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Abbreviations and Acronyms

AF	acre-feet
CalSim II	California Simulation Model II
cfs	cubic feet per second
CVP	Central Valley Project
CVPM	Central Valley Production Model
DBP	disinfection by-product
DBPP	disinfection by-product precursor
Delta	Sacramento-San Joaquin River Delta
DMC	Delta-Mendota Canal
DWR	California Department of Water Resources
EC	electrical conductivity
EC_e	soil salinity
EC_w	salinity of applied water
EQ	Environmental Quality
I-O	input-output
M&I	municipal and industrial
mmhos/cm	millimhos per centimeter
MWH	megawatt-hour(s)
NED	National Economic Development (account)
O&M	operations and maintenance
OSE	Other Social Effects
P&Gs	*Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies*
PFR	Plan Formulation Report
Project	DMC Recirculation Project
Reclamation	Bureau of Reclamation
RED	Regional Economic Development (account)
SJR	San Joaquin River
SWP	State Water Project
WAPA	Western Area Power Administration
WTP	willingness to pay

Appendix J
Economic Analysis

J1 Introduction

This economic analysis supplements the Plan Formulation Report (PFR) prepared for the Delta-Mendota Canal (DMC) Recirculation Project (Project) that is being proposed by the Bureau of Reclamation (Reclamation) and California Department of Water Resources (DWR). This analysis has been prepared in accordance with the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* (P&Gs, Water Resources Council 1983). The economic analysis has two main components. The first focuses on the benefits and costs of the Project at the national level, which are captured under the National Economic Development (NED) account outlined under the P&Gs. The information on benefits and costs is important for decision-makers to consider in making a final recommendation regarding the Project’s feasibility. These economic parameters are also important considerations in the allocation of the Project’s costs among its beneficiaries and estimating related federal and nonfederal cost-sharing responsibilities. The second component evaluates regional economic impacts and documents the change in the distribution of regional economic activity attributed to the Project, which is captured under the Regional Economic Development (RED) account.

J1.1 Project Background and Overview

This analysis covers the economic effects of the No-Action Alternative and the alternative plans that use recirculation strategies to improve water quality and flows in the lower San Joaquin River (SJR). Specifically, the Project would recirculate water from the Sacramento-San Joaquin River Delta (Delta) through the Central Valley Project (CVP) pumping and conveyance facilities to the SJR, upstream from Vernalis, the point at which SJR enters the Delta. The use of excess capacity in export pumping and conveyance facilities could provide greater flexibility in meeting the existing water quality standards and flow objectives for which the CVP has responsibility, reduce the demand on water from New Melones Reservoir, and help meet obligations to CVP water contractors that use New Melones Reservoir.

The study area for the Project and this economic analysis is the lower main stem of the SJR below its confluence with the Merced River; the areas served by the Merced, Tuolumne, and Stanislaus rivers on the western side of the Sierra Nevada Mountains; the areas served by the DMC, which includes approximately 30 water agencies; and the south Delta area, which serves as a source of water supply for agricultural and urban uses within the Delta.

The DMC is located along the western side of California's San Joaquin Valley, running for approximately 120 miles between Tracy at the southern edge of the Delta and terminating at Mendota Pool on the SJR. Other CVP facilities that may be affected by the Project are C.W. "Bill" Jones Pumping Plant; Westley, Newman, Volta, and Firebaugh wasteways; O'Neill Pumping Plant; O'Neill Forebay; and New Melones and San Luis reservoirs. Under some alternative plans, State Water Project (SWP) facilities may also be used to implement recirculation strategies.

A complete description of the Project, including alternative plans; affected facilities; related studies, projects, and programs; and assumptions regarding without-Project conditions are included in PFR Chapter 2. In addition, the planning objectives, which provide the framework for the analysis of economic benefits, are presented in **Section J3**.

J1.2 Purpose and Scope of Economic Analysis

Economics plays a key role in the federal water resource planning process. Throughout the various stages of the planning process, economics is used for benefits assessment, benefit-cost analysis, cost allocation, and project financing, all of which are interrelated and can be integrated into the NED analysis. During plan formulation, the calculation of net economic benefits across the No-Action Alternative and the alternative plans is used to identify the NED Plan (i.e., the alternative plan that reasonably maximizes net NED benefits consistent with the federal objective); economic information can also play an important role in selecting the recommended plan (if different than the NED Plan). In addition, net economic benefits, expressed in terms of a benefit-cost ratio, are used by Congress to evaluate the economic efficiency of all national projects, and can be used in the cost allocation process to help determine how reimbursable costs should be allocated among project beneficiaries for repayment and the corresponding federal interest.

The purpose of this analysis is to specify the Project's economic impacts and quantify those impacts as warranted and permitted by available data. The scope of the economic analysis is intended to cover all beneficial and adverse economic impacts anticipated under the Project, which for this Project, are predominantly attributed to the primary and secondary planning objectives (see **Section J3**). It is these planning objectives that characterize the desired physical and environmental consequences of the Project, which in turn, affect economic values. Economic benefits and costs that cannot be readily quantified or do not warrant quantification are assessed qualitatively. In some cases, even where benefits are quantified, the magnitudes are so small as to be outside the level of precision of the methods used to estimate them. In these cases as well, the potential impacts are discussed qualitatively.

With adequate quantitative information on benefits and costs, benefit-cost ratios can be developed across alternative plans. The impacts quantified for the alternative plans considered for this project relate to agricultural water supplies and hydropower. Separable costs, those related specifically to a particular project purpose, have not been developed. Rather, construction costs related to improvements to the wasteway conveyance facilities would be the same for all alternative plans. Operations and maintenance (O&M) costs other than energy usage for pumping have not yet been developed. Consequently, the economic analysis does not include quantified benefit-cost ratios or a separable costs-remaining benefits (SC-RB) analysis.

J1.3 Organization of Appendix

The remainder of this appendix is organized into the following sections:

- **Section J2 – Principles and Guidelines Accounts**. This section provides a brief description of the four accounts covered under the P&Gs. The focus of the discussion is on the NED and RED accounts, which are being considered in this study; however, the relationship among the NED, RED, and other accounts considered in the P&Gs is also addressed.
- **Section J3 – Planning Objectives**. This section identifies the Project's primary and secondary planning objectives, which provide the framework for the economic analysis. The economic effects associated with each objective are also presented on a conceptual level.
- **Section J4 – Economic Values and Methods**. This section expands on the discussion of economic values referenced in **Section J3** and describes the economic methods that are used to quantify them.
- **Section J5 – Economic Analysis and Results**. This section includes the results of the economic analysis. The results are organized by type of benefit and include estimates for the No-Action Alternative and the alternative plans being considered in the PFR as permitted by available data.
- **Section J6 – Comparison of Economic Impacts of Alternative Plans**. This section concludes the appendix with a comparison of the No-Action Alternative and the alternative plans from an economic perspective, taking into account economic benefits and costs, as permitted by available data.

J2 Principles and Guidelines

J2.1 Overview of Accounts

The P&Gs were developed pursuant to Section 103 of the Water Resources Planning Act (Public Law 89-80) and Executive Order 11747. The main purpose of the P&Gs is to establish standards and procedures for use by federal agencies in formulating and evaluating alternative plans for water and related land resources implementation studies, including Reclamation's potential projects. The evaluation of alternative plans is based on a set of four accounts, which encompass all significant effects of a plan on the human environment as required by the National Environmental Protection Act. The four accounts are:

1. National Economic Development (NED). The NED account shows effects on the national economy as represented by changes in the economic value of the national output of market and nonmarket goods and services. Effects in the NED account are to be expressed in monetary units.

2. Regional Economic Development (RED). The RED account shows the change in the distribution of regional economic activity, which includes the regional incidence of NED effects, income transfers, and employment effects. RED effects can be expressed in monetary units, other numeric units, or nonnumeric terms.

3. Environmental Quality (EQ). The EQ account shows effects on ecological, cultural, and aesthetic attributes of significant natural and cultural resources that cannot be measured in monetary terms. EQ effects are to be expressed in appropriate numeric units or nonnumeric terms.

4. Other Social Effects (OSE). The OSE account shows effects from perspectives that are relevant to the planning process, but which are not reflected in the other three accounts, such as urban and community impacts and effects on life, health, and safety. Similar to RED, OSE effects can be expressed in monetary units, other numeric units, or nonnumeric terms.

J2.2 National Economic Development Account

The primary focus of this economic analysis is the NED account, which is the only account required under the P&Gs.[1] The NED account identifies beneficial and adverse effects on the economy. Beneficial effects in the NED account are increases in the economic value of the national output of goods and services from a plan; the value of output resulting from external economies caused by a plan; and the value associated with the use of otherwise unemployed or under-employed labor resources. Conversely, adverse effects in the NED account are the opportunity costs of resources used in implementing a plan, which include implementation outlays, associated costs, and other direct costs. The alternative plan that reasonably maximizes net NED benefits, consistent with the federal objective, is referred to as the NED Plan. That alternative plan is not necessarily

[1] Note that other information required by law or that will have a material bearing on the decision-making process should be included in the other accounts.

the same as the alternative plan that would provide the highest benefit-cost ratio.

J2.3 Regional Economic Development Account

The RED account examines changes in economic activity at the local or regional level, based on the regional incidence of NED benefits and costs. Regions included in the RED analysis are those in which the alternative plans are expected to have significant income, output, or employment effects. NED effects that are not expected to occur in the significantly affected regions are considered to be in a “rest of nation” category. RED analysis is not required under the federal project evaluation process because the measured changes in local economic activity may reflect only a shift in productivity from one region to another, not a change in output at the national level, which is required and captured under the NED account. However, the effects of a project on local economic activity may be of interest to decision makers and stakeholders and, therefore, RED analyses are frequently included in water project studies.

