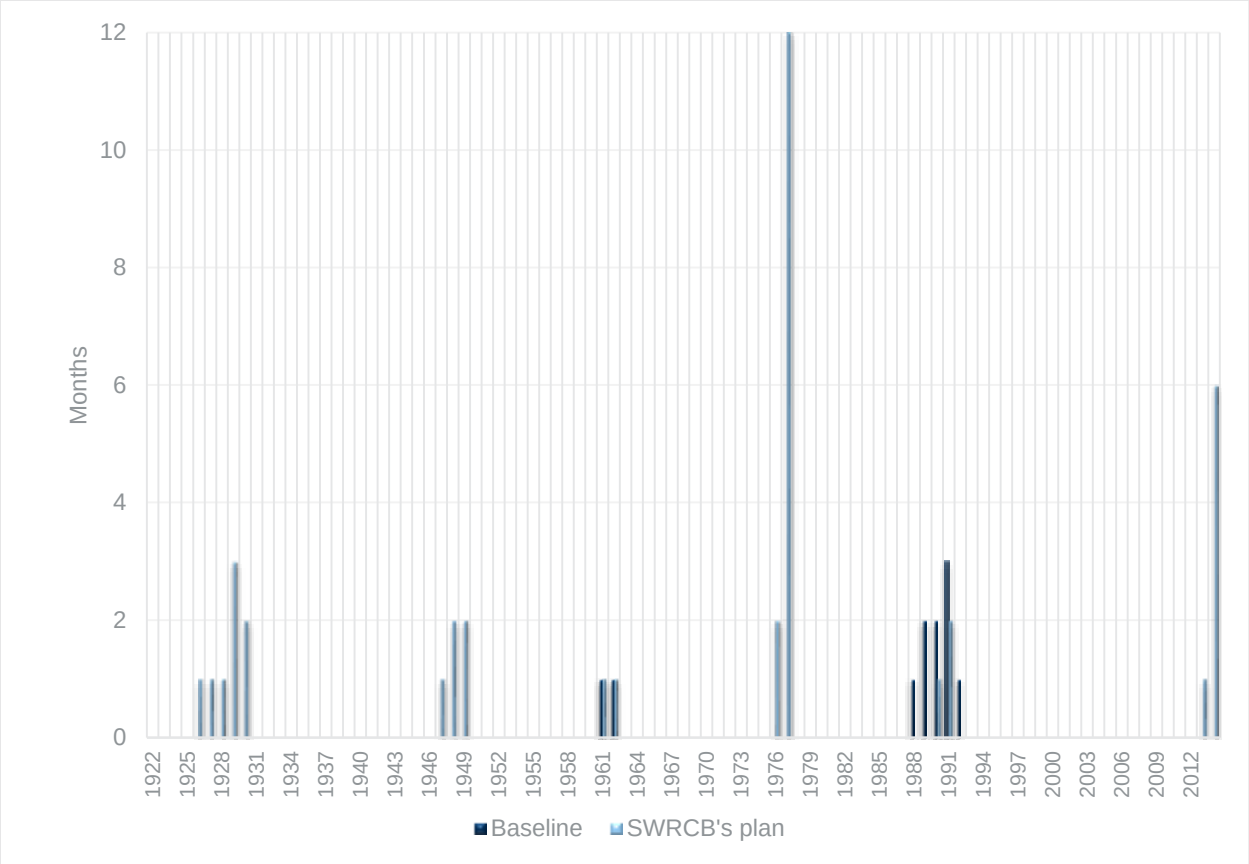



**Figure 4-4 Estimated Frequency of Interruptions in M&I Water Service to LDPCSD by Year and Number of Months per Year, Baseline versus SWRCB plan.**

Under the SWRCB's proposed plan the number of years in which there is at least a 1 month interruption in service increases from 7 years out of 93 to 15 years out of 93 years: a 5-year period from 1926 through 1930. A 3-year period from 1947 through 1949, the 2-year period from 1961 to 1962 (the same as the baseline), 2 years (1990 and 1991) during the late 1980-drought and two years during the current drought (2013 and 2014). In general the service interruptions occur between one and three months, except for 1977, when the hydrologic model estimated that the LDPCSD would experience interruption in service in all 12 months of the year (**Table 4-1**).

**Table 4-1 M&I Water Service Interruption Statistics by Water-Year Type**

| | Baseline | | | SWRCB Plan | | |
|---|---|---|---|---|---|---|
| **Water –Year Type** | **Number of Years** | **Average Number of Months Per Year** | **Total Number of Months** | **Number Of Years** | **Average Number of Months Per Year** | **Total Number of Months** |
| Wet | 0 | 0 | 0 | 0 | 0 | 0 |
| Above Normal | 0 | 0 | 0 | 1 | 1 | 1 |
| Below Normal | 1 | 1 | 1 | 4 | 1.5 | 6 |
| Dry | 0 | 0 | 0 | 2 | 1 | 2 |

**Table 4-1 M&I Water Service Interruption Statistics by Water-Year Type**

| Water –Year Type | Baseline | | | SWRCB Plan | | |
|---|---|---|---|---|---|---|
| | Number of Years | Average Number of Months Per Year | Total Number of Months | Number Of Years | Average Number of Months Per Year | Total Number of Months |
| Critical | 6 | 1.7 | 10 | 8 | 3 | 30 |
| Total | 7 | | 11 | 15 | | 39 |

Source: Bergfeld, L., 2015.

### 4.1.3 Hydro Power Generation

The hydrologic model estimates an annual average of 39,054 fewer MWh generated under the SWRCB's plan compared to baseline conditions (**Table 4-2**). The difference in power generation is greatest in dry and critical years by 50,484 MWh and 56,898 MWh, respectively. This information was used below to estimate the reduction in power and power revenue.

**Table 4-2 Annual Average Estimated Power Generation by Water-Year Type, Baseline versus SWRCB's Plan (MWh)**

| Water-Year Type | Baseline | SWRCB's Plan | Difference |
|---|---|---|---|
| Wet | 537,159 | 497,951 | -39,208 |
| Above Normal | 369,041 | 359,414 | -9,627 |
| Below Normal | 285,274 | 248,521 | -36,752 |
| Dry | 268,755 | 218,271 | -50,484 |
| Critical | 170,763 | 113,865 | -56,898 |
| Average | 346,424 | 307,370 | -39,054 |

Source: Bergfeld, L., 2015

## 4.2 Economic Models

The methodology used to estimate the value of impacts to reductions in surface water supply to agriculture and M&I uses as well as hydropower generation are discussed below. The impacts are both quantified, where possible, and qualified.

### 4.2.1 Agricultural Economy

Economic activity in the agricultural sector is described in three categories: (1) crop commodity production, (2) animal commodity production, and (3) crop and animal processing (**Figure 4-5**). These three categories comprise an ever increasing circle of economic activity. Crop production contributes to both animal production and crop processing, and animal production contributes directly to animal processing. As described in Chapter 2, Study Area, each of these three categories represents a relatively large portion of Merced County's total economy.

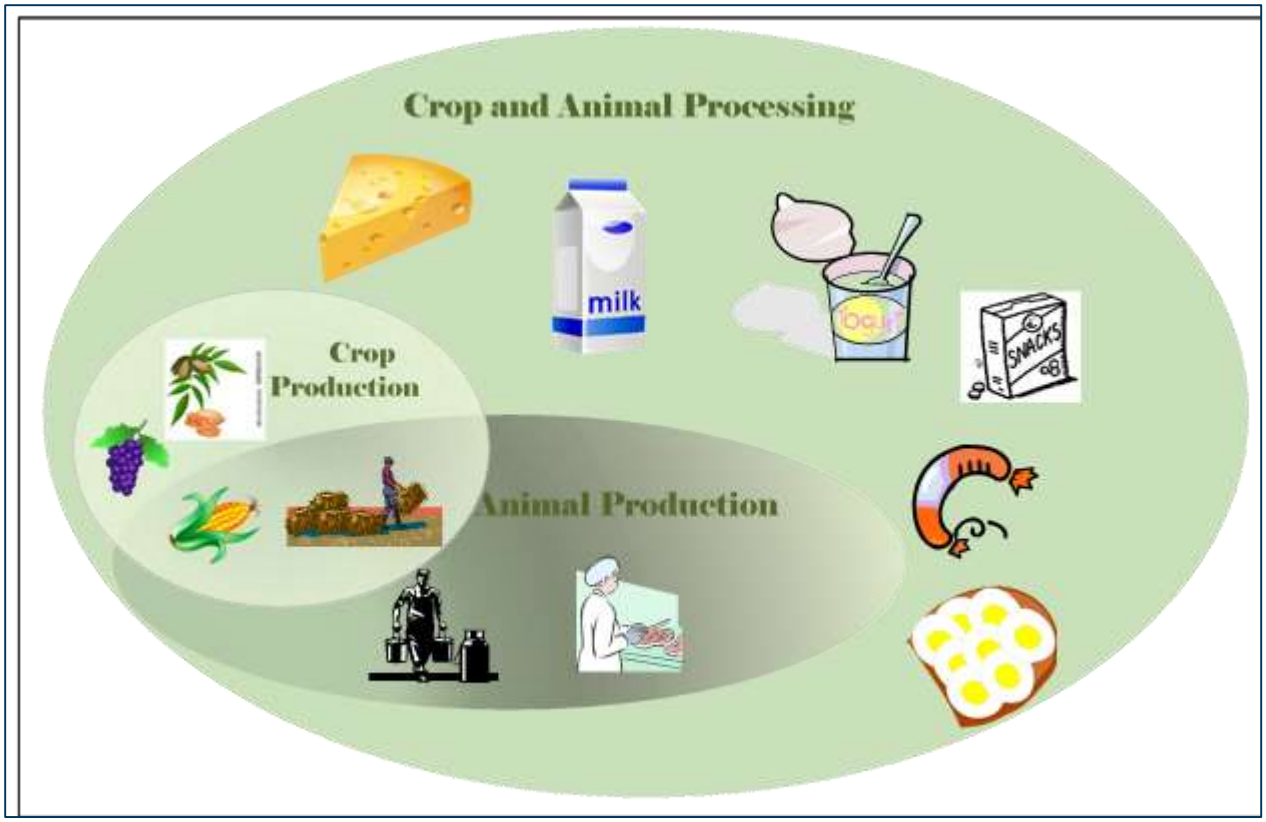



**Figure 4-5 Categories of Agricultural Economic Activity**

As was described in Chapter 2 and Chapter 3 above, crop production consists of crops grown for both human consumption (e.g., almonds and grapes) and for animal consumption (e.g., corn silage, alfalfa hay and irrigated pasture). The production value of milk and almonds consistently rank first and second on the top commodities list for both Merced County as well as the state. Additionally agricultural processors have invested heavily in facilities in Merced County, supported by the historically high reliability of processing inputs, both animal and crop products.

In addition to estimating impacts to the value of commodity production and processing output, potential impacts are also measured in changes in employment and labor income, as well as the induced regional economic impacts created throughout the county.

#### 4.2.1.1 Crop Production

The model selected to estimate impacts to crop production is based on the Statewide Agricultural Production (SWAP) model. SWAP simulates the decisions of farmers based on principles of economic optimization. The model assumes that farmers maximize profit given constraints on available production inputs (land, water, technology) and crop prices. The model selects those crops, water supplies, and irrigation technologies that maximize profit subject to resource constraints.

The SWAP model utilizes Positive Mathematical Programming (PMP), an agricultural production model that maximizes farm profits and employs a self-calibration method that matches the observed base data in a given year (Howitt 1995). The PMP methodology has been presented in several peer reviewed publications, including Howitt et al. (2010), Medellin-Azuara et al. (2010), and Medellin-

Azuare et al. (2012) Howitt, et al. (2008). SWAP has been used in the development of varied planning scenarios and studies, including support of the California Department of Water Resources' 2009 Water Plan Update (DWR 2009). SWAP was also used by the SWRCB when estimating impacts resulting from the SED.

Modifications were made to SWAP in order to accurately reflect the study area and grower's decision set. These modifications are summarized in the bulleted list below and described in detail in the text that follows, along with the data used for the model.

- Represented the crops and geographic regions that use water supplied by the Project
- Changed surface water prices to those established by MID
- Allowed water transfers between crops as established by MID's policy to facilitate in-district transfers
- Restricted the volume of groundwater pumping to historical levels, e.g. groundwater was not used to substitute for reduced surface water irrigation supply
- Restricted the annual reduction in acreage of animal feed-crops to a maximum of 50 percent.
- Modeled the reduction in fruit and nut production as a reduction in yield versus a reduction in acreage planted by utilizing deficit irrigation yield curves.

The model was modified to represent the crops and the geographic regions that use water supplied by the Project. Nearly 70 different crops have been grown with irrigation water suppled from the Project between 2008 and 2014 (MID 2015b). Because it is not feasible or efficient to model impacts for 70 separate crops, the individual crops were aggregated into 8 crop categories that represent the majority of crops grown with water supplied by the Project. **Table 4-3** lists the crops grown with Project water, the aggregate crop, crop type, (annual, perennial, and animal feed), and the UCCE study selected to provide production costs in the model. The crop aggregation for the group designated 'Other' was created to include several high-value crops that individually comprise 5 percent of total acres in the study area.