The key measures used to evaluate a project’s RED effects are changes in regional income and regional employment, although other measures such as economic output (production) and population may also be reported. The effects on regional income are the sum of (1) the regional incidence of the NED income benefits and (2) transfers from outside the region. Income transfers include income from implementation outlays, transfers of basic economic activities, and income from indirect and induced effects. Indirect effects result from the changed outputs of goods and services in industries, which help meet changes in final products and export demands. Induced effects result from changes in consumer expenditures stimulated by changes in personal income. A project’s effects on regional employment parallel those on regional income. Typically, employment impacts are developed for individual industries to discern the distributional impacts on business sectors.

A close relationship exists between the RED account and other accounts. RED impacts include, principally, changes in income, employment, and output. However, the nuances of each of those categories may easily overlap with other accounts defined within the P&Gs. For example, NED impacts are also RED impacts if they occur within the region of interest. As noted in the P&Gs (page 11), typically all or almost all of the NED benefits of a project will accrue to the specific region, in addition to income transfers from outside the region. Typically, indirect and induced effects are excluded from NED accounting because such effects usually occur on both the cost and benefit sides, which are often assumed to balance out. Conversely, indirect and induced impacts are shown in the RED account, and differences between it and the NED accounts are, therefore, accounted for as transfers from or to the rest of the nation. The RED account may also overlap with the OSE account. The OSE account is intended to capture, among others, urban and community impacts, which may include the social effects related to changes in income and employment distribution covered under the RED account.

J3 Planning Objectives

The Project's economic benefits are based primarily on the attainment of specified planning objectives, as outlined in PFR **Section 1.3**. These objectives include not only the objectives related to fishery flows and water quality, but also "other opportunities" identified that address related environmental concerns in the Project area. A summary of the planning objectives and opportunities and a conceptual discussion of related economic benefits follow.

J3.1 Planning Objectives

On the basis of identified problems and needs, five planning objectives have been identified related primarily to fishery flows and water quality:

- **Objective A –** Provide supplemental flow in the lower SJR to meet fishery flow objectives using excess capacity in export pumping and conveyance facilities.
- **Objective B –** Provide lower salinity water to the lower SJR to meet water quality objectives at Vernalis using excess capacity in export pumping and conveyance facilities.
- **Objective C –** Provide greater flexibility in meeting the existing water quality standards and objectives for which the CVP has responsibility to reduce the demand on water from New Melones Reservoir used for that purpose; and to assist the Secretary of the Interior in meeting any obligation to CVP contractors from the New Melones Project.
- **Objective D –** Use recirculation to improve dissolved oxygen levels in the SJR.
- **Objective E –** Provide lower salinity water to the SJR to meet water quality objectives at interior south Delta stations through the use of excess capacity in export pumping and conveyance facilities.

Objective A addresses the need to meet fishery flow objectives in the SJR and south Delta area. SJR flow objectives were developed to provide flows and suitable habitat for various life stages of aquatic organisms. The Project would help conserve fishery resources in the Delta, including Delta smelt and anadromous fish species such as Chinook salmon and steelhead. The conservation of fishery resources would increase fish populations, which in turn could result in a range of economic benefits including increased nonmarket values associated with recreational fishing and species conservation and market values attributed to commercial fish harvests.

Objectives B, D, and E address various aspects of water quality in the Project area. Improvements in water quality may provide agricultural, urban, and environmental benefits. Agriculture may benefit if improved water quality causes increased crop yields and/or reduced irrigation costs, which in turn would enhance the value of crop production and net farm revenues. Urban benefits of improved water quality would include reduced water treatment costs for local municipalities and residents. Environmental benefits of water quality improvements would accrue to fishery populations, which would potentially result in recreational and commercial fishing benefits.

Objective C relates to improved water supplies for CVP contractors along the Stanislaus River, which could result in greater agricultural production, crop values, and farm revenues. However, by increasing water supplies in the Delta region, CVP water users south of the Delta may experience declines in water supplies, which would have adverse economic effects.

J3.2 Other Opportunities

The planning objectives address, in part, other opportunities provided by the Project, such as greater water supply reliability, reduced groundwater overdraft, increased anadromous fish survivability, and improved south Delta water levels:

- **Increased Water Supply Reliability –** The recirculation of water may improve water supply reliability for CVP contractors in the Delta export areas and the Stanislaus River. This opportunity is closely related to Objective C, which would capture the economic benefits and impacts of increased water supply reliability.
- **Reduce Groundwater Overdraft –** Merced Irrigation District and Oakdale Irrigation District pump groundwater from the Merced, Modesto, and Eastern San Joaquin County groundwater basins to help meet demand during drought conditions, and some basins are in a state of overdraft. Westside water users rely on deep groundwater pumping and saline surface supplies to supplement inadequate contract deliveries. Potential impacts associated with overdraft include increased depths to groundwater and pumping and land subsidence, as well as adverse effects on water quality (e.g., increased salinity). Also, continuous overdraft can lead to the aquifer's eventual loss. With increased surface-water reliability, demands on groundwater resources may decline, which may provide economic benefits such as reduced pumping costs and avoided costs associated with land subsidence.
- **Anadromous Fish Survivability –** State Water Resources Control Board Water Rights Decision 1641 requires an evaluation of the potential impacts on imprinting juvenile fall run Chinook salmon and steelhead in the SJR basin from recirculation. This opportunity is closely related to Objective A addressing flow requirements for fisheries. Similar economic benefits are expected.
- **Improve South Delta Water Levels –** Low SJR flows combined with high export rates and low tides can cause south Delta water levels to become so low as to constrain diversions for irrigation. This problem is being addressed, in part, by the South Delta Improvement Project, whose likelihood of success could increase with the Project, which

would increase flows for fisheries, and reduced exports south of the Delta would cause south Delta water levels to increase, which would help reduce constraints on agricultural water diversions, promote agricultural production, and increase crop values. In turn, adverse water supply effects and related economic impacts could also occur to water users south of the Delta, as described above.

J4 Economic Values and Methods

This analysis focuses on the economic benefits (and costs) generated by the Project at both the national and regional level. Multiple approaches can be used to measure economic values for the purposes of an NED evaluation. This section first addresses the general types of economic values related to water, and then presents an overview of economic valuation techniques. Next is a comprehensive discussion of economic valuation techniques applicable to the Project, which relate, in part, to the economic values associated with the planning objectives presented in **Section J3**. Following is a discussion of techniques used to estimate regional economic benefits under the RED account.

J4.1 Conceptual Overview of Economic Values and Benefits

The economic value of a good or service is equal to the maximum amount of other goods or services (typically measured in dollars) that an individual is willing to give up to obtain the desired good or service, referred to as “willingness to pay” (WTP). Economic value can be attributed to actual use of good or service (i.e., use value) or independent of their use (i.e., nonuse values). Further, value can either be measured based on trading with established markets (i.e., market value) or outside of markets when unavailable (i.e., nonmarket value). Determining the economic value of goods and services allows for the estimation of economic benefits to both consumers and producers. Economic benefits accruing to consumers and producers of a good or service are measured by consumer and producer surplus, respectively. These broad concepts are discussed in more detail below to provide context to the economic values and benefits considered in this study.

Types of Economic Value

Use Value Use value is the value (or utility) derived from direct or indirect physical use of a resource. In other words, the concept of use value implies that individuals derive direct benefit from interacting with or being in the presence or vicinity of the resource. Use values can further be separated into consumptive and nonconsumptive benefits. Consumptive use benefits are private (exclusionary) benefits that are derived from resource consumption and contribute to resource depletion. Examples of consumptive use benefits associated with natural resources include, for example, agricultural production or certain recreational activities, such as fishing and hunting. Nonconsumptive use benefits do not deplete resources and include, for example, hiking and wildlife viewing.

A wide range of use values are associated with water resources. Under the P&Gs, the specified categories of goods and services are:

- Municipal and industrial (M&I) water supply
- Agricultural floodwater, erosion and sedimentation reduction
- Agricultural drainage
- Agricultural irrigation
- Urban flood damage reduction
- Energy (hydropower)
- Transportation (inland navigation)
- Transportation (deep draft navigation)
- Recreation
- Commercial fishing

Nonuse Value Individuals also value natural resources independent of their present use of those resources. These nonuse measures are a critical component of the total economic value of natural resources. If nonuse values are substantial, excluding them from natural resource policymaking could result in significant misallocation of resources. The three types of nonuse values usually referenced in economic literature are existence, option, and bequest values.

Existence value is one that people place on simply knowing that a resource exists, even if they will never see or use the resource. A representative existence value is that associated with the preservation of endangered species. Nonuse values specific to water resources include those attributed to water supplies that support special-status fisheries.

Option value is one that people place on having the option to enjoy a resource in the future. For example, a person may wish to participate in recreational fishing in the Delta in the future and, thus, may be willing to pay something to preserve the area to maintain that option.

Bequest value is one that people place on knowing that future generations will be able to enjoy a resource. For example, a person may value the protection of water resources in the Delta so that future generations will have the opportunity to enjoy it.

Measurement of Economic Value

Market Value For items traded in established markets, market prices are often used as a proxy for economic value. The market price is established when the price consumers are willing to pay equals the price suppliers are willing to accept for any given quantity of a good. However, price and economic value are not necessarily synonymous and can differ based on inefficiencies in markets, particularly with scarce resources.

Economic value is represented by price for some items, but not others. Such typical household expenditures as food and clothing take place in organized markets, and prices for these goods and services are typically used to represent values. However, the valuation of environmental and natural resources and services, including water, can be complex and controversial because they are not typically traded in markets.

Nonmarket Value It is widely acknowledged that resource-based goods and services that are not traded in markets still have economic value. Further, the price of some natural resources that are traded in markets do not fully reflect their full value, Because their full value, i.e., how much people would be willing to pay for them, is not revealed by market prices, it is necessary to utilize nonmarket valuation methods. Without information on nonmarket values, such resources may be implicitly undervalued and decisions regarding their use may not accurately reflect their true value to society.

Economic Benefits

Measurement of economic benefits tiers off of the concept of economic value. Economic benefits are based on changes in the social value, i.e., welfare of consumers and producers of goods and services. Benefits to consumers are measured by consumer surplus, and benefits to producers are measured by producer surplus. Consumer surplus is defined as the difference between the amount that a consumer is willing to pay for a good or service and what he or she must actually pay to purchase it. Producer surplus is the difference between the amount that a producer of a good or service actually realizes and the amount that he or she is willing to accept for the good or service (see Beskano and Braeutigam 2002). Total economic surplus, which is used to estimate economic benefits, is the sum of consumer and producer surplus. (Total economic surplus is referred to as "economic benefit" throughout this appendix).

J4.2 Overview of Economic Valuation Techniques

Market Valuation

Market valuation techniques are based on the revealed preference of consumers either (1) directly, in the market for the good or service in question via market prices or (2) indirectly, by evaluating the good or service as a factor of production in another good or service traded in markets.

- ***Market Prices.*** As described above, market prices can be used to estimate an individual's WTP for goods or services that are traded in markets, including some natural resources. For this analysis, market prices are used to quantify use values associated with Project-related impacts on hydropower generation. In this case, the value of changes in the net generation of energy attributed to the Project can be measured by the market price of energy, which is actively traded on the established markets.

- ***Productivity Method.*** This approach estimates use values for natural resources that contribute to the production of commercially marketed goods, with their value measured by their contribution to the profits made from the final good. In terms of water supplies, farmers who either receive more (or less) water from the CVP and SWP systems due to the Project are expected to increase (decrease) agricultural production and realize profits (losses) due to changes in the quantity and reliability of these water supplies. Similarly, the value of water quality improvements attributed to the Project can be measured by changes in agricultural productivity. Because changes in net farm revenues are based on crop values that are determined in markets, they are considered market-based values.

Nonmarket Valuation

Nonmarket valuation techniques provide estimates of economic use and nonuse values for goods and services not directly traded in markets, e.g., water resources. Because markets for many natural resources are not developed, economic values are based on revealed or stated WTP. Common valuation techniques used to develop estimates of nonmarket goods and services are described below:

- ***Hedonic Pricing Method.*** This approach estimates use values of natural resources that directly affect market prices of some other good. It is often applied to variations in housing prices that intrinsically reflect the value of local environmental amenities.
- ***Travel Cost Method.*** This approach estimates use values associated with natural resources or sites that are used for recreation. It assumes that the value of a site is reflected in how much people pay to travel to the site.
- ***Damage Cost Avoided, Replacement Cost, and Substitute Cost Methods.*** This approach estimates use values based on avoided costs from lost ecosystem services provided by natural resources, costs of replacing ecosystem services, or costs of providing substitute services. These methods do not provide strict measures of economic values based on individuals' WTP for a product or service. Instead, they are based on the assumption that resources are worth at least as much as people are willing to pay to avoid damages to them or to replace the services that the resources provide.
- ***Contingent Valuation Method.*** This stated-preference approach can be used to estimate the nonuse values associated with virtually any ecosystem or environmental service. It involves surveying individuals to assess their WTP for specific environmental services, based on a hypothetical or contingent scenario. The method is subject to some

controversy because it is based on peoples’ responses to hypothetical scenarios rather than actual behavior.

- ***Contingent Choice Method.*** This approach is similar to contingent valuation, but provides estimates of nonuse values based on asking people to make hypothetical choices or tradeoffs among sets of ecosystem or environmental services or characteristics. The method does not include asking individuals directly for their WTP. Rather, WTP is inferred from tradeoffs that include cost as an attribute.

Benefits Transfer

Benefits transfer involves the use (transfer) of benefit estimates from previous studies that analyzed similar issues in other locations to the resource being analyzed. It has become an increasingly common technique used to estimate natural resource values because of the cost and difficulty in directly estimating economic values, particularly nonmarket values. However, because it represents an indirect approach in estimating economic values, it can be limited in its application due to different study objectives, geographic areas, and socioeconomic classes under consideration. Nevertheless, benefits transfer methodology can be a useful technique for obtaining an indicative measure of economic values and can be used as a screening tool to determine whether more rigorous assessments of economic benefits are warranted.

J4.3 National Economic Development Values and Valuation Methods Applicable to the Delta-Mendota Canal Recirculation Project

This section presents a conceptual overview of NED values expected from the Project and related applicable valuation methods. For each type of economic value (or NED benefit) considered, the information includes the selected valuation technique, modeling tools, level of analysis (e.g., quantitative vs. qualitative), and data sources and limitations. As noted previously, benefit-cost ratios cannot be developed for the alternative plans because of the unavailability of project cost data. The results of the economic analysis are presented in **Section J5**.

Values Related to Fisheries Flow Objectives and Enhancement

The Project would help to meet established SJR flow objectives, which were designed in part to protect beneficial uses established for fisheries. Accordingly, the Project may enhance resident and anadromous fish populations in the SJR and Delta, primarily fall-run Chinook salmon, but also Sacramento splittail and Delta smelt. The benefits of fisheries enhancement can be estimated using different approaches, both qualitative and quantitative, depending on the species of fish and availability of data on a project’s potential physical effects on fishery resources. Quantification of economic values associated with fishery benefits would require quantitative estimates of impacts on fishery populations from models (e.g., SALMOD[2]) and/or other information regarding potential impacts on the pertinent characteristics of affected fishery populations, such as quality and distribution of fisheries. With these data, several types of economic benefits could be analyzed:

- Use values associated with commercial and recreational fish harvests
- Nonuse values related to the continued existence of fisheries (regardless of harvest or other uses)
- Reduced costs for the fishery's recovery and management

A conceptual overview of these fishery benefits is presented below. However, based on the lack of quantified data on the physical effects on fishery populations, fishery-related economic benefits have not been enumerated in this study, and instead, are addressed qualitatively.

Harvest Values (Recreational and Commercial) Project features that result in fisheries benefits may enhance recreational and commercial fishing opportunities. The primary fish species affected by the Project and that has significant harvest value is Chinook salmon. For recreational anglers, improved catch rates in the SJR, Delta, and ocean result in an increased WTP for recreational fishing, thereby increasing consumer surplus values for anglers. For commercial anglers, improvements to the Chinook salmon fishery would likely result in increased commercial fish harvests. All other factors equal, increases in commercial harvests and market values of fish landings can be used to estimate changes in economic values.

If primary data on expected fishery benefits were available, related effects on recreational and commercial fishing and economic values could be estimated using a benefits-transfer approach. Representative values are available from a recent economic evaluation of the proposed North-of-Delta Offstream Storage project being considered by Reclamation and DWR. That analysis includes an estimate of the dollar value of escaping fall-run Chinook salmon based on its harvest value. The combined recreational and commercial value of harvest associated with each escaping fall-run adult Chinook salmon was estimated at approximately $105 (Reclamation and DWR 2007).

Societal Values of Fisheries In addition to enhancing use values associated with fish harvests, benefits to local fisheries under the Project may also aid protected fish species. By promoting the viability of these protected species, the Project would generate nonuse values related to continued species existence. The main species at risk in the Project area are Sacramento splittail (state and federal species of concern) and Delta smelt (state and federal threatened species). The Sacramento splittail is found in the SJR, while both are found in the south Delta and, thus, could indirectly benefit from the designated flow

[2] SALMOD is a computer model developed by the U.S. Geological Survey that simulates the dynamics of freshwater salmonid populations, both anadromous and resident.

objectives. If the Project improves the viability of these at-risk species, society would realize a nonmarket economic value. Although not a protected species, continued viability of fall-run Chinook salmon would also be expected to provide nonuse values realized by society. These values can be estimated using stated WTP techniques, such as contingent valuation. Alternatively, they could be inferred from the management costs that would otherwise be expended for the conservation of these species without the Project.

Stated Willingness to Pay Contingent valuation techniques can be used to estimate the nonuse value that people place on at-risk fish species. Such studies typically require surveys and are data and resource intensive and, therefore, are often expensive to implement. Alternatively, nonuse values can be inferred from other economic studies using a benefits-transfer approach. Ideally, such studies would be available for species identical or closely related to the species and geographical location under consideration. However, no such studies are known to have been conducted specifically for Delta smelt or Sacramento splittail.

Alternatively, for this appendix, studies on species with similar attributes and/or geographic distribution have been reviewed for information on economic value. Studies that focused on species characterized primarily by nonuse values and minimal use values are particularly applicable for Delta smelt and Sacramento splittail. For example, Boyle and Bishop (1987) found that citizens of Wisconsin are willing to pay $7.52 (2002$) per household per year to preserve the striped shiner (a small minnow of the Milwaukee River, which is listed by the State of Wisconsin as endangered); a study by Berrens et al. (1996) found that preservation of the endangered silvery minnow in New Mexico would be worth an average of $8.32 (2002$) per household per year (U.S. Environmental Protection Agency 2004). The economic analysis prepared for the North-of-Delta Offstream Storage project also referenced nonuse values for special-status species, including a contingent value survey in California that found that Californians would be willing to pay more than $200 per household per year to establish a viable salmon population in the SJR (Hanemann et al. 1991), while another study found a lower value of $31.29 per household per year for salmon conservation (U.S. Department of the Interior 1996). The large variation in values suggests that research findings concerning nonuse values can be significantly influenced by different study parameters and assumptions. Nevertheless, based on these representative values and the size of California's population, it is clear that nonuse values associated with species recovery of Delta smelt and Sacramento splittail could be substantial. However, it would be difficult to quantify the WTP for small incremental benefits on fisheries expected from the Project.

Value as Avoided Conservation Costs Under the P&Gs, increases in economic efficiency due to a project may be included as an NED benefit for that project. In this case, the Project's implementation could generate fishery benefits that reduce the scope and related costs of species recovery efforts. Alternatively, fishery benefits can be valued based on the cost of other conservation efforts that would achieve the same level of fishery benefits as those provided by the Project. (Note that the avoided cost technique is an alternative approach for estimating nonuse values and could not be used in conjunction with the stated WTP techniques described above.)