**Table 4-3 District-Level Crop Categorization and Cost and Return Studies Used for SWAP Calibration**

| Crops Grown with Project Surface water supply | Planning Model Assumptions | | |
|---|---|---|---|
| | Aggregate Crop | Crop Type | UCCE Study Crop |
| Alfalfa, sudan, alfalfa and alfalfa mixtures, grain and hay crops, hybrid sorghum/sudan | Alfalfa hay | Feed (dairy; cattle & calf) | Oat Hay |
| Corn silage, corn, grain/oats/rye | Corn silage | Feed (dairy; cattle & calf) | Silage |
| Cotton | Cotton | Field | Cotton |
| Apricots, cherries, citrus, figs, kiwi, mixed subtropical fruits, nectarines, olives, peaches, plums, pomegranate, prunes | Fruit | Tree | Peaches |
| Grapes, vineyards | Grapes | Vine | Grapes (wine) |

**Table 4-3 District-Level Crop Categorization and Cost and Return Studies Used for SWAP Calibration**

| Crops Grown with Project Surface water supply | Planning Model Assumptions | | |
|---|---|---|---|
| | Aggregate Crop | Crop Type | UCCE Study Crop |
| Clover pasture, forage, open/fallow, per-pasture, mixed pasture, native pasture, pasture | Irrigated pasture | Feed (dairy; cattle & calf) | NA |
| Almonds, mixed trees, pecans, pistachios, walnuts | Nuts | Perennial | Almonds |
| Artichokes, beans, berries, broccoli, bush berries, carrots, cauliflower, eggplant, eucalyptus, field crops, garden, lettuce, melons, miscellaneous, mixed vegetables, onion, outside district, peanuts, peas, peppers, safflower, squash, strawberries, sugar beets, taro root, truck, nursery and berry crops, unassigned, unknown, white potatoes | Other | Vegetable | Water-melon |
| Rice | Rice | Field | Rice |
| Sweet potatoes | Sweet potatoes | Vegetable | Sweet potatoes |
| Tomatoes, | Tomatoes | Vegetable | Tomatoes |

Sources: Crops reported by District: MID 2015b.
Cost and Yield Studies: University of California Cooperative Extension (UCCE) 2006; 2008a,b; 2010a; 2011a,b; 2012a,b.

Since the SWAP model is based on an assumption that growers maximize profits from their farms, revenue and cost are included as the basis for calculating profit for each crop. Gross revenue is calculated using crop prices and crop yields, both taken from the annual crop reports prepared by the Merced County Agricultural Commissioners (**Table 4-4**). Crop costs include three main categories: production supplies (e.g., seed, chemicals, and fertilizer), land, and labor. Crop costs are obtained from cost and return studies published by the UCCE (**Table 4-3**). Also obtained from these studies are estimated applied-water demands per acre for each crop.

SWAP's geographic area includes MID's service area, MID's sphere of influence, and Stevinson Irrigation District (**Table 4-4**). Class I water is served to users within MID's original service area and comprises 80 percent of the total 116,000 acres served. Since the early 1930s, MID has provided water to lands within the former El Nido Irrigation District (ENID), when surface water supplies were adequate. In 2004, the ENID's 9,000 acres was consolidated into the MID service area, and lands within the former ENID service area were classified as MID Class II users (MID 2013a). As part of the consolidation, it was agreed that Class II water users would be entitled to 50 percent of the surface water made available (acre-feet per acre) to Class I users, i.e., the MID service area prior to consolidation. In addition to water demands by MID users, MID delivers water to satisfy other entitlements, and for sale to irrigators located outside of the District. The entitlements include deliveries to Stevinson Water District (formerly Stevinson Corporation) and other users outside MID's service area.

**Table 4-4 Irrigated Crop Area, Water Use, and Value by Crop Category used in SWAP**

| Crop Category | Acres | | | | | | Water Use (acre-feet/ acre) | Gross Revenue ($/acre) |
|---|---|---|---|---|---|---|---|---|
| | MID Service Area | | Outside MID's Service Area (000s acres) | Stevinson Irrigation District (000s acres) | Number of Total Acres (000s acres) | Percent of Total Acres (percent) | | |
| | Class I (000s acres) | Class II (000s acres) | | | | | | |
| **Feed (Dairy; Cattle & Calf)** | **37** | **7** | **4** | **3** | **51** | **44%** | **NA** | **NA** |
| Alfalfa | 8 | 4 | 2 | 3 | 16 | 14% | 3.5 | $1,406 |
| Corn Silage | 20 | 3 | 2 | 0 | 25 | 21% | 3.3 | $1,103 |
| Irrigated Pasture | 10 | 0 | 0 | 0 | 10 | 9% | 2.5 | $655 |
| **Field Crops** | **4** | **0** | **0** | **0** | **5** | **4%** | **NA** | **NA** |
| Cotton | 2 | 0 | 0 | 0 | 3 | 3% | 3.5 | $1,582 |
| Rice | 2 | 0 | 0 | 0 | 2 | 2% | 4.5 | $1,914 |
| **Vegetables** | **14** | **1** | **1** | **0** | **15** | **13%** | **NA** | **NA** |
| Sweet Potatoes | 4 | 0 | 0 | 0 | 4 | 3% | 3.5 | $10,030 |
| Tomatoes | 5 | 0 | 0 | 0 | 5 | 4% | 4.5 | $3,515 |
| Other | 5 | 1 | 1 | 0 | 6 | 5% | 1.5 | $9,399 |
| **Perennials** | **38** | **1** | **5** | **1** | **45** | **39%** | **NA** | **NA** |
| Fruit | 3 | 0 | 0 | 0 | 3 | 3% | 5.0 | $7,010 |
| Grapes | 1 | 0 | 0 | 0 | 2 | 1% | 3.5 | $3,038 |
| Nuts | 34 | 1 | 5 | 1 | 40 | 34% | 2.5 | $3616 |
| **Total** | **93** | **9** | **10** | **4** | **116** | **100%** | **NA** | **NA** |
| **Percent of Total** | **80%** | **8%** | **9%** | **3%** | **100%** | **NA** | **NA** | **NA** |

Sources:
Crops reported by District: MID 2015b.
Water Use: University of California Cooperative Extension (UCCE) 2006; 2008a,b; 2010a, 2011a,b; 2012a,b.
Value: Merced Agricultural Commissioner, indexed average price from 2008 through 2013, average yield 2008-2013, multiple years.

**Table 4-5** shows the 2013 water prices used to calibrate the SWAP calibration year for the model. MID charged $24.00 per acre-foot in 2013 for all deliveries. In addition, MID managed a supplemental water supply pool program at a price of $73.25 per acre-foot. Surface water made available is summarized generally as follows:

- MID made surface water available to Class I and Class II growers. (Class II receives 50 percent of surface water made available to Class I, **Table 4-2**).
- MID authorized a supplemental water supply pool program. Water was made available from conjunctive groundwater pumping.

**Table 4-5 2012 Irrigation Rates and Allotments for MID**

| Category | Measure |
|---|---|
| In-District Water Price ($/acre-foot) | $24.00 |
| Tier price | NA |
| Surface Water Made Available (acre-feet per acre) | 2.4 |
| Supplemental Water Supply Pool Program | Available |
| Supplemental Water Supply Pool ($/acre-foot) | $73.25 |

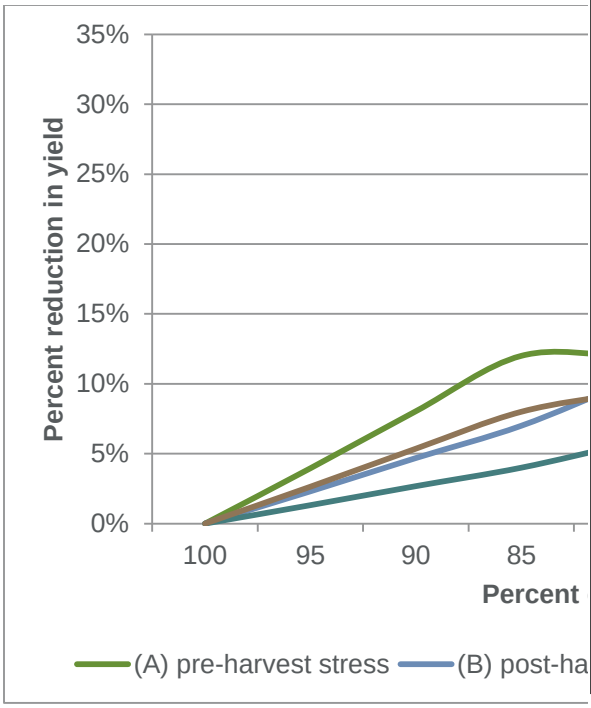
Sources: Merced Irrigation District 2015.

It was assumed that groundwater pumping would not be used to substitute for a reduction in surface water irrigation supply. This assumption was included to isolate the impact of a reduction in surface water diversions on crop production. Additionally, continued use of groundwater at historical extraction rates is less certain as the region works to implement the State's 2014 Sustainable Groundwater Management Act.

The maximum annual reduction in animal-feed crop acres was constrained to 50 percent of baseline acres. This assumption was made to provide a balance in the reduction of crop-type, assuming that not all of the corn silage, alfalfa hay and irrigated pasture would be eliminated in favor of the higher valued perennial and vegetable crops. Note, animal feed crops have a relatively low return compared to trees, vines and vegetables because the net revenue does not include the value contribution to milk and beef production.

The model was also modified to estimate the change in yield, rather than acres in production, for perennial crops. Because of the capital investment required to grow trees and vines growers do not respond to an annual reduction in available surface water supplies by reducing the number of acres in production. Rather, an annual deficit irrigation can be adopted to keep crops alive despite a reduction in yield from the practice. For the SWAP model deficit irrigation yield curves were developed for almonds, peaches and vines.

Although almond trees are considered drought tolerant (Fereres and Goldhamer 1990, Hutmacher et al. 1994, Torrecillas et al. 1996), there is no doubt that irrigation is critical to producing high yields of top quality nuts (Castel and Fereres 1982, Prichard et al. 1993; Nanos et al. 2002). Water stress can negatively affect both the primary yield components in almond: kernel size (Girona et al. 1993) and fruit load (Goldhamer and Smith 1995, Goldhamer and Viveros 2000, Esparza et al. 2001). **Figure 4-6** illustrates the results of a field trial that tested yield (measured as kernel yield) over a range of reductions in evapotranspiration (ET), as well as a range of delivery patterns (Goldhamer and Viveros 2006). The yield ranges between a 4 percent reduction when ET is 85 percent of full ET (under a uniform stress delivery pattern) up to a 29 percent reduction when ET is 55 percent of full ET (under a post-harvest delivery pattern). Currently SWAP's estimate of yield reduction is within the range of the Goldhamer study up to 80% reduction in water, beyond which the model overestimates the reduction in yield in any one year. However, what the field trials do not reflect is the reduction in the subsequent years' yield from a reduction in the ET. Because the SWRCB's proposed plan would reduce water availability in consecutive years (discussed in section 4.2) the SWAP yield estimates are thought to include this year-over-year impact on yield.



Source: University of California 2016

**Deep suture in nectarine caused by water stress.**

Source: 'Model' – refers to the SWAP model output. All other data from Goldhamer, D.A. 2006.

NOTE: The Goldhamer study estimated the yield response to a 85.0%, 70.0% and 55.0% change in crop ET. For exposition purposes, to compare the Goldhamer results to the SWAP estimates, the data presented in the graph include a liner extrapolation for the points in between the data available in Goldhamer.

**Figure 4-6 Percent Change in Almond Yield for Variations in Applied Water**

In a deep soil under flood irrigation, peach trees have been shown to survive and remain productive for four consecutive years with no irrigation between June and October (Larson et al. 1988, Johnson et al. 1994. However, water stress in late summer also interferes with flower bud development and can cause fruit defects the following year. Fruit doubles, deep sutures (see box below), split pits, and smaller fruit size can all result from water stress (Handley and Johnson 2000, Johnson and Phene 2008, University of California 2016). The modified SWAP model estimates a range of yield reductions between 6 percent and 40 percent in response to irrigation water reductions between 10 percent and 55 percent, respectively.

In the late 1990s, growers began adopting a practice called regulated deficit irrigation (RDI) on wine grapes. RDS means applying less than the full potential water requirement on vines with a drip irrigation system to achieve properly timed mild water stress. The results are improved wine quality and conservation of water and energy. For the purposes of the SWAP model we assume that grapes grown in with Project water are already being given the desired volume of water under the RDI practice, and reductions in irrigation supplies that could result from SWRCB's proposed plan go beyond the desired RDI levels.

The modified SWAP model estimates a range of yield reductions from 2 percent for a 90 percent irrigation water supply, and up to a 13 percent reduction in yield for a 60 percent irrigation water supply.

Like all models, there are limitations to SWAP. First, SWAP is a short-run model, estimating annual changes in cropping patterns based on an estimated annual change in irrigation water supplies. SWAP does not assume a structural change in the agriculture sector from long-term changes in irrigation surface water supply. Long-term responses to a reduction in average annual surface diversions or impacts to the highly reliable surface water supply could reduce growers', ranchers', and processors' investment in agriculture. For example, growers may reduce their acres of perennial crops (e.g., high-value almonds, peaches, and grapes). Ranchers may consolidate or reduce herd size, reducing the demand for feed crops. Processors may close plants or downsize facilities, reducing demand for some crops. SWAP does not estimate these types of long-term structural changes to the economy.