It is reasonable to assume that efforts toward recovery of the Delta smelt and Sacramento splittail species would continue to occur irrespective of the Project. Therefore, the Project could reduce the cost of recovery based on its contribution to recovery goals, holding constant the ultimate population of the fish under recovery conditions. If the benefits to fishery populations generated by the Project are quantified, then the share of the recovery goal achieved by the Project can be deduced. Further, if the cost of recovery can be estimated, then the share of recovery cost avoided because of the Project could likewise be estimated. However, because the Project's contribution to fishery recovery goals has not been quantified, and is likely negligible, avoided conservation costs have not been quantified for this appendix.

Values Related to Water Quality Objectives

The Project is designed to meet water quality objectives to help protect beneficial uses associated with Delta water supplies, including irrigation, M&I, and environmental purposes. The main constituents of concern in the SJR are salts, boron, and selenium, as well as toxicity and low concentrations of dissolved oxygen. The potential economic benefits from improved surface-water quality are increased crop yields and revenues (for agricultural water supplies) and reduced water treatment costs and/or avoided costs of replacement supplies (for M&I supplies).

Agricultural Water Quality Values The quality of agricultural water supplies may limit agricultural production of salt-sensitive crops. The primary agricultural water quality concern in the southern Delta is salinity (electrical conductivity [EC]). The capability to grow salt-sensitive crops in saline conditions depends, in part, on the concentrations of salts in the rootzone (soil salinity or EC_e) and on various environmental and cultural conditions.[3] The most common effect of salinity on plants is a general stunting of growth, which for agriculture may affect crop yields and force shifts in cropping patterns to lower-value crops. Soil salinity is directly affected by the salinity of applied water (EC_w) and different leaching fractions. By improving water quality (i.e., reducing EC levels) in the southern Delta, soil salinity may decrease, and the Project may increase agricultural productivity and the value of crop production in the region.

Crop sensitivity to salinity varies. Researchers have estimated the salt tolerances of numerous crops, including several of those crops grown in the Delta (see

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[3] Note that ECe can be manipulated according to irrigation technique and intensity, which may represent a limitation for strictly relying on ECe values in estimating agricultural impacts.

Maas 1993). Both soil salinity threshold values[4] and yield-reduction coefficients[5] have been estimated and form the basis for salinity-yield curves. The curves are developed under laboratory or controlled field conditions, however, and may not be fully representative of commercial agricultural operations.

The Vernalis Agricultural Water Quality Objective was established to maintain maximum yields of crops irrigated with SJR water diverted from the southern Delta. As outlined in Water Rights Decision 1641, the Vernalis Water Quality Objective was set at 0.7 mmhos/cm from April through August and 1.0 mmhos/cm from September through March. The primary salt-sensitive crops grown in the Delta for which this objective was set are beans, corn and alfalfa, which are the focus of this analysis. The critical months for the three crops were estimated to be April, May, and September, respectively. Using relationships between ECe and EC_w presented in Grattan (2002),[6] threshold EC_w values for the crops of interest were estimated to be 1.133 mmhos/cm (corn), 0.666 mmhos/cm (beans), and 1.333 mmhos/cm (alfalfa).

The estimation of economic benefits attributed to improved water quality should consider the salinity-yield relationships for affected crops, existing and future EC_w at key agricultural diversions in the Delta, existing crop yields, and existing acreages of different crops irrigated with surface-water supplies affected by the Project. The extent to which the quality of existing surface-water supplies affects agricultural production in the study area may be estimated by comparing existing EC_w values during critical growing periods (especially germination, emergence, and early vegetative growth)(Grattan, pers. comm., 2008) to threshold salinity values above which crop yields are adversely affected. If existing salinity levels exceed threshold values and, thus, constrain agricultural production, the reduction in EC attributed to the Project is analyzed to estimate increased crop yields attainable with less saline water supplies. The potential increase in yield could then multiplied by the number of acres receiving irrigation deliveries and the average value of affected crops to estimate the total change in farmgate agricultural values, an economic impact of the Project.

Water quality data from various stations in the south Delta were assessed to analyze the potential impacts on crop yields of the alternative plans. Daily data from January 1, 1921, through September 30, 2003, were analyzed to determine average, minimum, and maximum EC readings for the critical months for corn, beans, and alfalfa. The data used to analyze the impacts of the DMC on south Delta crop yields and results are presented in **Section J5.1**.

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[4] The maximum soil salinity value that will support 100 percent (that is, maximum) crop yield.
[5] The percent yield reduction at salinities exceeding the threshold; represents the slope of the salinity-yield curve.
[6] Based on a leaching fraction of 15-20 percent.

Urban Water Quality Values The Project may affect the quality of urban water supplies for those M&I users that divert water from the Delta. Water quality in urban service areas would be affected by changes in both the amount and quality of Delta water supplies. Many water quality constituents would be affected, including salinity and disinfection by-product precursors (DBPPs), as well as nutrients, pathogens, and others. The economic benefits of improved water quality are primarily avoided treatment costs, but also include extended equipment lives. Representative economic benefits for different classes of urban users are presented below:

- **Residential:** Residential benefits from reduced salinity levels would likely include an increase in the service lives of appliances and residential plumbing as well as reduced usage of bottled water and water softening products. The total avoided cost at the residential level is a function of population, costs of appliances and water softener products, and salinity. The level of water softener use and useful appliance life are functions of the salinity levels.
- **Commercial and Industrial:** Commercial and industrial benefits from reduced salinity would likely include decreased costs for water softening and treatment and for cooling, and extended equipment lives. Total economic impacts are a function of water use, cost of treatment and maintenance, and salinity level.
- **Utilities:** Utility benefits from reduced salinity levels include increased service lives of treatment and distribution facilities. The total economic impacts are a function of population, useful lives of facilities, and salinity levels.

Disinfection by-products (DBPs) and DBPPs are an important Delta water quality problem. Important DBPPs include total organic carbon and bromides. No developed economic model exists for estimating the economic benefits associated with reduced DBPP concentrations. Moreover, the capital costs for treatment technologies to comply with federal DBP standards are largely unaffected by small changes in DBPP concentrations. Incremental economic costs include those for treatment chemicals, sludge disposal, and public health. However, changes in water quality related to M&I use were quantified (See **Appendix G**, Drinking Water Evaluation), but judged to be small and similar among alternative plans. For the purpose of the PFR, quantification of the costs associated with these changes was not developed as it was thought they would not be a discriminating factor in the economic evaluation process.

Values Related to Water Supply Reliability

The Project may improve water supply reliability in the region. Planning Objective C seeks a reduction in demand for water from New Melones Reservoir to meet the water supply obligations to CVP contractors from the New Melones Project. An increase in water supply reliability represents an important source of potential economic benefits that would be provided by the

Project. Specifically, the Project would increase water supplies and improve water supply reliability along the Stanislaus River, thereby benefiting local agricultural and urban land uses. However, the Project may also decrease agricultural water supplies available to other CVP contractors south of the Delta. For the purposes of quantifying water supply benefits and costs, it is assumed that the Project would only affect agricultural water supplies; economic values attributed to changes in urban water supplies are addressed qualitatively. No changes to environmental water supplies (e.g., Environmental Water Account) are anticipated; therefore, no related economic impacts are considered.

Agricultural Water Supplies The economic value of Project-related changes in agricultural water supplies and reliability is based on the resultant marginal changes in agricultural production, crop values, and farm-level costs, which affect consumer and producer surplus values (or social value) provided by the Project. They are estimated for this study using the Central Valley Production Model (CVPM). CVPM is a nonlinear, multiregion, and multicrop simulation model of irrigated agriculture in California's Central Valley. It includes constraints on regional resources, water supplies, and irrigation technologies, among others. The model was developed and is maintained by DWR to analyze the impacts on crop production, water use, and farm net returns of changes in water supply conditions and economic factors. It is run using Generalized Algebraic Modeling System (GAMS) software.

The CVPM includes 21 crop production regions and 20 crop categories. **Figure J-2** is a map of the regions. **Table J-1** describes the regions included in the model. The 21 regions include 5 in the Northern Sacramento Valley, 4 in the Southern Sacramento Valley, 4 in the Northern San Joaquin Valley, and 8 in the Southern San Joaquin Valley. **Table J-2** includes the crop categories and representative crops used for each category.

For this study, the CVPM is used to measure the economic benefits (costs) associated with increases (decreases) in agricultural water supplies and reliability, which in turn are based on outputs from the California Water Resources Simulation Model II (CalSim II). The values estimated by the CVPM include changes in agricultural water use, farm production, farm revenue and profit, and producer and consumer surplus. Surface-water costs are based on water district charges. Estimated groundwater costs are based on depth to water, drawdown rate, and cost per acre-foot per foot of pumping lift. For the measurement of NED benefits and costs, the key measure of changes in agricultural water supply reliability is total economic surplus, the sum of producer and consumer surplus (i.e., "economic benefit"). The model can be used to calculate producer surplus at the regional level, by crop. Consumer surplus can be calculated for all crops produced in the Central Valley. However, the model does not calculate regional values for consumer surplus, as they would require data on the quantity of each crop consumed within each region.

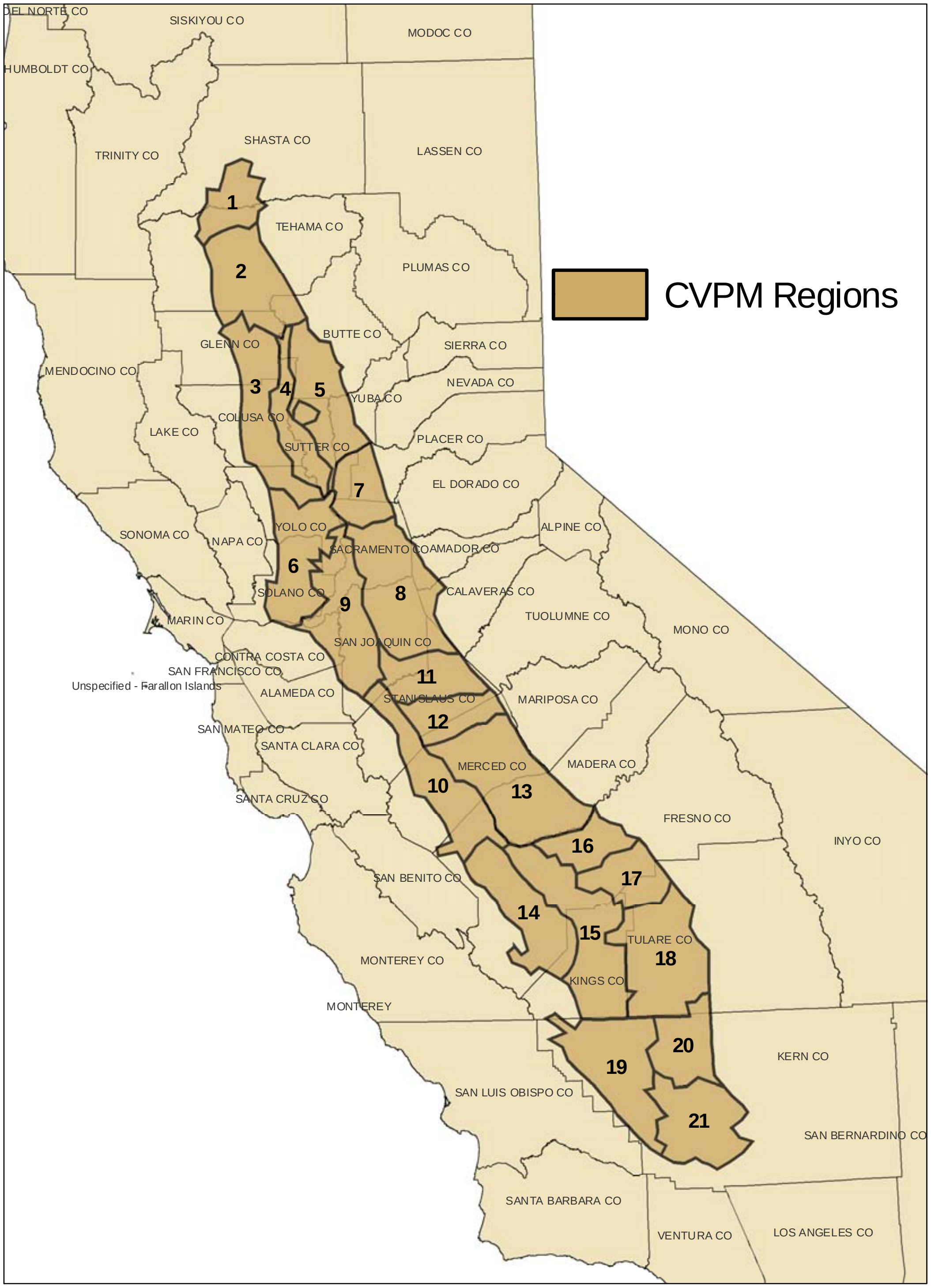

Figure J-2. Central Valley Production Model Regions

Table J-1. Central Valley Production Model Regions and Major Water Users

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

Key:
CVP = Central Valley Project
ID = Irrigation District
MWC = Mutual Water Company
WC = Water Company
WD = Water District

Table J-2. Central Valley Production Model Crop Categories and Representative Crops

Crop Category	Proxy	Unit of Measurement
Grain	Wheat	Tons
Rice	Rice	Tons
Cotton	Cotton	Bales
Sugar Beets	Sugar Beets	Tons
Corn	Corn Silage	Tons
Dry Beans	Dry Beans	Tons
Safflower	Safflower	Tons
Other Field	Sudan Grass	Tons
Alfalfa	Alfalfa Hay	Tons
Pasture	Irrigated Pasture	Acres
Processing Tomatoes	Processing Tomatoes	Tons
Fresh Tomatoes	Fresh Tomatoes	Tons
Cucurbits	Cantaloupes	Tons
Onions And Garlic	Dry Onions	Tons
Potato	White Potato	Tons
Other Truck	Broccoli	Tons
Almonds And Pistachios	Almonds	Tons
Other Deciduous	Walnuts	Tons
Subtropical	Oranges	Tons
Vine	Wine Grapes	Tons

For the NED analysis, the CVPM was used to estimate project-related agricultural impacts. NED benefits were based on the results of the CVPM analysis, the same approach as that used in other water resources investigations, e.g., the North of Delta Offstream Storage study. Several assumptions and data sources are incorporated into the baseline on which the model is calibrated. They include crop prices and harvest and other costs taken from crop enterprise budgets published by the University of California; harvested acreage and crop yields from County Agricultural Commissioner reports; and cost of surface water based on water district charges.

For the DMC analysis, the CVPM was not modified to correspond to the NED concepts as described in the P&Gs. Thus, no distinction was made in the benefits or costs accruing to basic versus nonbasic crops. Because crop yields, production costs, and harvest costs are exogenous to the model, intensification impacts for nonbasic crops measured as changes in yields or production costs similarly were not incorporated. Further, as noted above, producer surplus can be estimated at the individual crop level, by region. That level of resolution is not possible with the model for consumer surplus. If the assumptions incorporated in the CVPM and, by extension, in the DMC analysis, are not fully reflective of the NED account as outlined in the P&Gs, then the results of the NED analysis for agricultural production may be under- or overstated. Reclamation economists in Denver are working on a post-processing model that will utilize CVPM outputs and other variables to develop NED impacts (McLeod, pers. comm., 2008). However, that tool is not yet available, nor are other tools that can be used to convert CVPM outputs to NED impacts.

For the DMC analysis, CalSim II was used to simulate hydrological conditions under the No-Action Alternative and the alternative plans, including projections of water supply conditions in the study area. CalSim II includes water rules for the CVP and SWP systems as constraints and uses linear and mixed integer linear programming to compute optimal water operation decisions.

Simulations used for this analysis were based on projected level of development, environmental conditions, and water system operations for year 2030. Key assumptions include CVP full contract demand south of the Delta and SWP demand of 3.0 to 4.1 million acre-feet (AF). Additional assumptions include projected conditions, decisions, and settlements in the Sacramento River, the SJR, and the Delta; total maximum daily load and water quality actions including Grassland Bypass Project; and Vernalis Adaptive Management Plan. MBK Engineers provided CalSim II results summarizing estimated annual water supplies by water supply source and CVPM region. The agricultural economic impacts estimated with CVPM were based on separate CalSim II results for average and dry water years.[7]

Acreage planted, crop mix, water application rates, and evapotranspiration rate estimates for Water Years 1998, 2000, and 2001 from DWR are used to develop a baseline on which to calibrate the model. Harvested acreage and crop yields are from County Agricultural Commissioner reports and University of California Cooperative Extension crop budgets. Harvest price and harvest cost are also from those budgets.

For this study, it was necessary to project agricultural water use and efficiency for both average and dry years. Observed 1995, 2000, and 2001 data on water use and efficiency were used to develop baseline conditions for an average year. Similar data for 1998 were used to develop baseline conditions for a dry year.

Urban Water Supplies The Project would likely increase urban water supplies and reliability in the Stanislaus River vicinity based on deliveries to the Stockton East Water District, which is a joint agricultural and M&I contractor. The economic benefits of increased urban water supplies can be attributed to avoided water shortages, during which certain urban land uses (and related economic values) would be foregone. In other words, increased urban supplies would improve water supply reliability, thereby allowing local businesses to continue production of goods and services and residents to continue deriving benefits from common household uses of water. The benefit of improved reliability of urban water supplies can be measured based on the opportunity

[7] The average water year scenario was based on historical hydrology of the region using years 1922 to 2003. The dry water year scenario was based on historical hydrology of the region using years 1929 to 1934, 1976 to 1977, and 1987 to 1992.

cost of achieving a certain level of water reliability, i.e., increased supplies would help reduce the costs of achieving a specific level of water supply reliability in the region. These avoided costs may include those for securing higher-priced alternative water sources and foregone investment costs in water supply infrastructure. Based on the anticipated small changes in urban water supplies attributed to the Project, the economic values associated with increased urban water supplies have not been quantified for this analysis.

Values Related to Improving Groundwater Overdraft Conditions

Groundwater overdraft is a concern in the study area, as pumping has increased in several groundwater basins in response to inadequate surface-water supplies. By increasing surface-water supply reliability, the Project, other factors equal, would result in decreased groundwater use. The associated economic benefits are reduced pumping costs and avoided costs associated with land subsidence. Other factors equal, reduced groundwater use would help stabilize depth to groundwater. Accordingly, the power needed to pump groundwater would be reduced, as would energy costs.

Quantification of these impacts would require data on energy costs per AF per foot of lift, existing groundwater depths, amount of pumping, and energy costs. Information on marginal pumping costs would then be applied to estimated changes in groundwater depths and the number of wells in the Project area to estimate the total reduction in pumping costs. The reduced probability of land subsidence in turn would reduce the probability of property and crop damage; no attempt is made to quantify these impacts for this analysis due to the lack of information on physical impacts on these resources.

Values Related to Anadromous Fish Survivability

Fish survivability is a potential benefit of the Project, which could generate economic benefits related to species conservation (nonuse values) and recreation and commercial harvests (use values) for various species. Federal Endangered Species Act-listed species are the winter-run Chinook salmon, Central Valley spring-run Chinook salmon, Central Valley steelhead, Delta smelt, and North American green sturgeon. Other species either not listed or of concern are popular for commercial and recreational anglers. The Project could generate fishery-related use values if it increases population levels of those species. Based on the close relationship between anadromous fish survivability and the Project's fishery flow objectives, the valuation framework for these benefits is the same as that discussed in **Section J4.3**.