The second shortcoming relates to the estimate of a change in water delivery patterns on livestock operations. Livestock and/or their products, like milk, are not modeled explicitly in SWAP. The model estimates the change in acres of feed crops in response to a change in surface water supply but not the change in animal production that might result. Changes in livestock production will be estimated in a post-processing environment, discussed next.

#### 4.2.1.2 Animal Production

The challenge of estimating the response of livestock (dairy and cattle/calf) operations to a change in irrigation supplies is the diversity of livestock operations and the associated diversity of solutions available to respond to impacts of a reduction in the supply of feed crops due to a change in available irrigation supply.

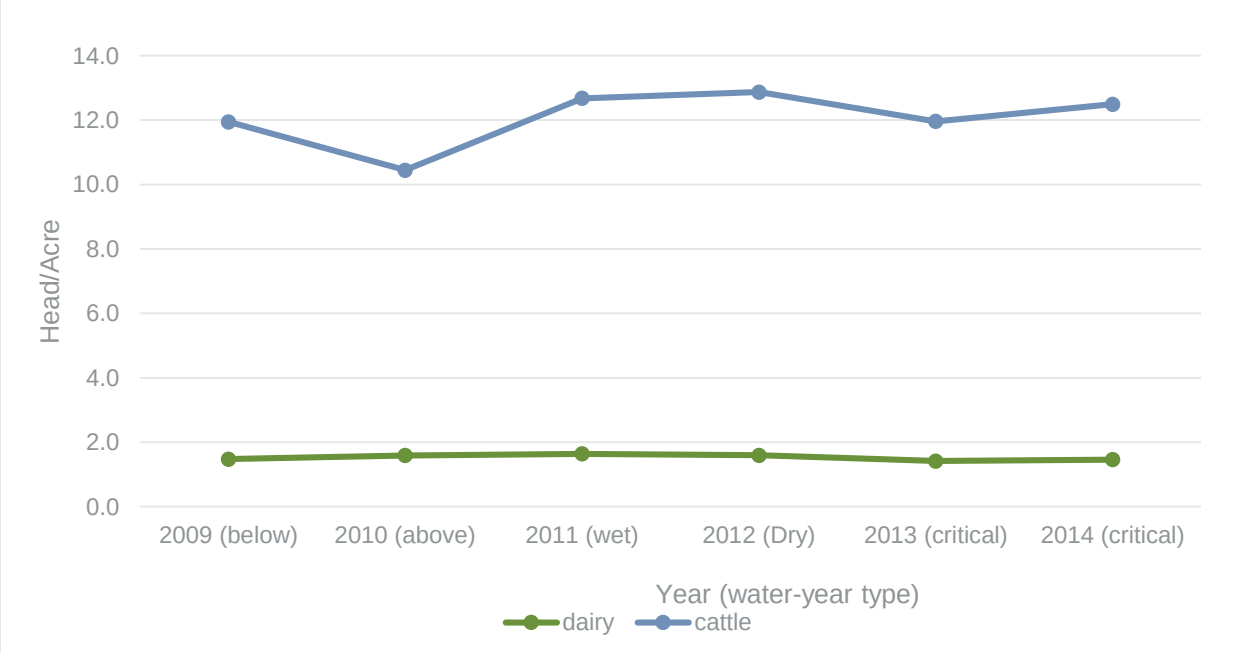
The economic model assumes, as rational economic agents, with the objective of maximizing profit, dairy farmers and ranchers respond to a change in locally grown feed supplies with the least cost (i.e., reduction in profit) solution. Solutions may increase cost, reduce revenue, or both. An operation's ability to respond can depend on several individual characteristics of the operation including the degree to which land and other capital is leveraged, reliance on purchased feed, current scale relative to the minimum efficient scale, and marketing and contractual commitments.

Livestock operations may have limited ability to find alternative sources of feed supply, particularly roughage, for two reasons: (1) the SWRCB proposal would reduce water supplies to not just MID, but agricultural areas throughout Merced, Tuolumne, and Stanislaus counties, with consequent widespread reductions in agricultural output throughout the local region and associated difficulty for processors in obtaining alternative inputs, and (2) throughout California, future groundwater management called for under the 2014 Sustainable Groundwater Management Act is likely to constrain groundwater pumping that might otherwise have been used to offset any reductions in production of animal feed in Merced, Tuolumne, and Stanislaus counties due to the SWRCB's proposed unimpaired flow requirement.

The relationship between local dairies' production of milk and the availability of silage and alfalfa hay underscores the importance of these crops, which are dependent on Project water supplies. Roughage accounts for approximately 40 percent of feed costs in the diet of dairy cows, while concentrates and byproducts account for 50 percent (CDFA 2012, Heguy 2013). Major components of roughage in the dairy feed ration include corn silage and alfalfa hay, each of which is grown with irrigation water supplied by the Project.

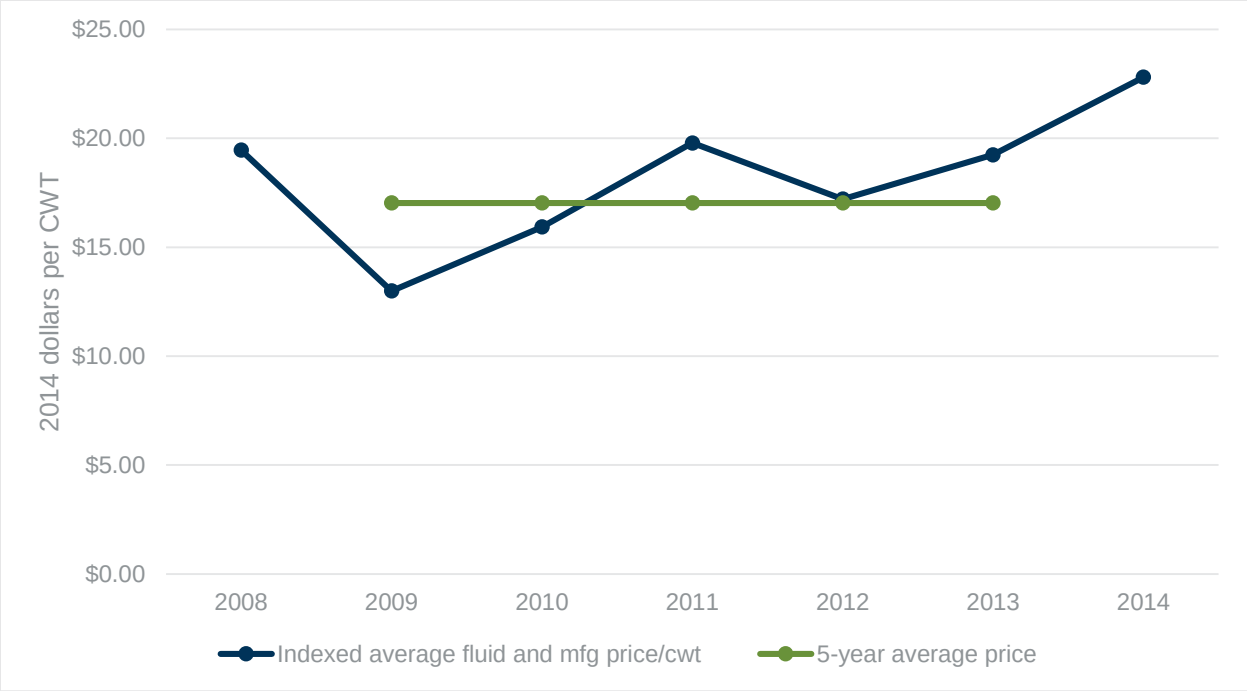
The estimated reduction in animal production (e.g., milk and beef) caused by a reduction in feed crops grown with Project water was modeled as a linear relationship between the number of acres of feed crops and the volume of animal production. The number of dairy cows per acre of corn silage and alfalfa grown in Merced County has been consistently close to 1.5 cows/acre (between 1.4 and 1.6 cows/acre) over the last 7 years (**Figure 4-7**). Tying the change in the value of milk production to a change in the availability of feed assumes that it is not economical to transport feed crops to replace the crops that could not be grown locally due to lack of irrigation water. This is a reasonable assumption given two facts: corn silage, one of the main components of roughage, is heavy and therefore expensive to transport, and as was mentioned the SWRCB-proposed reduction in irrigation supplies will impact growers throughout Stanislaus, Merced, San Joaquin, and Tuolumne counties, straining supplies of feed crops throughout the region.

Two ways to estimate the value of milk production per acre of roughage are: (1) calculate the annual average value of production per cow (average yield per cow (CDFA, 2014) times the average price of milk (Merced County, multiple years) and multiply the result by the number of cows/acre and the number of acres of corn silage the SWAP model estimates, and (2) multiply the Merced Agricultural Commissioner's annual estimate of milk production value by the percent of corn silage grown using Project water. Under the first method, the estimate of the value of milk production supported with crops grown from Project water is $5,881/acre. This assumed an annual milk yield per cow of 23,020 cwt [CDFA 2014], an average milk price of $17.03/cwt, and an average of 1.5 cows/acre (**Figure 4-8**). The second method yielded an estimate of the value of milk production supported by crops grown with Project water to be $3,617/acre. To be conservative, this report used the lower of the two values, $3,617/acre of corn silage grown. Therefore a one-acre reduction in corn silage would result in a $3,617 reduction in the value of milk production.




Source: Merced County Agricultural Commissioner's Annual Reports: 2009-2014

**Figure 4-7 Average Head per Acre of Feed Crop in Merced County**




Source: Merced County Agricultural Commissioner's Annual Reports: 2008-2014

**Figure 4-8 Average Price per Hundredweight (cwt) of Milk in Merced County (2014 dollars)**

A reduction in animal production could be the result of either reducing herd size or switching feeds, or a combination of both. Reducing herd size is an expensive option for a dairy operation as profits are sensitive to the scale of production. However, in cases of extreme drought this has happened; in Texas, for example, herd size fell 12 percent from 2011 to 2012 (Thibodeaux 2013). Operations could also be moved out of state. Several states have been enticing California dairies to move to their states (Daniels 2015). Finding substitute rations for dairy cows when high-quality roughage is not available can also be expensive. A dairy cow's diet is balanced to maximize milk production. Substituting other forms of roughage to maintain the size of the herd is possible; however, switching feed could have a negative impact on milk yield (Nennich n.d.]). For example, almond hulls and shells have been used for roughage. In 2014, the Merced County Agricultural Commissioner's Annual Report of Agriculture included for the first time a commodity called "almond hash."

With various options available to dairy farmers, it is not known how an individual operator would respond to a reduction in high-quality feed; however, the end result of the operator's response is likely to be a reduction in milk production.

In cattle and calf operations the number of head per acre of irrigated pasture has been constantly around 12 head/acre, except in 2010 when it dipped to 10 head/acre (**Figure 4**-7). Assuming an annual yield per cow of 8.5 cwt and an average price of $97.36/cwt (Merced County Agriculture Commission, multiple years), a one-acre reduction in irrigated pasture would result in a $9,931 reduction in the value of beef production.

As with dairy cows, beef cattle operations face the same options about feeding a herd when high-quality pasture is not available (Thibodeaux 2013). A regional reduction in irrigation supply, with

competition for available supply from high-value trees and vines, may drive feed prices up and may have an impact on the yield of beef producers.

#### 4.2.1.3 Crop and Animal Processing

There are several large food processing industries in Merced County that rely on local crop and animal output as inputs to the manufacturing process (see Attachment A for more detail). Crop processing is estimated in the following sectors: (1) wineries, (2) vegetable canning (primarily tomatoes), (3) frozen fruit processing (primarily peaches), and (4) nut drying and roasting (primarily almonds). Animal processing is estimated in the following industries: (1) Slaughtering (beef cattle), (2) meat processing, (3) cheese and (4) fluid milk (**Table 4-6**).

The contribution that each crop makes to the food and beverage processing sectors was first estimated using the proportion and dollar value of local crop production that is processed locally in these sectors, and then estimating the value of processing output per dollar of crop input. Both steps draw from the following data sources:

- IMPLAN data on local, within-county purchasing relationships and processing industry production relationships,
- Total value of local crop production,
- Total demand for crop from each processing sector, and
- Availability of crop production in other areas and feasibility of shipping to Merced County,
- Interviews with growers, processors, and extension agents.

For example, approximately 90 percent of peaches grown locally are processed locally, primarily in the frozen foods sector. So, for every $1 million of peach gross crop value approximately $900,000 is purchased by the frozen foods industry. For every dollar of peach crop purchased, the value produced by the frozen foods industry is estimated at $2.78. In other words, the frozen foods sector converts the $900,000 in fruit crop purchases to approximately $2.5 million of frozen product ($900,000 multiplied by $2.78 is $2.5 million).

**Table 4-6 Estimated Merced County Crop and Food Processing Sector Relationships: Forward Linkage Analysis.**

| Agricultural Commodity | IMPLAN Processing Sector | Crop Production Processed in County (%) | Processed Product Value Per Dollar of Crop Input |
|---|---|---|---|
| Peaches | 79-Frozen Foods | 90% | $2.78 |
| Processing Tomatoes | 81-Canned Foods | 50% | $2.29 |
| Wine Grapes | 109-Wineries | 5%[1] | $4.00 |
| Nuts | 99-Roasted Nuts/Butter | 8% | $2.22 |
| Beef Cattle | 89-Animal Slaughtering | 8% | $1.42 |
| Beef Cattle | 90-Meat Processing | 5% | $2.55 |
| Dairy Milk | 86-Cheese Manufacturing | 31% | $1.62 |
| Dairy Milk | 84-Fluid Milk Manufacturing | 3% | $2.04 |

Notes:
Totals may not sum due to rounding.
This figure is highly conservative due to lack of available information and the global nature of the wine juice market.
Source: Highland Economics analysis.