Values Related to South Delta Water Levels

Currently, low flows in the SJR combined with high water export rates can cause water in the south Delta to fall to levels that limit the ability to divert water for agricultural purposes. The Project may improve south Delta water levels, which in turn may improve agricultural production in the study area.

The agricultural and economic benefits of improving south Delta water levels depend on the frequency of constraints on agricultural diversions, the amount of water that cannot be diverted, and the cost of replacement water (e.g., groundwater), as well as the values of crops being irrigated. If replacement water supplies are available at higher, yet reasonable costs that would encourage their use, the Project's economic benefits would include the avoided costs of those replacement supplies for irrigation purposes, thereby enabling the maintenance of comparable crop yields and production values. To estimate these benefits, the quantity and net cost of replacement water supplies are required. If replacement supplies are not available and crop production is currently hindered by south Delta water levels, the Project's economic benefits are tied to the value of crop losses that would be avoided by improving the reliability of south Delta water supplies. In this case, information on crop values and crop production losses is required.

Other Economic Effects

Several other economic effects are possible with the Project's implementation, including the economic value attributed to changes in recreational use levels at affected reservoirs and rivers, and changes in hydropower generation and values.

Recreation The Project may affect recreational resources in the Project area because of changes in reservoir levels, river flows, and recreational fishery populations. This section includes a conceptual framework for estimating recreation-related economic impacts due to physical changes in water resources; the economic value related to recreational fishing is discussed in **Section J4.3**.

The Project would increase water storage at New Melones Reservoir while decreasing Stanislaus River releases for flow under certain alternative plans. Both effects could alter recreational quality and access. Increasing water storage at New Melones Reservoir would increase surface-water elevations. Generally, an increase in reservoir levels results in improved water access (both shoreline and boating), better access to recreational facilities (e.g., marinas), reduced crowding, reduced water hazards, and increased aesthetic value. Resultant recreational use levels thus increase for such activities as boating, fishing, camping, hiking, swimming, picnicking, and sightseeing, particularly during the peak summer recreational season. Conversely, a reduction in water releases from New Melones Reservoir would reduce flows in the Stanislaus River, which could have an adverse effect on the quality of whitewater recreational opportunities (e.g., rafting and kayaking) in this stretch of the river. A significant change in the flow regime and decline in whitewater opportunities could result in decreased recreational use.

Such economic values are measured by consumer surplus values (or WTP) for different types of recreational activities. Consumer surplus values capture the amount that a recreational user is willing to pay to engage in a recreational activity above and beyond what is actually paid. **Table J-3** shows representative consumer surplus values for various types of recreation on the Pacific Coast.

Table J-3. Average Consumer Surplus Values for Recreation, Per Person Per Day, Pacific Coast Area ($2004)

Activity	# Estimates	Mean Value ($)	Standard Error
Backpacking	6	$52.10	$9.29
Camping	4	$104.35	$45.38
Cross-country skiing	1	$48.38	--
Downhill skiing	1	$25.08	--
Fishing	15	$44.36	$8.68
Floating/Rafting/Canoeing	4	$27.84	$1.01
General recreation	9	$32.35	$14.38
Hiking	49	$23.24	$2.65
Hunting	18	$45.49	$7.73
Motor boating	8	$26.94	$5.90
Mountain biking	16	$49.68	$2.74
Off-road vehicle driving	1	$40.37	--
Other recreation	1	$74.47	--
Picnicking	3	$64.22	$39.66
Scuba diving	10	$52.60	$25.86
Sightseeing	4	$20.27	$13.51
Snorkeling	9	$30.31	$15.36
Swimming	4	$27.29	$11.35
Wildlife viewing	23	$72.48	$16.90

Source: Loomis 2005

Consumer surplus values can be affected by changes in recreational quality, which in turn affects the marginal value of a recreational experience. Estimating consumer surplus unit values can be difficult without complex valuation techniques. However, published representative consumer surplus values for various recreational activities can be applied to changes in recreational use levels to estimate changes in total consumer surplus values (across all recreational users), referred to as benefits-transfer methodology.

The use of such benefit-transfer methods requires data on changes in recreational activity. For this Project, estimates of Project-related changes in the number of recreational visitors to New Melones Reservoir and the Stanislaus River would be required. The analysis should also account for the potential substitution of recreational users from other regional recreational sites so that the net change in recreational values to society is measured.

Hydropower Generation and Pumping Costs Recirculation under the Project would affect energy generation at CVP and SWP hydropower facilities and energy use at pumping facilities, resulting in a net change in energy values that are considered as part of the NED analysis. **Appendix I** presents the results of the Project's Energy Resources Evaluation. Background information, methods, and results from **Appendix I** are summarized and presented in this economic analysis, where applicable.

The approach to estimate the economic impact associated with changes in energy values is based on the cost of replacement energy supplies (in the case of net energy deficits) or marginal energy revenues (in the case of net energy surpluses). CVP-generated energy is used first for pumping and other purposes of the CVP itself. Any surplus energy is marketed by Western Area Power Administration (WAPA) to its preference customers. The Project would affect energy demand at CVP pumping facilities because of increased pumping. It would also affect hydropower production in both the CVP and SWP systems because of system reoperations. The net change from changes in energy generation and use resulting from the Project would affect the amount of energy available for sale through WAPA. As noted in **Appendix I**, in the case of net energy deficits, WAPA's preference customers may, therefore, purchase replacement energy from other sources at market prices. The net reduction in available energy represents an economic cost of the Project. In the case of net energy surpluses, the marginal energy generated with the Project could be sold resulting in additional revenues for CVP, which is considered an economic benefit. To calculate these economic costs and benefits, the change in energy generation is multiplied by the market price of energy; for this analysis, the gross unit cost of energy is estimated at approximately $53 to $87 per megawatt hour (MWH) depending on time of year.[8]

Implications for Benefit-Cost Analysis

Several of the Project's potential economic benefits are not quantifiable with currently available data and/or are not large enough to warrant quantification. Consequently, several benefits are not quantified herein. Further, the Project's costs have not yet been developed. As a result, a strict comparison of benefits and costs cannot be made.

J4.4 Regional Economic Development Estimation Methods

This section discusses the methodological approach used to estimate the Project's and alternative plans' RED impacts. The focus of the RED analysis is on changes in regional income and employment among industries, businesses, and individuals within a specified geographical region. Because of the large area potentially affected by the Project and the linkages between affected industries throughout California, two regions are considered in the RED analysis. The first is the primary region consisting of the 10 counties (San Joaquin, Stanislaus, Merced, Madera, Fresno, Kings, Tulare, Kern, Santa Clara, and San Benito) that comprise the study area considered throughout the PFR. The second is the State of California, which captures statewide economic effects. With these two regions, the RED analysis highlights two types of

[8] The interpreted monthly average of weekly bilateral electricity price from January 1, 2005, through December 31, 2008, for Northern California (see **Appendix I**).

distribution of regional activity: (1) in California as compared to the rest of the nation and (2) economic impact measures for the 10-county study area within California.

RED measures reflect changes in economic activities due to “backward linkages,” which represent the local-economy purchases by those businesses and households affected by an action. For example, if crop acreage increases, the backward linkages are reflected in farmers’ increased purchases of seed, fertilizer, chemicals, and other inputs. The economic impacts are typically expressed in terms of changes in output, employment, and income. These changes may be estimated using input-output (I-O) analysis, which uses inter-industry and intraregional market relationships and mathematical programming to analyze the dispersal of project expenditures throughout a region and the multiplied impacts of those transactions.

The size of the study area directly affects the magnitudes of impacts within an area. Larger and diverse areas are more self sufficient and, thus, capture more of the multiple buy and sell transactions resulting from an activity. Smaller areas import more goods and services to meet these demands. I-O analysis uses information on sales and expenditures by industry, including the shares of expenditures paid to in-region businesses, to estimate economic multipliers. The multipliers can be used to estimate the total economic impact per dollar of direct output change for any industry. The ratio of the total increase to the direct increase is the multiplier, usually defined for output, employment, and income.

For this analysis, IMPLAN is used to estimate regional economic impacts (for a detailed discussion of IMPLAN, see Minnesota IMPLAN Group, Inc. 2004). IMPLAN is an I-O modeling package and database for 519 industries that can be used to develop an I-O model of any county-level or larger economy. For this RED analysis, 2006 data were used to develop the economic models for both the primary study area and California.

Typically, RED analyses are organized into construction and operations effects. For each phase, changes in final demand attributed to the Project are used as inputs into the IMPLAN models. During construction, changes in final demand represent the short-term costs of implementing the Project. Once construction is complete, long-term expenditures on O&M activities would then be analyzed separately as part of the RED analysis. For this appendix, neither construction nor O&M costs have been determined, and the impacts of those activities have not been quantified for the RED analysis. However, the RED analysis does include the regional economic impacts of changes in agricultural production.

J5 Economic Analysis and Results

This section presents the results of the economic analysis of the alternative plans. The alternative plans are described in detail elsewhere in the PFR and are referenced here as Alternatives A1, A2, B1, B2, C, and D. The economic analysis also considers the No-Action Alternative, which covers the economic effects of not implementing the Project and which serves as the baseline against which economic impacts of the alternative plans are measured. The results of the NED analysis are presented in **Section J5.1**, followed by the RED analysis in **Section J5.2**.

J5.1 National Economic Development Analysis

The NED analysis includes the Project's economic benefits and costs from the federal (or national) perspective. The analysis of economic benefits reflects changes in economic values associated with physical effects on natural resources and resource management, while the Project's costs are based on the monetary outlays required to implement the Project.

Net Economic Benefits

The presentation of economic benefits (costs) is organized by source of benefit (cost). For each considered, results are presented for each of the alternative plans (where applicable) and the No-Action Alternative. The analysis utilizes both quantitative and qualitative techniques. For benefits or impacts that could be readily quantified, the analysis is based on the methodology and analytical approach discussed previously. However, economic benefits and impacts related to certain Planning objectives and opportunities were not quantified because of the small magnitude of impacts and/or unavailability of data.