The estimated baseline value of the commodities that are processed locally is $92.4 million in all water year types but a critical year (**Table 4-7)**. In a critical year the value of crop commodities processed locally declines to $63.3 million. The value of the processing of these commodities is $180.3 million in all water year types but critical and $130.2 million in critical years.

**Table 4-7 Baseline Value of Commodities Grown with Project Water and Processed in Merced County, by Water-Year Type: Forward Linkage Analysis (2014 $ millions)**

| Agricultural Commodity | IMPLAN Processing Sector | District Crop Output Purchased by Processing Sector | | Processing Sector Output Reliant on District Crop Production | |
|---|---|---|---|---|---|
| | | 100% (W, AN, BN, D) | 75% (C) | 100% (W, AN, BN, D) | 75% (C) |
| Peaches | Frozen Foods | $13.3[1] | $13.0 | $36.9 | $36.3 |
| Processing Tomatoes | Canned Foods | $4.2[2] | $4.0 | $9.6 | $9.2 |
| Wine Grapes | Wineries | $0.3 | $0.3 | $1.2 | $1.1 |
| Nuts | Roasted nuts/butter | $11.3 | $10.5 | $25.1 | $23.4 |
| *Crop Subtotal* | | *$29.1* | *$27.8* | *$72.8* | *$70.0* |
| Beef Cattle | Slaughtering | $8.2 | $4.2 | $11.6 | $5.9 |
| Beef Cattle | Meat Processing | $5.1 | $2.6 | $13.0 | $6.6 |
| Dairy Milk | Cheese | $45.6 | $26.2 | $73.9 | $42.5 |
| Dairy Milk | Fluid Milk | $4.4 | $2.5 | $9.0 | $5.2 |
| *Animal Product Subtotal* | | *$63.3* | *$35.5* | *$107.5* | *$60.2* |
| Total | | $92.4 | $63.3 | $180.3 | $130.2 |

Notes:
1. Totals may not sum due to rounding.
2. Only about 70 percent of the estimated crop production value categorized as "fruit" in the SWAP model are peaches. The remaining 30 percent is comprised of prunes, figs, plums, kiwi, and nectarines,
3. Only about half of total tomato production is processing tomatoes, or approximately $8.4 million of farmgate value in noncritical water-years from Merced Irrigation District (based on 2013 and 2012 Merced County Agricultural Commissioner reports).Of this amount, we estimate that approximately 50 percent, or $4.2 million, is purchased by the local canned food processing sector to make tomato paste and other products.

Water-year types: W = wet, AN = above normal, BN = below normal, D = dry, C = critical
Source: Highland Economics analysis.

In all water year types except critical years, the value of *crop commodities* grown with Project water that are processed locally is estimated to be 8.4 percent of the annual value of baseline crop commodities, or $29.1 million (**Table 4-7**). The remaining agricultural output of $318.8 million is assumed to be exported, consumed locally in raw form, or used in other industries. In critical years

$27.8 million (9 percent) of crop commodity output is processed locally. Crop processing is estimated to be $72.8 million in all years but critical years, when processing revenue declines to $70.0 million.

In addition, beef and dairy outputs from animal production reliant on crops grown with Project water are also processed locally. In all water-year types except critical years, an estimated 25 percent of animal product output, or $63.3 million, is used in these animal product processing sectors (**Table 4-7**). Creating $107.5 million in animal processing revenue. In critical years the estimated value of animal production that is processed locally declines to $35.5 million (a 44 percent decline from all other years) due to the decline in animal feed crops that is projected to occur in critically dry years.

IMPLAN data for 2013 (the most recent available) for Merced County was used to estimate these changes in agricultural processing on the county economy. IMPLAN is a widely-used and accepted regional economic modeling system that can measure the effect of projects, programs, and/or policies on local economic conditions. The primary advantages of IMPLAN include a comprehensive underlying dataset, opportunities for customization, robust multipliers based on a complete set of social accounts, and detailed trade-flow data that allow for multiregional analysis.

Further, although the IMPLAN model is designed to measure effects associated with backward linkages, the base data can be used to estimate effects on forward-linked sectors in the economy.

The IMPLAN model and data were customized to best reflect conditions in Merced County. Specifically, matching the level of agricultural sector output to the values in the Merced County crop reports, and then modifying the data for the crop production sectors to match local production relationships (i.e., levels of net profit, labor income and employment, and spending on custom farm work). Based on interviews with local food processors, the IMPLAN default data on the production relationships were also modified for wineries, frozen food manufacturing, fruit and vegetable canning, fluid milk manufacturing, cheese manufacturing, animal slaughtering, and meat processing.

Since the production functions for these forward-linked industries account for the purchase of local inputs (i.e., crops, cattle and dairy products), it is necessary to modify the IMPLAN model prior to analyzing the final demand for these forward-linked sectors. These changes are to avoid calculating twice the economic benefits of crop, cattle and dairy production that are used as inputs to forward-linked sectors, which would result in double-counting of benefits. To accomplish this, the IMPLAN model was modified so that the forward-linked sectors dependent on crop (cattle and dairy) are assumed to make no purchases of local crops (cattle and dairy).[4] Through this process, double counting the production value as both a direct and indirect impact is avoided.

[4] This is done by changing the model parameters measuring the purchases of local products to zero.

#### 4.2.1.4 Regional Economic Impact Analysis

The regional economic impact analysis is based on the principles of input-output analysis (I-O) implemented using the IMPLAN regional economic model, the same model used to estimate the forward linkages in the processing sector. This framework measures the flow of commodities and services among industries, institutions, and final consumers within the economy being evaluated. I-O models capture all market transactions related to the demands for goods and services, accounting for interindustry linkages and availability of regionally produced goods and services. For example, each industry not only produces its own goods and services, but also purchases goods and services for use as inputs to its own production process. To the extent that these inputs to production are purchased locally, economic benefits are generated. Regional I-O analysis is based on a standardized accounting framework that is modified to reflect regional characteristics defining industry production processes and household spending patterns.

Using this framework, I-O models estimate the total economic effects within an economy. Total economic effects are often expressed in terms of economic multipliers, which state the total economic effect across all industries within an economy relative to the direct effect in any one industry. Multipliers are calculated based on the ratio of the total economic activity relative to direct effects. For example, an income multiplier of 2.0 for the vegetable farming industry indicates that $1 million in vegetable income supports a total of $2 million in income throughout the regional economy, including the initial $1 million in the farm production sector. The size of the multiplier depends on the types and magnitudes of linkages in the local economy. The stronger the local interindustry dependence, i.e., the more one industry purchases its inputs from another local industry (rather than purchasing from a non-local supplier), the larger the multiplier. Multipliers are larger for bigger, more complex economies that provide a diverse array of products and services to meet local demand.

As described in 4.2.1.3, IMPLAN data for 2013 (the most recent available) for Merced County was used to model effects of changes in agricultural production on the county economy.

The total economic impact, or economic contribution, of an economic activity represents the sum of direct, indirect, and induced effects, defined below.

- **Direct effects.** Initial impacts of the economic activity or change in the sector being analyzed. For example, the jobs and income generated from total agricultural production and processing value.
- **Indirect effects.** Impacts resulting from industries purchasing from other industries in order to satisfy the demand generated in the directly affected industry (such as agriculture). For example, indirect effects are generated in the truck transportation industry due to demand for shipping agricultural inputs and products. The truck transportation industry then increases its demand for such inputs as fuel and labor, which in turn are also indirect effects.
- **Induced effects.** Impacts resulting from increased expenditures by households employed by directly and indirectly affected economic sectors. For example, induced effects are generated when a farm laborer spends his or her income at a retail store. Income at the indirectly affected retail store thus also rises, and additional induced effects are generated when the

retail store owners and workers spend their income on other goods and services in the local economy.

As noted above, the analysis is limited to the total economic impacts to Merced County, though there are also economic benefits of the Merced River Hydroelectric Project to other California counties. Merced farms purchase inputs from outside the county, supporting local businesses elsewhere, and food processors from outside Merced County rely on crop production from Merced farms. Furthermore, farm and food production workers whose income depends on the Project purchase goods and services produced in other counties, thereby supporting economic activity elsewhere.

Agricultural economic activity supported by the Project stems from the initial, direct value of crop production (gross revenue or farmgate value) dependent on irrigation water. The crop production value across different crop categories under baseline conditions was estimated in SWAP (refer to Section 4.2.1.1, Crop Production, for additional details), and are presented in **Table 4-8** by IMPLAN sector. In total, SWAP estimates the annual gross value of irrigated crop production grown with water supplied by the Project was $347.9 million in most water year types (wet, above normal, below normal, and dry), and $310.2 million in critical water-years.

**Table 4-8 Baseline Crop Gross Revenues (2014 $ millions)**

| | Gross Revenues by Water-Year Type | | |
|---|---|---|---|
| **IMPLAN Sector** | **100% (W, AN, BN, D)** | **75% (C)** | **SWAP Crop Group** |
| 2-Grain farming | $31.4 | $15.8 | corn silage, rice |
| 3-Vegetable and melon farming | $57.7 | $56.9 | tomato, sweet potato |
| 4-Fruit farming | $27.1 | $26.6 | fruit, grapes |
| 5-Tree nut farming | $141.6 | $131.7 | nut |
| 8-Cotton farming | $4.6 | $3.6 | cotton |
| 10-All other crop farming | $85.4 | $75.6 | alfalfa hay, irrigated pasture, other |
| Total | $347.9 | $310.2 | N/A |

Water-year types: W = wet, AN = above normal, BN = below normal, D = dry, C = critical

Source: Cardno (based on SWAP modelling), aggregation by Highland Economics. Totals may not sum due to rounding.

The estimated baseline conditions for Animal Production are presented in **Table 4-9**. In total, an estimated 249.2 million of animal production was supported by feed crops grown with water supplied by the Project in most water year types (wet, above normal, below normal, and dry), and $136.6 million in critical water-years.

**Table 4-9 Baseline Animal Production Gross Revenues (2014 $ millions)[1,2]**

| | Gross Revenues by Water Year Type | |
|---|---|---|
| **IMPLAN Sector** | **100% (W, AN, BN, D)** | **75% (C)** |
| 11-Cattle Ranching and Farming | $101.9 | $84.6 |

| IMPLAN Sector | Gross Revenues by Water Year Type | |
|---|---|---|
| | 100% (W, AN, BN, D) | 75% (C) |
| 12-Dairy Cattle and Milk Production | $147.2 | $52.0 |
| Total | $249.2 | $136.6 |

Note: Totals may not sum due to rounding.
Water-year types: W = wet, AN = above normal, BN = below normal, D = dry, C = critical
Source: Cardno.

IMPLAN analysis has some limitations, many of which are attributable to the I-O methodology. In general, these limitations can lead to an overestimate of the long-term impacts of small economic changes, but may also lead to underestimates of long-term impacts of big economic changes. The biggest limitation pertinent to our study is that IMPLAN uses fixed, proportional relationships, with the result that it predicts the same incremental income and employment impact for every $1 change in industry output. In reality, impacts may be larger or smaller than estimated by the model, depending on the size of the change and the response by businesses. For example, IMPLAN estimates may overstate job impacts if employers reduce employee hours but not jobs, or if people who lose a job in agriculture are able to easily transition and start a new position. Conversely, IMPLAN estimates may understate job and income impacts if output changes are large and result in business closures and/or relocations. Key limitations of the IMPLAN model, and steps taken to minimize effects of these limitations on the analysis, are described in more detail in Appendix A.

Below is a summary of the key limitations:

- Fixed Proportions. For any good or service, all productive inputs are combined in fixed proportions that are constant regardless of the level of output. Hence, there is no substitution among production inputs and no economies of scale are possible.
- Fixed Technology. Each production function incorporates fixed technology; thus, for example, the same proportions of labor and capital are used. If an industry is undergoing rapid technological change, this rigidity may under or overestimate impacts for any industry. This concern is offset in part by the slow, gradual technological changes that are typical in many sectors of the economy.
- Constant Prices. Regardless of the level of production, it is assumed that price and returns per unit of production are constant. An investigator wishing to analyze price impacts must do so outside of the I-O framework.
- Fixed Employment of Resources. I-O assumes that resources that become unemployed or employed due to a change in final demand have no alternative employment.
- Aggregation of Economic Activities. I-O models are organized by industry sector. The IMPLAN database contains 440 economic sectors nationwide. While this is a large number of sectors, some sectors contain a wide range of products or services and the production functions reflect the average or aggregate production technology for the goods or services

produced. There are 10 crop production sectors in IMPLAN. Each sector includes an average production function for the crops included in that sector.

- Issues of Geographic Scale. The IMPLAN database is developed from national, state, and county level data sets, with the national level used as a control. A proven, reliable disaggregation procedure is used to ensure that the state data sets add up to the national totals, and that the county data sets add up to their respective state totals. There are occasional instances where apparent anomalies occur, particularly in counties with very small economies and particularly with very small sectors within these counties.
- No Direct Accounting of Forward-Linkages. IMPLAN software is designed to measure the total multiplier effects of a change in output (final demand) in the industry under study from changes in demand for labor and goods and services it utilizes as inputs (i.e., backward linkages). IMPLAN software is not designed to directly measure multiplier effects of the same change in output on industries purchasing the targeted industry's output, such as food processing in the case of crop production. Resulting changes in final demand in the forward linked industries must be computed outside of IMPLAN and then re-input as a direct change in output (final demand) of the forward-linked industry.

### 4.2.2 Municipal and Industrial Impacts

The impact of the SWRCB's plan to the volume of groundwater that MID is recharging has not been estimated; therefore, the valuation of the impact has not been estimated. The impact of the SWRCB's plan on the ability of the LDPCSD to withdraw water from Lake McClure was estimated by calculating the additional power costs required to pump groundwater to replace surface water when lake elevations are too low for LDPCSD's pumps to operate. The cost of assuming that LDPCSD is investing in groundwater wells to provide emergency water supply.[5]

To understand the full costs associated with groundwater pumping, the capital costs associated with well construction as well as the additional power costs of pumping must be considered. The cost of a typical municipal groundwater well in the City of Modesto, with a yield of 1,500 GPM (or 2,420 acre-feet per year) is estimated at approximately $2 million (Bond 2013). The annualized value over 30 years at a six percent interest rate is $143,300. Based on these figures, the capital costs for groundwater wells is about $60.05 per acre-foot per year for the City of Modesto. The LDPCSD's water demand averages 600 acre-feet annually, which is 25 percent of the yield from the City of Modesto's example. The capital costs that LDPCSD is paying to develop emergency groundwater supply would likely be less than the costs in the City of Modesto example however at the same time the costs are amortized over a smaller yield. Therefore the $60.50 per acre-foot is a reasonable proxy for the amortized cost of capital for construction of emergency groundwater wells.

[5] On April 16, 2015, the LDPCSD published a Drought and Emergency Water Supply Information Update, stating they were working on plans to increase supply reliability to replace the surface water from Lake McClure. Plans include investing in groundwater wells with the assistance of $462,000 in grant funds from the State of California (LDPCSD 2016b).

The electricity costs for pumping groundwater for the City of Modesto in 2012 was $67.81per acre-foot (Peterson-Brustad, Inc. 2012). Accounting for both capital and operating costs, groundwater costs are an estimated $127.86 per acre-foot. The model assumes that this cost of pumping groundwater will be incurred during the months which surface water supply to LDPCSD's supply is interrupted (**Table 4-1**). The average monthly volume is 50 acre-feet, making the impact in any one month $6,393.

### 4.2.3 Power Impacts

A spreadsheet model was used to estimate the reduction in direct economic benefit of power generation as a result of SWRCB's plan. The model calculated the reduction in profit by multiplying the reduction in power generation (**Table 4-2**) by an annual estimate of dollars per kWh (**Table 3-9**).

The IMPLAN model was used to estimate the indirect and induced effects of the change in power revenue, plus the number of direct jobs and labor income. Note that the number of jobs was assumed to remain constant, even when power generation was reduced because the number of MID employees at the power station is not dependent on production volume. Estimated impacts to jobs occur in the indirect and induces categories.

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# 5 POTENTIAL ECONOMIC IMPACTS OF REDUCED PROJECT WATER SUPPLIES

Under the SWRCB's SED, water availability to the Project, measured as a difference in canal deliveries relative to baseline, declines in below normal, dry, and critical water-year types, which collectively occur an average of every other year (53 percent of years). Reduction in canal deliveries range from 15 percent in below normal years, to 25 percent in dry years (**Table 5-1**).

The reduction in available water supplies reduces agricultural and hydropower output, jobs, and labor income below baseline in every water-year type (**Table 5-1**). Impacts are greatest in below normal, dry and critical water-year types. Total estimated annual output losses range between $1 million (in wet water-year types) to $234 million (in dry years). Full- and part-time jobs would not be impacted in wet and above normal water-year types. However, in all other water-year types the annual number of jobs lost is estimated to range between 587 and 970, with the subsequent reduction in labor income ranging between $37 million and $59 million.

**Table 5-1 Estimated Regional Economic Policy Impacts to Agriculture and Power by Water-Year Type (2014 $ millions)**

| Impact Category | Unit of Measure | Water Year Type (Percent of Years Impacted) | | | | |
|---|---|---|---|---|---|---|
| | | Wet (29%) | Above Normal (18%) | Below Normal (15%) | Dry (16%) | Critical (22%) |
| **Total** | | | | | | |
| Canal diversions | Percent of baseline | 0% | 0% | -15% | -25% | -20% |
| Output | $000,000s | -$1 | $0 | -$129 | -$234 | -$151 |
| Employment | Full and part-time jobs | 0 | 0 | -587 | -970 | -855 |
| Labor Income | $000,000s | $0 | $0 | -$37 | -$59 | -$43 |
| **Agriculture** | | | | | | |
| Output | $000,000s | $0 | $0 | -$127 | -$231 | -$147 |
| Employment | Full and part-time jobs | 0 | 0 | -587 | -970 | -855 |
| Labor Income | $000,000s | $0 | $0 | -$37 | -$59 | -$43 |
| **Hydropower** | | | | | | |
| Power | GWh | -39 | -9 | -37 | -50 | -57 |
| Output | $000,000s | -$1 | $0 | -$2 | -$3 | -$4 |
| Employment | Full and part-time jobs | 0 | 0 | 0 | 0 | 0 |
| Labor Income | $000,000s | $0 | $0 | $0 | $0 | $0 |

Source: Cardno

Estimated losses are highest in the agricultural industry, which is impacted in below normal, dry, and critical water-year types. The estimated annual impacts range from a $127 million output loss (in below normal water-year types, or 15 percent of years) to a $231 million loss (in dry water-year types, or 16 percent of the years). The resulting reduction in full- and part-time agricultural jobs ranges between 587 and 970, with the annual reduction in labor income estimated to range between $37 million and $59 million.

Hydropower generation would decline between 9 GWh (above normal years) to 57 GWh (in critical years). Hydropower revenue, impacted in every water-year type, would decline between $1 million (wet water-year types) and $4 million (critical water-year types). Jobs are not expected to be reduced due to changes in hydropower operations.

Impacts to M&I water supply would occur in two ways: a reduction in groundwater recharge and an increase in the cost of M&I water from LDPCSD. Under SWRCB's plan the number of years that LDPCSD would experience an interruption in service due to low McClure Lake levels would double, from 1 in 13 years to 1 in 6 years. The number of months a service interruption would occur would triple. During service interruptions, LDPCSD is expected to pump groundwater from wells that are currently being installed to meet service interruptions caused by the 4-year drought. The total additional annual average cost of pumping groundwater rather than surface water is estimated to be modest, just over an average of $900 per year. The change in groundwater recharge due to the SWRCB's plan was not estimated.

Each of these impacts is described below in detail.

## 5.1 Irrigated Agriculture

Agricultural output declines relative to baseline in below normal, dry, and critical water-year types. The total economic impact of the SED is particularly pronounced in dry water-year types (38 percent of years). Although critical water-years have the lowest surface water supply, the baseline for critical water-year types is lower than the baseline for dry water-year types therefore the impact compared to baseline is not as great as in a dry year.

In below normal, dry and critical water-year types, total economic output supported by the Project declines an estimated **$127 million, $231 million and $147 million**, respectively, compared to baseline conditions (**Figure 5-1**). Combining the probability of occurrence: 15 percent for an above normal year, 16 percent of a dry year and 22 percent for a critical year, an annual impact of between $127 million and $231 million is estimated to occur 53 percent of the time under the SWRCB's SED. The animal production commodities are estimated to decline more rapidly than the crop production of high valued nuts, fruits and vegetables. However eventually, under a critical year, the decline in output impacts all types of commodities.

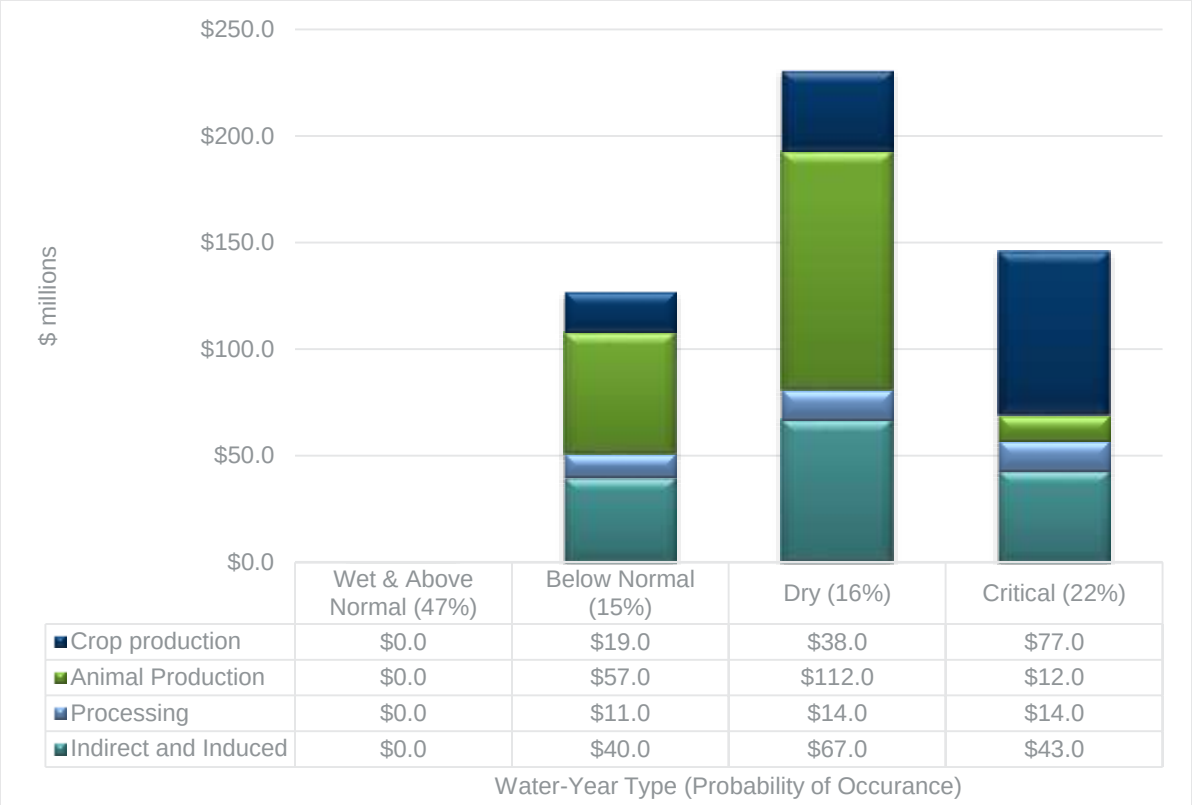


**Figure 5-1 Impact of the SWRCB's SED on Regional Economic Agricultural Output by Water-Year Type, 2014 $ millions**

As a percent of output under full water deliveries, estimated impacts are slightly less than the percent reduction in canal deliveries in nearly every year. For example, in a below normal year canal deliveries are estimated to be 85 percent of full canal deliveries and economic output is estimated to be 87 percent of output when irrigation demands are fully met (**Figure 5-2**). This result occurs based on the assumption that scarce irrigation supplies would be voluntarily transferred to high value nut and fruit trees, vines and vegetables.

Details of estimated direct impacts to the output of crop production, animal production and processing are described below. This chapter concludes with a description of the regional economic impacts, e.g. indirect and induced impacts as well as estimates of full- and part-time jobs and labor income supported by agricultural production and processing.