Fisheries Benefits

Harvest Values The primary fish species affected by the Project that maintains significant harvest value is Chinook salmon. The Project would help achieve targeted flows in the SJR that would aid in the emigration of juvenile fall-run Chinook salmon during an approximate 1-month period between mid-April and mid-May. To the extent that the Project aids in emigration, recreational and commercial fisheries could improve slightly, resulting in improved catch rates. Available data are not sufficient to quantify these impacts.

Species Conservation The Project's fishery benefits would also extend to the Sacramento splittail (state and federal species of concern) and Delta smelt (state and federal threatened species). Because of their low populations and because they are not harvested for recreational or commercial purposes, the economic value of potential fishery benefits to these species is attributed mainly to species conservation. **Appendix H,** Fisheries Evaluation includes a comparison of alternative plans on fisheries. The comparison is not on the basis of numbers or distributions of fish and the economic benefits are therefore not quantifiable.

Water Quality Impacts

Agricultural Water Quality Benefits The Project's agricultural water quality data benefits would be attributable to potential crop yield increases arising from reduced salinity at agricultural diversions in the Delta. **Table J-4** presents for the 1921–2003 period the average, maximum, and minimum EC levels for the months in which crop sensitivity is the greatest for corn, beans, and alfalfa, by alternative plan and gauging station from the DSM2 modeling results (Appendix B). Thus, under the No-Action Alternative, the average EC April reading at Old River at Tracy Road is 489.1, the maximum is 823.6, and the minimum is 207.3. Salinity thresholds are exceeded rarely, even under the No-Action Alternative, and the number of exceedances under the alternative plans is reduced only slightly (see **Table J-5**). Consequently, the economic benefits of water quality improvements generated by the Project would be minimal. For the PFR, changes in water quality were modeled for Alternatives B1, B2, and D to provide an indication of how the range of alternative plans may affect water quality benefits. Of these three, Alternatives B2 and D would provide slightly greater agricultural water quality benefits than Alternative B1 as measured by the number of exceedances of water quality thresholds. Based on these small numbers of exceedances and the difficulty in matching gauging stations with specific agricultural diversions, these benefits have not been quantified for this analysis.

Urban Water Quality Benefits As discussed previously, disinfection by-products, including total organic carbon and bromides, represent important water quality problems associated with Delta supplies. Incremental economic benefits associated with improving water quality include reduced treatment costs (e.g., less treatment chemicals and sludge disposal), as well as lower health care costs based on improved public health. Changes in water quality at M&I intake facilities were small relative to the No-Action Alternative. As a result, related treatment costs have not been developed for the Project and the corresponding economic benefits are not quantified.

Agricultural Water Supply and Reliability The Project's water supply benefits are based on estimates of social welfare (or economic benefit), which is measured as the sum of producer and consumer surplus; see **Section J4.1**. The CVPM is used for this estimation and forecasts regional water deliveries across CVPM regions, based on projected 2030 levels of development. CalSim II modeling results show that the Project would primarily affect water deliveries in CVPM Regions 8 and 14.[9] Water deliveries in all other CVPM regions are unchanged relative to the No-Action Alternative. The results of the CVPM model were tabulated separately for average and dry water year conditions.

[9]The results of the CalSim II modeling show that water supply impacts south of the Delta would primarily occur in Region 14, although potential exists that impacts could also occur in Region 10. For modeling purposes, only Region 14 was considered.

Table J-4. Average, Maximum, and Minimum Electrical Conductivity Readings, by Month and Alternative Plan, 1921–2003

Station and Alternative Plan	Averages by Month, 1921-2003			Maxima, by Month, 1921-2003			Minima by Month, 1921-2003		
Old River at Tracy Road (ROLD059)	**April**	**May**	**September**	**April**	**May**	**September**	**April**	**May**	**September**
No-Project Alternative	514.4	459.7	533.7	833.0	697.8	704.1	220.6	193.9	236.7
No-Action Alternative	489.1	439.7	534.9	823.6	703.1	668.9	207.3	180.7	228.2
Alternative B1	488.0	439.2	534.8	823.6	703.6	668.9	207.3	180.7	228.2
Alternative B2	487.1	439.0	534.9	823.6	705.3	668.9	207.3	180.7	228.2
Alternative D	480.9	436.4	534.8	823.6	706.2	668.9	207.3	180.7	228.2
Old River w. of Victoria Island, nr Hwy 4 (ROLD034)									
No-Project Alternative	335.7	348.0	532.9	641.2	581.3	806.4	235.8	225.8	206.4
No-Action Alternative	330.7	332.7	552.9	575.4	538.2	817.6	228.2	221.8	203.0
Alternative B1	344.0	345.0	552.7	567.4	539.4	817.1	227.1	218.5	203.0
Alternative B2	332.0	333.7	552.9	577.0	544.1	817.6	228.2	221.6	203.0
Alternative D	332.2	335.7	552.8	577.9	547.8	817.6	228.2	221.1	203.0
Rock Slough near Power Plant 1 (SLRCK005)									
No-Project Alternative	415.0	379.0	573.2	876.7	529.8	852.7	240.4	281.3	275.7
No-Action Alternative	367.1	338.9	584.9	806.1	511.7	900.2	238.5	267.4	208.8
Alternative B1	370.4	346.3	584.6	805.7	514.1	899.2	240.0	271.9	208.8
Alternative B2	367.8	339.0	584.9	806.1	511.7	900.2	238.5	267.3	208.8
Alternative D	368.0	341.0	584.8	806.1	511.7	900.1	239.7	268.8	208.8
San Joaquin River at Antioch (RSAN007)									
No-Project Alternative	566.0	833.4	4,852.9	3,038.0	4,095.9	7,448.7	187.7	189.5	210.9
No-Action Alternative	401.9	574.7	3,856.9	1,974.6	2,944.7	5,396.3	190.0	187.2	200.0
Alternative B1	379.6	545.3	3,856.5	2,092.2	3,066.6	5,396.3	192.0	187.5	200.0
Alternative B2	398.3	566.7	3,856.8	1,908.5	2,689.6	5,396.3	190.0	187.2	200.0
Alternative D	394.9	558.0	3,856.8	1,872.4	2,614.5	5,396.3	190.1	187.2	200.0
San Joaquin River at Brandt Bridge (RSAN072)									
No-Project Alternative	469.9	444.4	548.4	757.8	782.9	727.3	208.7	189.9	234.0
No-Action Alternative	433.8	419.8	517.2	757.2	678.3	682.3	198.1	178.4	225.9
Alternative B1	429.0	418.3	517.2	725.1	676.6	682.3	198.1	178.4	225.9
Alternative B2	431.4	418.1	517.2	756.9	676.8	682.3	198.1	178.4	225.9
Alternative D	423.9	415.3	517.2	720.8	676.0	682.3	198.1	178.4	225.9

Table J-4. Average, Maximum, and Minimum Electrical Conductivity Readings, by Month and Alternative Plan, 1921–2003 (concluded)

Station and Alternative Plan	Averages by Month, 1921-2003			Maxima, by Month, 1921-2003			Minima by Month, 1921-2003		
Victoria Canal (CHVCT000)	**April**	**May**	**September**	**April**	**May**	**September**	**April**	**May**	**September**
No-Project Alternative	387.2	379.7	371.0	654.4	593.6	486.0	236.9	228.3	225.3
No-Action Alternative	369.2	356.4	375.4	625.2	553.2	490.9	231.8	219.4	220.1
Alternative B1	381.9	365.1	375.2	625.2	555.5	490.5	230.4	220.1	220.1
Alternative B2	370.5	357.7	375.4	625.2	562.3	590.9	231.8	219.4	220.1
Alternative D	373.1	359.8	375.4	625.2	569.7	490.8	231.8	219.4	220.1
Clifton Court Forebay (CLFCT)									
No-Project Alternative	363.6	361.8	465.0	759.7	689.1	674.3	238.5	216.2	217.5
No-Action Alternative	350.7	343.5	478.0	771.6	644.4	694.4	230.1	206.1	210.5
Alternative B1	361.2	352.9	477.8	771.6	644.4	696.9	231.4	205.0	210.5
Alternative B2	351.5	344.4	478.0	771.6	644.4	697.4	230.1	206.1	210.5
Alternative D	352.8	346.1	478.0	771.6	644.4	697.4	230.1	206.1	210.5
Tracy Pumping Plant (CHDMC006)									
No-Project Alternative	363.6	361.8	465.0	759.7	689.0	674.3	238.5	216.2	217.5
No-Action Alternative	393.3	364.8	495.2	682.2	583.8	702.0	221.9	188.7	223.2
Alternative B1	396.7	369.3	495.0	676.5	585.6	701.6	221.9	187.6	223.2
Alternative B2	394.4	365.9	495.2	684.5	591.7	702.0	221.9	188.7	223.2
Alternative D	394.7	367.2	495.1	685.7	595.6	702.0	221.9	188.7	223.2
Grant Line Canal at Tracy Rd (CHGLR009)									
No-Project Alternative	483.3	445.3	550.9	775.7	702.7	721.5	213.3	190.9	234.4
No-Action Alternative	449.3	421.9	519.7	762.7	691.3	683.9	201.6	178.7	226.0
Alternative B1	447.4	420.2	519.7	754.4	687.1	683.9	201.6	178.7	226.0
Alternative B2	447.1	420.5	519.7	756.8	687.2	683.9	201.6	178.9	226.0
Alternative D	440.3	417.6	519.7	753.7	685.5	683.9	201.6	178.9	226.0
Old River west of Bacon Island (ROLD024)									
No-Project Alternative	274.6	295.3	611.8	521.7	514.2	965.6	211.0	234.1	192.1
No-Action Alternative	272.0	284.2	641.0	465.9	493.1	958.7	211.7	224.2	190.2
Alternative B1	279.0	291.2	640.9	464.1	507.7	958.1	215.2	231.0	190.2
Alternative B2	272.7	284.6	641.0	466.1	480.8	958.7	211.7	224.2	190.2
Alternative D	273.1	285.8	641.0	466.4	477.2	958.6	211.8	224.2	190.2
Middle River at Mowery (RMID040)									
No-Project Alternative	471.6	447.6	549.2	744.8	813.1	727.6	208.6	190.1	234.5
No-Action Alternative	452.0	425.3	518.6	742.9	691.5	683.2	198.7	178.7	226.5
Alternative B1	450.8	424.9	518.6	736.9	690.2	683.2	198.7	178.7	226.5
Alternative B2	450.6	424.1	518.6	735.9	689.7	683.2	198.7	178.7	226.5
Alternative D	445.3	422.3	518.6	731.2	687.7	683.2	198.7	178.6	226.5