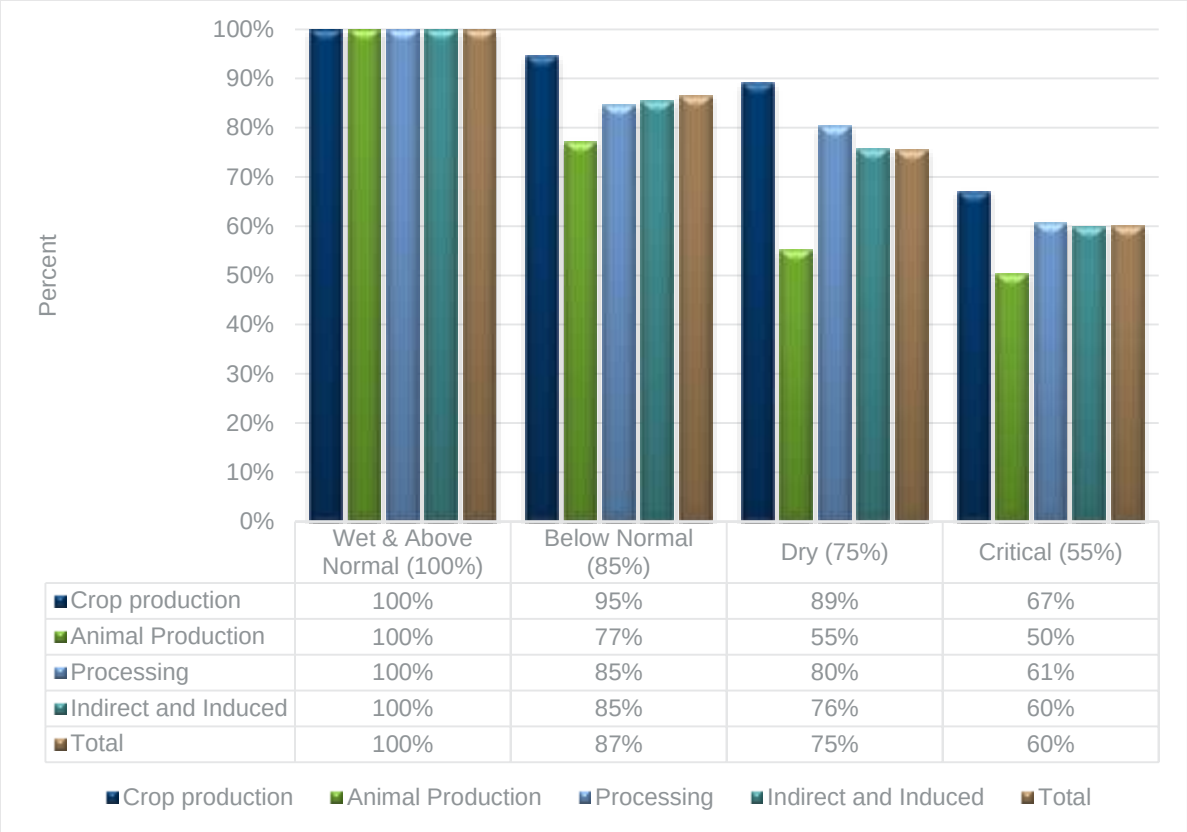


**Figure 5-2 Percent Change in Agricultural Output Caused by the SWRCB's SED by Water-Year Type**

### 5.1.1 Direct Agricultural Impacts

Direct impacts, measured in terms of the output value of crop and animal commodities and local processing of those commodities is described below.

#### 5.1.1.1 Crop Production

Policy impacts of the SWRCB plan to crop commodity production by water-year type are shown in **Table 5-2**. In below normal water-year types (15 percent of years) the estimated canal deliveries are 85 percent of baseline (shown in **Table 5-3** as 100% to 85%). This 15 percent reduction in canal deliveries causes a 5 percent reduction in the total value of crop production. The higher valued crops; vegetables, trees and grapes are minimally impacted, reflecting the voluntary transfer of irrigation water into production of these crops and away from the production of lower valued crops like animal feed and field crops. Animal feed and field crops are estimated to have a 27 percent and 12 percent decline below baseline, respectively.

In dry water-year types (16 percent of years) the estimated canal deliveries are 75 percent of baseline (shown in **Table 5-3** as 100% to 75%). This 25 percent reduction in canal deliveries results in a $38 million decline in production revenue, or 11 percent of baseline. Output of the higher valued crops—vegetables, trees, and grapes—decline by 2 percent, 6 percent, and 3 percent of baseline, respectively. Animal feed is estimated to decline $24 million to 41 percent of baseline. Field crops decline by $4 million to 34 percent of baseline. Also, when canal deliveries are 25 percent of

baseline, the model constraint that sets the maximum limit on crop reduction at 50 percent of baseline (see Section 4, Study Methodology) binds for both corn silage and rice.

**Table 5-2 Estimated Change in Annual Gross Crop Output by Water-Year Type**

| Crop Type<br>Crop | Policy Impact By Water-Year Type (% change from baseline canal deliveries) | | | | Percent Change from Baseline Canal Deliveries | | |
|---|---|---|---|---|---|---|---|
| | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Critical (-20%)(a) | Below Normal | Dry | Critical |
| | | ($ millions) | ($ millions) | ($ millions) | (%) | (%) | (%) |
| **Animal Feed** | No Impact | **-$15** | **-$24** | **-$4** | **-27%** | **-41%** | **-13%** |
| Alfalfa Hay | | -$1 | -$7 | -$4 | -7% | -30% | -26% |
| Corn Silage | | -$13 | -$14 | $0 | -49% | -50% | 0% |
| Irrigated Pasture | | -$1 | -$3 | $0 | -9% | -46% | -2% |
| **Field Crops** | | **-$1** | **-$4** | **-$11** | **-12%** | **-34%** | **-22%** |
| Cotton | | $0 | -$1 | -$1 | -4% | -21% | -34% |
| Rice | | $0 | $0 | -$1 | -22% | -49% | 0% |
| **Vegetables** | | **-$1** | **-$2** | **$0** | **-1%** | **-2%** | **-2%** |
| Other | | $0 | $0 | -$1 | 0% | 0% | -2% |
| Sweet Potato | | $0 | -$1 | -$7 | 0% | 0% | -3% |
| Tomato | | -$2 | -$10 | -$61 | -1% | -4% | -42% |
| **Trees** | | **$0** | **$0** | **-$4** | **-1%** | **-6%** | **-40%** |
| Fruit | | -$2 | -$10 | -$56 | 0% | -2% | -21% |
| Nut | | $0 | $0 | -$2 | -1% | -7% | -43% |
| **Grapes** | | **$0** | **$0** | **-$2** | **-1%** | **-3%** | **-36%** |
| Total | | -$19 | -$38 | -$78 | -5% | -11% | -25% |

(a) The percent difference in canal deliveries in critical water-year types is the 20 percent difference between the critical year baseline (75 percent of canal deliveries) and the critical water year types canal deliveries estimated under the SWRCB SED (55 percent)
Source: Cardno

In critical water-year types (22 percent of years) the baseline for comparison is 75 percent of full water deliveries. Under the SWRCB's SED the canal deliveries in a critical water-year type are 55 percent of full canal deliveries. Making the impact in a critical water-year type the difference between crop production at 75 percent of canal deliveries and 55 percent of canal deliveries (shown in **Table 5-3** as 75% - 55%). This 20 percent reduction in canal deliveries results in a $78 million decline in production revenue, or 25 percent of the reduced baseline. The constraint setting the maximum reduction in crops acres binds for all animal feed and field crops. Crop acres planted in tomatoes declines by 42 percent. And the average yields of tree crops and grapes also declines by 40 percent and 36 percent respectively. This estimated reduction in fruit and tree yield is slightly higher than the one-year stress irrigation yield curves presented in Section 4, Study Methodology, however the modeled results could be considered as taking into account lag effects on yields.

In summary, the model predicts that animal feed and field crops are the first crops to be removed from production. Yield on trees and vines declines due to deficit irrigation, primarily in critical water-year types. High-valued vegetables remain in production the longest as the volume of canal deliveries declines.

As a check on these estimates it would be instructive to compare them to actual growers' decisions during years in which there has been a reduction in irrigation supplies. However, there are no examples of years in which canal deliveries were as limited as those proposed under the SWRCB's plan ***and*** in which groundwater was not used by individual growers to substitute for reduced surface water availability. The closest example of such a year occurred in 2014, when MID only delivered one acre-foot of surface water per acre and limited groundwater pumping to approximately 70 percent of 2013 pumping volume, roughly a 55 percent reduction in allocation. In 2014, MID reported that acres planted in animal feed crops, and irrigated with water delivered by MID, fell to a 6-year low—from a 5-year (2009 through 2013) average of 47,000 acres to 32,000 acres, a 32 percent decline. Acres planted in field crops and irrigated with water delivered by MID declined from a 5-year average of just under 6,000 acres to 2,000 acres, a 67 percent decline. At the same time vegetable crops and fruit and nut yields remained relatively constant.

#### 5.1.1.2 Animal Production

Policy impacts of the SWRCB plan to animal production by water-year type are shown in **Table 5-3**. In below normal water-year types (15 percent of years) the estimated canal deliveries are 15 percent below baseline, causing a 27 percent reduction in animal feed crops (see above for explanation) and consequently a 23 percent reduction in the total value of animal production. This relatively larger decline in the percent of animal feed crops is the result of the voluntary transfer of water to the higher valued tree, vegetable and vie crops that the model estimates occurs. Corn silage is the primary component of wet roughage in the diet of dairy cows. The 49 percent decline in corn silage in below normal years is estimated to result in a 32 percent decline in diary production (e.g. fluid and manufacturing milk). Given that corn silage is heavy and costly to transport, and the SWRCB's SED would reduce canal deliveries to multiple agricultural irrigation districts in a three county area corn silage would not be imported into the study area.

**Table 5-3 Estimated Change in Annual Gross Crop Revenues by Water-Year Type**

| Commodity Type | Policy Impact By Water-Year Type (% change in baseline canal deliveries) | | | | Percent Reduction from Baseline | | |
|---|---|---|---|---|---|---|---|
| | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Wet & Above Normal (-20%) | Below Normal | Dry | Wet & Above Normal |
| | | ($ millions) | ($ millions) | ($ millions) | (%) | (%) | (%) |
| **Animal Production** | No Impact | | | | | | |
| Dairy | | -$61 | -$85 | -$14 | -32% | -43% | -13% |
| Livestock Production | | -$10 | -$50 | -$1 | -10% | -49% | -2% |
| **Total** | | **-$57** | **-$113** | **-$12** | -23% | -45% | -9% |
| Note: | | | | | | | |

| Commodity Type | Policy Impact By Water-Year Type (% change in baseline canal deliveries) | | | | Percent Reduction from Baseline | | |
|---|---|---|---|---|---|---|---|
| | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Wet & Above Normal (-20%) | Below Normal | Dry | Wet & Above Normal |
| | | ($ millions) | ($ millions) | ($ millions) | (%) | (%) | (%) |
| **Animal Feed** | | **-$15** | **-$24** | **-$4** | -27% | -41% | -13% |
| Alfalfa Hay | | -$1 | -$7 | -$4 | -7% | -30% | -26% |
| Corn Silage | | -$13 | -$14 | $0 | -49% | -50% | 0% |
| Irrigated Pasture | | -$1 | -$3 | $0 | -9% | -46% | -2% |

Source: Cardno

In dry water-year types (16 percent of years) the estimated canal deliveries are 25 percent below baseline. Animal feed is estimated to be 41 percent compared to baseline and animal production is estimated to decline by $113 million or 45 percent of baseline.

In critical water-year types (22 percent of years) the baseline for comparison is 75 percent of full water deliveries. Under the SWRCB's plan the canal deliveries in a critical water-year type are 55 percent of full canal deliveries. This makes the impact in a critical water-year type the difference between crop production at 75 percent of full canal deliveries and 55 percent of full canal deliveries. This additional 20 percent reduction in canal deliveries in a critical year results in a $12 million decline in animal production revenue, or 9 percent of the reduced baseline.

In summary, the model predicts that animal feed crops are the first to be removed from production. Given the SWRCB's geographic scale of impacts, in a three county area, the animal feed, specifically corn silage for dairy and irrigated pasture for cattle, that is not grown with MID Project water would be too costly (for corn silage) or impossible (for irrigated pasture) to import and therefore would cause a reduction in animal production.

#### 5.1.1.3 Food Processing Industry

As described in the Chapter 4, Study Methodology, local processors may have limited ability to find alternative sources of critical agricultural inputs for three reasons: (1) processors have established relationships with agricultural suppliers and cannot easily obtain crops or animal products from other producers on short notice to make up shortages in locally produced commodities, (2) in the long-term, the SWRCB proposal would reduce water supplies to not just Merced Irrigation District, but agricultural areas throughout Merced, Tuolumne, and Stanislaus Counties, with consequent reductions in agricultural output throughout the local region exacerbating local processors ability to obtain inputs, and (3) throughout California, constraints use of groundwater will limit the ability of growers to maintain production by pumping substitute groundwater to offset reductions in surface water reductions The estimated decline in output of local processing of commodities produced with Project water is estimated to be $17.6 million, $29.0 million and $50.1 million in below normal, dry and critical water year types, respectively (**Table 5-4**). The pattern of processing impacts mirrors the pattern of impacts to commodities. First animal processing declines as irrigation supplies decline, reflecting the reduction in animal feed crops (corn silage, alfalfa hay and pasture). In a dry water

year (canal deliveries are 25 percent of baseline) animal processing declines by $47 million (44 percent of baseline) whereas crop processing only declines $2.7 million (4 percent from baseline). When canal deliveries are 55 percent of full canal deliveries, in critically dry years, the situation reverses; animal processing declines by $6.4 million (11 percent of the reduced critical-year baseline and crop processing declines by $22 million (31 percent of the reduced critical-year baseline).

The final columns of **Table 5-4** are the estimated commodity values on which these processing impacts are based. The processing impacts represent the direct impact change to processing sectors of reduced crop production and are the 'final demand' values analyzed in IMPLAN. These "final demand" numbers, along with the estimates of direct impacts in commodity production are used in IMPLAN to estimate the indirect and induced effects, as well as employment and labor income estimates presented in the next section.

**Table 5-4 Estimated Change in County Food Processing by Water-Year type and IMPLAN Processing Sector: Forward Linkage Analysis (2014 $millions)**

| Agricultural Commodity | IMPLAN Processing Sector | Change in Processing Sector Output Reliant on District Crop Production (% change in baseline canal deliveries) | | | | Change in District Commodity Output Purchased by Processing Sector | | |
|---|---|---|---|---|---|---|---|---|
| | | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Critical (-20%) | Below Normal | Dry | Critical |
| | | . | ($millions) | ($millions) | ($millions) | ($millions) | ($millions) | ($millions) |
| Peaches | Frozen Foods | No Impact | -$0.1 | -$0.6 | -$7.6 | $0.0 | -$0.2 | -$2.7 |
| Processing Tomatoes | Canned Foods | | -$0.1 | -$0.4 | -$3.9 | $0.0 | -$0.2 | -$1.7 |
| Wine Grapes | Wineries | | $0.0 | -$0.4 | -$0.4 | $0.0 | $0.0 | -$0.1 |
| Nuts | Roasted nuts/ butter | | -$0.3 | -$1.8 | -$10.0 | -$0.2 | -$0.8 | -$4.5 |
| **Crop Subtotal** | | | **-$0.5** | **-$2.7** | **-$21.9** | **-$0.9** | **-$1.5** | **-$0.2** |
| *Percent Reduction from Baseline* | | | *-1%* | *-4%* | *-31%* | *-1%* | *-4%* | *-32%* |
| Beef Cattle | Slaughtering | | -$1.1 | -$5.7 | -$0.1 | -$0.8 | -$4.0 | -$0.1 |
| Beef Cattle | Meat Processing | | -$1.3 | -$6.4 | -$0.1 | -$0.5 | -$2.5 | -$0.1 |
| Dairy Milk | Cheese | | -$23.7 | -$31.5 | -$5.5 | -$14.6 | -$19.4 | -$3.4 |
| Dairy Milk | Fluid Milk | | -$2.9 | -$3.8 | -$0.7 | -$1.4 | -$1.9 | -$0.3 |
| **Animal Subtotal** | | | **-$29.0** | **-$47.4** | **-$6.4** | **-$17.4** | **-$27.8** | **-$3.9** |
| *Percent Reduction from Baseline* | | | *-27%* | *-44%* | *-11%* | *-27%* | *-44%* | *-11%* |
| **Total Processing** | | | **-$29.5** | **-$50.1** | **-$28.3** | **-$18.3** | **-$29.3** | **-4.1** |
| *Percent Reduction from Baseline* | | | *-16%* | *-28%* | *-22%* | *-19%* | *-31%* | ***20%*** |

Source: Highland Economics.

### 5.1.2 Regional Economic Impacts

This section presents detail of the estimated regional economic impacts to the Merced County economy, measured in terms of jobs and labor income as well as the induced and indirect impacts of the direct commodity and processing output resulting from changes in irrigation water supplies that would be expected under the proposed SWRCB's SED.

As noted in Chapter 4, Study Methodology, the IMPLAN model used to estimate total regional economic impacts analysis has some limitations and impacts may be larger or smaller than estimated. Chapter 3 presented the baseline economic activity supported by croplands irrigated with water from the Project. The regional economic impact assumes (in accordance with IMPLAN and general I-O methods) that for every one percent change in this irrigated agricultural production, there is a one percent drop in the employment, output, and income supported by MID agriculture. Thus, if agricultural demand for on-farm services drops by one percent, employment and labor income supported in the baseline in the on-farm services sector will drop by one percent. Employment reported in this analysis represents both full and part-time jobs. As such, employment in particular may be impacted differently than described here, as employers may reduce hours or wages, but not total number of jobs.

In below normal, dry and critical water-year types, total employment supported by the Project declines an estimated 587, 970 and 855 full or part time jobs, respectively when compared to baseline conditions (**Table 5-5**). As a relative measure a decline in 1000 jobs would result in a one percent increase in Merced County's unemployment rate (see **Table 2-2**). So the SWRCB's SED could increase unemployment between half a point to nearly a full point. Merced County's unemployment rate in 2012 was estimated to be 12.8 percent. Assuming that the jobs lost in agriculture could not be replaced in another sector the SWRCB's SED could, at least temporarily, increase unemployment in the County to above 13.0 percent. The state unemployment rate is 7.5 percent.

As with all of the results, impacts are estimated to be highest in the diary and cattle commodity sectors in below normal and dry water-year types. Impacts are more pronounced in the crop sector, representing impacts to high value trees, vines and vegetables in critical years.

**Table 5-5 Estimated Change in Annual Employment by Water-Year Type**

| Economic Activity | Policy Impact By Water-Year Type (% change from baseline canal deliveries) | | | | Percent Change from Baseline Canal Deliveries | | |
|---|---|---|---|---|---|---|---|
| | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Critical (-20%)(a) | Below Normal | Dry | Critical |
| | | (Jobs) | (Jobs) | (Jobs) | (%) | (%) | (%) |
| **Production** | | **-508** | **-867** | **-748** | **-12%** | **-20%** | **-21%** |
| Crop | | -147 | -294 | -664 | -5% | -10% | -24% |
| Direct | | -86 | -161 | -348 | -5% | -9% | -22% |
| Indirect & Induced | | -62 | -133 | -315 | -5% | -10% | -27% |
| Dairy | | -250 | -398 | -60 | -28% | -44% | -12% |

**Table 5-5 Estimated Change in Annual Employment by Water-Year Type**

| Economic Activity | Policy Impact By Water-Year Type (% change from baseline canal deliveries) | | | | Percent Change from Baseline Canal Deliveries | | |
|---|---|---|---|---|---|---|---|
| | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Critical (-20%)(a) | Below Normal | Dry | Critical |
| | | (Jobs) | (Jobs) | (Jobs) | (%) | (%) | (%) |
| Direct | | -144 | -230 | -34 | -28% | -44% | -11% |
| Indirect & Induced | | -106 | -168 | -26 | -28% | -44% | -12% |
| Cattle | | -111 | -176 | -24 | -28% | -44% | -11% |
| Direct | | -49 | -77 | -11 | -28% | -44% | -11% |
| Indirect & Induced | | -62 | -99 | -14 | -28% | -44% | -11% |
| **Processing** | | **-70** | **-103** | **-105** | **-15%** | **-20%** | **-25%** |
| Crop | | -9 | -9 | -78 | -3% | -3% | -29% |
| Direct | | -5 | -5 | -42 | -3% | -3% | -29% |
| Indirect & Induced | | -4 | -4 | -36 | -3% | -3% | -29% |
| Dairy | | -62 | -80 | -28 | -29% | -37% | -20% |
| Direct | | -25 | -32 | -12 | -29% | -37% | -21% |
| Indirect & Induced | | -36 | -48 | -16 | -29% | -37% | -20% |
| Cattle | | -9 | -14 | -2 | -28% | -44% | -11% |
| Direct | | -5 | -8 | -1 | -28% | -44% | -10% |
| Indirect & Induced | | -4 | -6 | -1 | -28% | -44% | -11% |
| Grand Total | | -587 | -970 | -855 | -12% | -20% | -22% |

Source: Cardno and Highland Economics

Labor revenue would decline as a consequence of the reduction in employment. Labor income would fall by $37 million, $59 million and $43 million in above normal, dry and critical water-year types, respectively. The average annual salary for jobs ranges between $28 thousand and approximately $100 thousand, depending on the type of employment.

**Table 5-6 Estimated Change in Annual Labor Income by Water-Year Type**

| Economic Activity | Policy Impact By Water-Year Type (% change from baseline canal deliveries) | | | | Percent Change from Baseline Canal Deliveries | | |
|---|---|---|---|---|---|---|---|
| | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Critical (-20%)(a) | Below Normal | Dry | Critical |
| | | ($ millions) | ($ millions) | ($ millions) | (%) | (%) | (%) |
| **Production** | | -$32.6 | -$53.8 | -$35.8 | -13% | -23% | -20% |
| Crop | | -$6.0 | -$13.1 | -$29.3 | -4% | -9% | -22% |

**Table 5-6 Estimated Change in Annual Labor Income by Water-Year Type**

| Economic Activity | Policy Impact By Water-Year Type (% change from baseline canal deliveries) | | | | Percent Change from Baseline Canal Deliveries | | |
|---|---|---|---|---|---|---|---|
| | Wet & Above Normal | Below Normal (-15%) | Dry (-25%) | Critical (-20%)(a) | Below Normal | Dry | Critical |
| | | ($ millions) | ($ millions) | ($ millions) | (%) | (%) | (%) |
| Direct | | -$3.7 | -$8.1 | -$17.5 | -4% | -9% | -20% |
| Indirect & Induced | | -$2.3 | -$5.0 | -$11.8 | -5% | -10% | -26% |
| Dairy | | -$21.7 | -$34.4 | -$5.7 | -28% | -44% | -13% |
| Direct | | -$17.6 | -$28.0 | -$4.7 | -28% | -44% | -13% |
| Indirect & Induced | | -$4.1 | -$6.5 | -$1.0 | -28% | -44% | -12% |
| Cattle | | -$3.9 | -$6.3 | -$0.9 | -28% | -44% | -11% |
| Direct | | -$1.4 | -$2.2 | -$0.3 | -28% | -44% | -11% |
| Indirect & Induced | | -$2.6 | -$4.1 | -$0.6 | -28% | -44% | -11% |
| **Processing** | | -$5.1 | -$5.4 | -$7.2 | -17% | -18% | -29% |
| Crop | | -$0.5 | -$0.5 | -$4.0 | -4% | -3% | -30% |
| Direct | | -$0.3 | -$0.3 | -$2.3 | -4% | -4% | -31% |
| Indirect & Induced | | -$0.2 | -$0.2 | -$1.8 | -3% | -3% | -29% |
| Dairy | | -$4.2 | -$4.2 | -$3.0 | -29% | -29% | -29% |
| Direct | | -$2.3 | -$1.7 | -$2.4 | -29% | -21% | -37% |
| Indirect & Induced | | -$1.8 | -$2.5 | -$0.7 | -29% | -40% | -17% |
| Cattle | | -$0.4 | -$0.7 | -$0.1 | -28% | -44% | -11% |
| Direct | | -$0.2 | -$0.4 | -$0.1 | -28% | -44% | -11% |
| Indirect & Induced | | -$0.2 | -$0.3 | -$0.0 | -28% | -44% | -11% |
| Grand Total | | -$36.7 | -$59.1 | -$43.0 | -14% | -22% | -21% |

Source: Cardno and Highland Economics

**Table 5-7** present detailed summary of the regional economic impacts for each commodity, processing and indirect and induced impacts, including levels of estimates as well as impacts for each output, employment and labor income.

## Table 5-7 Regional Economic Impacts of the SWRCB's Plan by Water-Year Type: Output, Jobs and Labor Income

| Impact Category | Baseline By Year Type (% of full canal deliveries) | | Policy Runs By Year Type (% of full canal deliveries) | | | | Policy Impact By Year Type (% change from baseline canal deliveries) | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | W, AN, BN, D | C | W, AN | BN | D | C | W, AN | BN | D | C |
| | (100%) | (75%) | (100%) | (85%) | (75%) | (55%) | 0% | -15% | -25% | -20% |
| **Output ($millions)** | | | | | | | | | | |
| Crop Production (direct) | $348 | $310 | $348 | $329 | $310 | $233 | | -$19 | -$38 | -$78 |
| Animal Production (direct) | $249 | $137 | $249 | $192 | $137 | $125 | | -$57 | -$113 | -$12 |
| Processing, (direct, net of production inputs)(a) | $71 | $57 | $71 | $60 | $57 | $43 | | -$11 | 14 | -$30 |
| Indirect and Induced | $275 | $208 | $274 | $234 | $207 | $164 | | -$40 | -$67 | -$43 |
| Grand Total | $943 | $711 | $943 | $825 | $711 | $602 | | -$127 | -$231 | -$147 |
| *Percent of Total* | *100%* | *74%* | *100%* | *88%* | *75%* | *64%* | | *-12%* | *-25%* | *-15%* |
| **Employment (full- and part-time jobs)** | | | | | | | | | | |
| Crop Production (direct) | 1,735 | 1,574 | 1,735 | 1,649 | 1,574 | 1,226 | | -86 | -161 | -348 |
| Animal Production (direct) | 699 | 393 | 699 | 506 | 393 | 348 | | -193 | -307 | -45 |
| Processing, (direct, net of production inputs)(a) | 257 | 211 | 257 | 221 | 211 | 156 | | -35 | -46 | -55 |
| Indirect and Induced | 2,197 | 1,740 | 2,197 | 1,924 | 1,740 | 1,333 | | -273 | 970 | 407 |
| Grand Total | 4,888 | 3,918 | 4,888 | 4,301 | 3,918 | 3,062 | | -587 | -984 | -855 |
| *Percent of Total* | *100%* | *80%* | *100%* | *88%* | *80%* | *63%* | | *-12%* | *-20%* | *-22%* |
| **Labor Income ($ millions)** | | | | | | | | | | |
| Crop Production (direct) | $94 | $86 | $94 | $91 | $86 | $69 | | -$4 | -$8 | -$17 |
| Animal Production (direct) | $69 | $39 | $69 | $50 | $39 | $34 | | -$19 | -$30 | -$5 |
| Processing, (direct, net of production inputs)(a) | $17 | $14 | $17 | $14 | $14 | $10 | | -$3 | -$2 | -$5 |
| Indirect and Induced | $87 | $68 | $87 | $76 | $68 | $53 | | -$11 | -$19 | -$16 |
| Grand Total | $267 | $208 | $268 | $232 | $208 | $165 | | -$37 | -$59 | -$43 |
| *Percent of Total* | *100%* | *78%* | *100%* | *86%* | *78%* | *62%* | | *-14%* | *-22%* | *-21%* |
| (a) Gross processing values | $169 | $123 | $169 | $162 | $123 | $138 | | -$6 | -$46 | $15 |

Source: Cardno and Highland Economics

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## 5.2 Municipal and Industrial Impacts

M&I water supply impacts are measured as an increase in the cost of delivery of M&I raw water to LPDCSD. MID contributes to M&I water supply through groundwater recharge programs also; however, the impact of the SWRCB's plan on those groundwater recharge programs has not been quantified and therefore the value is not estimated in this report.

The total additional annual average cost of pumping groundwater rather than surface water is estimated to be $6,393 dollars in months in which there is a supply interruption. The hydrology model estimates that there are an additional 30 months of supply interruption under the SWRCB's SED, therefore, without discounting, the estimated cost of pumping additional groundwater is just under $200,000. The estimated annual average of that cost would be $2,060 per year, which appears modest. However the actual realization of those costs would likely occur in a more concentrated fashion. For example the hydrological model estimates that in the 1977 model year supply interruptions would occur in every month of the year. If LDPCSD had to pay the additional cost of pumping groundwater throughout the year the annual costs would be closer to $75,000. Again, it may appear modest however for such a small district, with only $5 million in assets, a $75,000 annual expense could prove a hardship.

## 5.3 Hydropower Impacts

Power generation is effected in every year type (**Table 5-8**). Impacts range from a reduction of 9 GWh (above normal water-year types) to 57 GWh (critical water-year types). The resulting impact on output (measured as gross revenue dollars) ranges between $0.3 million (above normal water-year types) and $3.4 million (critical water-year types). With estimated induced and indirect impacts included impacts decline between $0.4 million in above normal years to $4.3 million in critical years.

The hydropower project is estimated to support approximately 21 jobs (total of direct, indirect and induced). Since the number of jobs at the power plant is not dependent on the volume of power generated there is no associated impact to jobs or labor income.

## Table 5-8 Estimated Policy Impacts to Hydropower: Output, Jobs and Labor Income

| Impact Category | Baseline By Year Type (% of full canal deliveries) | | | | | Policy Runs By Year Type (% of full canal deliveries) | | | | | Policy Impact By Year Type (% change from baseline) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | W | AN | BN | D | C | W | AN | BN | D | C | W | AN | BN | D | C |
| | 100% | 100% | 100% | 100% | 75% | 100% | 100% | 85% | 75% | 55% | 0% | 0% | -15% | -25% | -20% |
| **Power Generation** | | | | | | | | | | | | | | | |
| Power Generation (GWh) | 537 | 369 | 285 | 269 | 171 | 498 | 359 | 249 | 218 | 114 | -39 | -9 | -37 | -50 | -57 |
| Weighted Avg Price/MWh | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0.02 | 0.03 | 0.04 | 0.05 | 0.06 | 0 | 0 | 0 | 0 | 0 |
| **Output ($millions)** | | | | | | | | | | | | | | | |
| Direct output | $10.7 | $11.1 | $11.4 | $13.4 | $10.2 | $10.0 | $10.8 | $9.9 | $10.9 | $6.8 | -$0.8 | -$0.3 | -$1.5 | -$2.5 | -$3.4 |
| Indirect | $0.4 | $0.4 | $0.5 | $0.5 | $0.4 | $0.4 | $0.4 | $0.4 | $0.4 | $0.3 | $0.0 | $0.0 | -$0.1 | -$0.1 | -$0.1 |
| Induced | $2.4 | $2.5 | $2.5 | $3.0 | $2.3 | $2.2 | $2.4 | $2.2 | $2.4 | $1.5 | -$0.2 | -$0.1 | -$0.3 | -$0.6 | -$0.8 |
| Total | $13.6 | $14.0 | $14.4 | $17.0 | $12.9 | $12.6 | $13.6 | $12.6 | $13.8 | $8.6 | -$1.0 | -$0.4 | -$1.9 | -$3.2 | -$4.3 |
| **Employment (full- and part-time jobs)** | | | | | | | | | | | | | | | |
| Direct | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 0 | 0 | 0 | 0 | 0 |
| Indirect | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Induced | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 0 | 0 | 0 | 0 | 0 |
| Total | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 21 | 0 | 0 | 0 | 0 | 0 |
| Labor Income ($ millions) | | | | | | | | | | | | | | | |
| Direct | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | 0 | 0 | 0 | 0 | 0 |
| Indirect | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | $0.3 | $0.3 | $0.3 | $0.3 | $0.3 | 0 | 0 | 0 | 0 | 0 |
| Induced | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | $0.1 | $0.1 | $0.1 | $0.1 | $0.1 | 0 | 0 | 0 | 0 | 0 |
| Total | $1.2 | $1.2 | $1.2 | $1.2 | $1.2 | $0.7 | $0.7 | $0.7 | $0.7 | $0.7 | 0 | 0 | 0 | 0 | 0 |

Source: Cardno and Highland Economics

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## 5.4 Comparison of Results

It is useful to compare the baseline estimates of crop value to similar studies as a way to increase confidence in the baseline data used to develop the estimates. The most useful study as a basis of comparison is the SWRCB's SED, Appendix G entitled, Agricultural Economic Effects of Lower San Joaquin River flow Alternatives (SWRCB 2012). The geographic scope of the SWRCB SED is larger than the geographic scope of this analysis. The SWRCB report included the entire LSJR area, specifically the Central Valley Project Modeling (CVPM) regions 11, Stanislaus River, 12, Tuolumne River and 13, Merced River. However, the comparison of the per acre estimates of output to this report to the SWRCB's report are a useful basis of comparison of baseline data.

In the SWRCB SED report, the estimated baseline crop production value was $2,878/acre, which is strikingly similar to this report's estimate of $2,999/acre. In the SWRCB's report there is no discussion of the animal production value or processing values, either for the baseline or at the percent unimpaired flow. This could be because the report assumed that there would be no impact to either animal production due to a reduction in locally grown feed crops. Alfalfa hay can and is imported into the region to supplement a reduction in locally produced supply. However in the critical dry water year types of 1962, 1978, 1989 through 1993 the SWRCB study estimated the number of acres of irrigated pasture would decline to near zero and corn acres (presumably including silage) declines by half. As stated in this report, due to corn-silage's weight (it is a wet roughage) it may be cost-prohibitive to import from a distance which is why the impact of an animal feed shortage was included in this report. Similarly irrigated pasture used for beef cattle is difficult to replace.

**Table 5-9 Comparison of Results to SWRCB SED**

| Agricultural Category | Merced County | | SWRCB | |
|---|---|---|---|---|
| | Baseline | Per Acre | Baseline | Per Acre |
| | $millions | $s | $millions | $s |
| Crop Production | $348 | $2,999 | $2,760 | $2,878 |
| Animal Production | $249 | $2,148 | NE | NE |
| Processing | $169 | $1,453 | NE | NE |
| Indirect and Induced | $274 | $2,366 | $1,941 | $2,024 |
| **Total** | **$942** | **$8,123** | **$4,701** | **$4,902** |

Source SWRCB, 2012 and Cardno. NE = not estimated. NA = not applicable

Likewise, the SWRCB's analysis does not include an estimate of processing revenue supported by irrigated agriculture, either for the baseline or for the impact estimate at the 35 percent unimpaired flow. This may reflect the assumptions that processing inputs would be imported to make up any loss in local crop and animal production.

The SWRCB's estimates the baseline indirect and induced values are $2,024/acre which is slightly higher than this reports estimate of $2,366/acre. The difference in the estimate is to be expected because this report includes the value of the induced and indirect impact that is supported by animal production and processing.

In general the baseline estimates of per acre revenue for crop production and indirect and induced effects are similar, which suggests that the base data used to develop both models is similar, including such as prices, yields and cost of production.

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# Economic Impacts of Reduced Water Availability to the Merced River Hydroelectric Project

## ATTACHMENT A

Using IMPLAN to Estimate Impacts to Agricultural Processing (e.g. Forward Linkages)

If all of the crops produced locally were exported or consumed as fresh produce, the value of crop production and its associated backward linkages would be the main drivers of economic activity attributed to the local agricultural industry. However, in addition to direct impacts in the agricultural sector, the production of crops in with Project water also supports forward-linked industries, including dairy production and cattle ranching (based on dependence on feed supplies) and processing industries that use raw inputs (both crops as well as dairy and cattle products) to manufacture a range of food and beverage products. Without local agricultural production, many local dairy and cattle operations and food processing industries would not exist because transportation costs to import the required commodities would be prohibitively expensive. As a result, it is important to evaluate these forward-linked industries dependent on locally-produced commodities in order to measure the full economic contribution of agriculture supported by the Project. To do so, the direct output (final demand) in these forward-linked industries was estimated, as outlined below.

Note that because the production functions for these forward-linked industries account for the purchase of local inputs (i.e., crops, cattle and dairy products), it is necessary to modify the IMPLAN model prior to analyzing the final demand for these forward-linked sectors. These changes are to avoid calculating twice the economic benefits of crop, cattle and dairy production that are used as inputs to forward-linked sectors, which would result in double counting of benefits. To accomplish this, the IMPLAN model was modified so that the forward-linked sectors dependent on crop (cattle and dairy) are assumed to make no purchases of local crops (cattle and dairy).[6]

Through this process, double counting the same production as both a direct and indirect impact is avoided. With this adjustment, the appropriate indirect and induced values are obtained. However, the direct output value of the raw crop, cattle, and dairy used as inputs in forward-linked sectors is still counted twice: once in the original crop, cattle, or dairy output value, and again in the forward-linked sector output value (output value includes the value of all intermediate inputs – such as crops, dairy, or cattle - required to produce the processing sector output). To eliminate the double counting of direct output, direct output values in forward-linked sectors are adjusted downwards by the value of the crop, cattle, and dairy production inputs that are included in the processing sector output value.

**Dairy (Milk) Production**

There is a strong relationship between crop production and milk production in the study area. In fact, some dairy farmers also produce feed and forage crops, such as alfalfa and corn silage, to support their internal operations and aid in waste management. Feed crops grown with Project water may be consumed by dairy cows located both within and outside of the service area boundary. The location of these crop operations proximate to the region's highly specialized dairy operations is a major support to the dairy industry. For the dairy sector, specifically milk production, direct output value supported by crops grown with the Project water was estimated. This estimate of the value of milk production was used to represent the final demand in IMPLAN Sector 12, *Dairy cattle and milk production*.

**Cattle Production**

[6] This is done by changing the model parameters measuring the purchases of local products to zero.

Similar to milk production, cattle and calves production is also dependent on crops grown with Project water. Instead of alfalfa hay and corn-silage, the majority of cattle and calves production in the region relies mainly on yields from irrigated pasture in the as well as hay (other than alfalfa).

The estimate of the total production value of beef dependent on crops grow with project water represents the final demand in IMPLAN Sector 11, *Cattle ranching and farming*.

**Food and Beverage Processing (Crop Production)**

There is a wide range of food and beverage processing industries in the study area which are dependent on local agricultural and dairy production. These are captured in 34 separate food and beverage processing sectors in IMPLAN. This analysis focuses only on the top five processing sectors that are reliant on *local* crop and dairy production.

The top five IMPLAN sectors, in terms of reliance on local crop inputs, are listed below,.

- *Wineries* (Sector 72)
- *Fruit and vegetable canning, pickling, and drying* (Sector 54)
- *Frozen food manufacturing* (Sector 53)
- *Other animal food manufacturing* (Sector 42)
- *Snack food manufacturing* (Sector 65)

The following discussion summarizes the methods used to convert the estimated value of local crop production into changes in final demands in the forward-linked processing sector.

Overall, an estimated 11.2 percent of local agricultural output, is used in these five crop processing sectors. The remaining agricultural output is exported, consumed locally, or used in other industries. The next step is to estimate the total value of crop processing output for every dollar of agricultural commodities that is purchased by the processing industry. Even though agricultural products are a primary ingredient in the processing sector, on average, these inputs only account for 9.9 percent of total production value. Accordingly, for every dollar of agricultural products used in processing, approximately $10.08 in value of crop processing output is supported. Therefore, the estimate of the value of the agricultural commodities purchased by the food and beverage processing sector is utilized in the production of manufactured products, which is the final demand value used in IMPLAN.

**Food and Beverage Processing (Milk Production)**

This process is repeated for dairy production used as inputs to the primary dairy processing sectors in the three-county area, consisting of the following three IMPLAN sectors listed below

- Fluid milk and butter manufacturing (Sector 55)
- Cheese manufacturing (Sector 56)
- Dry, condensed, and evaporated dairy product manufacturing (Sector 57)
- Ice cream and frozen dessert manufacturing (Sector 58)

In this case, of the estimated total value of milk production supported by crops grown with Project water is used in the dairy processing industry, and every dollar of dairy production supports about $2.67 in dairy processing output.

The processing output was estimated for each of the three sectors is as follows:

- Sector 55, *Fluid milk and butter manufacturing*
- Sector 56, *Cheese manufacturing* and
- Sector 57, *Dry, condensed, and evaporated dairy product manufacturing*

**Food and Beverage Processing (Cattle Production)**

This process is also repeated for cattle production used as inputs to the animal processing sector in the three-county area, consisting of the following IMPLAN sector listed below,:

- Animal (except poultry) slaughtering, rendering, and processing (Sector 59)