Data Summarized from DSM2 Modeling (Appendix B)

Table J-5. Number of Months Salinity of Applied Water Exceeded Threshold Values, by Crop, Station, and Alternative Plan

	Number of Months EC Exceeded Threshold		
	Corn	Beans	Alfalfa
Old River at Tracy Road (ROLD059)	**April**	**May**	**September**
No-Project Alternative	0	5	0
No-Action Alternative	0	3	0
Alternative B1	0	4	0
Alternative B2	0	3	0
Alternative D	0	3	0
Old River w. of Victoria Island, nr Hwy 4 (ROLD034)			
No-Project Alternative	0	0	0
No-Action Alternative	0	0	0
Alternative B1	0	0	0
Alternative B2	0	0	0
Alternative D	0	0	0
Rock Slough near Power Plant 1 (SLRCK005)			
No-Project Alternative	0	0	0
No-Action Alternative	0	0	0
Alternative B1	0	0	0
Alternative B2	0	0	0
Alternative D	0	0	0
San Joaquin River at Antioch (RSAN007)			
No-Project Alternative	12	31	76
No-Action Alternative	5	23	76
Alternative B1	3	18	76
Alternative B2	5	23	76
Alternative D	5	23	76
San Joaquin River at Brandt Bridge (RSAN072)			
No-Project Alternative	0	2	0
No-Action Alternative	0	2	0
Alternative B1	0	1	0
Alternative B2	0	1	0
Alternative D	0	1	0
Victoria Canal (CHVCT000)			
No-Project Alternative	0	0	0
No-Action Alternative	0	0	0
Alternative B1	0	0	0
Alternative B2	0	0	0
Alternative D	0	0	0
Clifton Court Forebay (CLFCT)			
No-Project Alternative	0	1	0
No-Action Alternative	0	0	0
Alternative B1	0	0	0
Alternative B2	0	0	0
Alternative D	0	0	0
Tracy Pumping Plant (CHDMC006)			
No-Project Alternative	0	1	0
No-Action Alternative	0	0	0
Alternative B1	0	0	0
Alternative B2	0	0	0
Alternative D	0	0	0
Grant Line Canal at Tracy Rd (CHGLR009)			
No-Project Alternative	0	4	0
No-Action Alternative	0	1	0
Alternative B1	0	1	0
Alternative B2	0	1	0
Alternative D	0	1	0
Old River west of Bacon Island (ROLD024)			
No-Project Alternative	0	0	0
No-Action Alternative	0	0	0
Alternative B1	0	0	0
Alternative B2	0	0	0
Alternative D	0	0	0
Middle River at Mowery (RMID040)			
No-Project Alternative	0	4	0
No-Action Alternative	0	2	0
Alternative B1	0	1	0
Alternative B2	0	1	0
Alternative D	0	1	0

Projected water deliveries in CVPM Regions 8 and 14 under the No-Action Alternative and the action alternative plans are summarized in **Table J-6** and **Table J-7**, respectively. Under average water year conditions, agricultural deliveries to CVP contractors along the Stanislaus River in Region 8 would increase by 0 to 304 AF/year (depending on the alternative plan) relative to the No-Action Alternative. Estimated changes in CVP water supplies in Region 8 are even less pronounced during dry water year conditions, increasing by only 0 to 11 AF/year. Relative to the No-Action Alternative, the alternative plans would increase Region 8 water supplies by a maximum of 0.04 percent.

Table J-6. Central Valley Project Agricultural Water Deliveries in Region 8 with Delta-Mendota Canal Recirculation Project (1,000 acre-feet)[1]

Water Year[2]	Alternative Plan						
	No-Action Alternative	**A1**	**A2**	**B1**	**B2**	**C**	**D**
Average	66.05	66.05	66.12	66.05	66.14	66.35	66.35
Dry	27.577	27.577	27.580	27.577	27.580	27.588	27.588
Difference from No–Action Alternative							
Average	--	0.00	0.07	0.00	0.09	0.30	0.30
Dry	--	0.00	0.00	0.00	0.00	0.01	0.01
% Difference from No–Action Alternative							
Average	--	0.00%	0.10%	0.00%	0.14%	0.46%	0.46%
Dry	--	0.00%	0.01%	0.00%	0.01%	0.04%	0.04%

Source: CalSim II (provided by MBK Engineers on January 9, 2008).
[1] Changes in agricultural water deliveries in Region 8 would only affect Central Valley Project contractors along the Stanislaus River. Groundwater supplies are not affected by the Delta-Mendota Canal Recirculation Project.
[2] Average water years include all years in hydrologic record (1922─2003). Dry water years correspond to the periods 1929─1934, 1976─1977, and 1987─1992.

Conversely, CVP agricultural water deliveries south of the Delta in Region 14 would decrease. The estimated declines in agricultural deliveries in Region 14 are greater than the estimated increases in water supplies in Region 8. Specifically, CVP agricultural water deliveries in Region 14 are estimated to decrease by approximately 0 to 17,600 AF/year during average water years and 0 to 28,000 AF/year during dry water years. The greatest changes in agricultural water supplies in both Regions 8 and 14 would occur under Alternative D; no changes in water supplies are expected under Alternatives A1 and B1.

Table J-7. Central Valley Project Agricultural Water Deliveries in Region 14 with Delta-Mendota Canal Recirculation Project (1,000 acre-feet)[1]

Water Year[2]	Alternative Plan						
	No-Action Alternative	A1	A2	B1	B2	C	D
Average	711.36	711.36	710.69	711.36	709.91	697.42	693.77
Dry	167.324	167.32	164.32	167.32	164.27	151.80	140.33
Difference from No-Action Alternative							
Average	--	0.00	-0.67	0.00	-1.45	-13.94	-17.59
Dry	--	0.00	-3.01	0.00	-3.05	-15.53	-27.00
% Difference from No-Action Alternative							
Average	--	0.00%	-0.09%	0.00%	-0.20%	-1.96%	-2.47%
Dry	--	0.00%	-1.80%	0.00%	-1.82%	-9.28%	-16.13%

Source: CalSim II (provided by MBK Engineers on January 9, 2008).
[1] Groundwater supplies are not affected by the Delta-Mendota Canal Recirculation Project.
[2] Average water years include all years in hydrologic record (1922–2003). Dry water years correspond to the periods 1929–1934, 1976–1977, and 1987–1992, which are 14 of the 82 years (17 percent of the years).

Agricultural production relates directly to the quantity of water available for irrigation. Agricultural production impacts are shown separately for average and dry water years. Economic impacts are expected within Region 8, where agricultural water supplies will increase; and in Region 14, where water supplies will decline. For this appendix, the economic impacts on these two CVPM regions are noted in the text, but the summary tables are based on aggregated values across all CVPM regions to meet the purposes of the NED analysis. A summary of net economic impacts is presented in **Table J-8**.

Average Water Year Conditions Under the No-Action Alternative during an average water year, irrigated cropland in the Central Valley would total about 4.6 million acres and would generate approximately $2.5 billion in annual economic benefits (i.e., total economic surplus). Under Alternatives A1 and B1, agricultural water supplies and, consequently, agricultural production and economic benefits would be the same as under the No-Action Alternative. Under Alternative A2, the net annual economic benefit of changes in water supplies in Regions 8 and 14 across the Central Valley is approximately $158,000 (+0.006) relative to the No-Action Alternative. Under all other alternative plans, the economic benefit is expected to decline. Specifically, the economic benefit is anticipated to fall by about $103,000 annually (-0.004 percent) under Alternative B2, $941,000 (-0.038 percent) under Alternative C, and nearly $1.2 million (-0.047 percent) under Alternative D. The net change in economic benefits across the Central Valley (i.e., all CVPM regions) is minimal due to offsetting impacts in Regions 8 and 14.

Table J-8. Effect of Proposed Delta-Mendota Canal Recirculation Project on Annual Economic Benefit ($1,000)[1]

	Alternative Plan						
	No-Action Alternative	A1	A2	B1	B2	C	D
Average Water Year[2]							
Economic Benefit	$2,508,648	$2,508,648	$2,508,806	$2,508,648	$2,508,545	$2,507,706	$2,507,461
Difference from No-Action Alternative	--	$0	$158	$0	-$103	-$941	-$1,187
Percent change from No-Action Alternative	--	0.00%	0.01%	0.00%	-0.00%	-0.04%	-0.05%
Dry Water Year[3]							
Economic Benefit	$2,407,214	$2,407,214	$2,406,274	$2,407,214	$2,406,394	$2,403,433	$2,398,715
Difference from No-Action Alternative	--	$0	-$940	$0	-$819	-$3,780	-$8,499
Percent change from No-Action Alternative	--	0.00%	-0.04%	0.00%	-0.03%	-0.16%	-0.35%

Source: Central Valley Production Model
[1] Economic benefit (i.e., total economic surplus) = producer surplus + consumer surplus.
[2] Mean over Water Years 1922–2003.
[3] Mean over Water Years 1929–1934, 1976–1977, and 1987–1992.

The change in economic benefits within specific CVPM regions relates solely to changes in producer surplus values; consumer surplus values are not region specific. In both Regions 8 and 14, agricultural production or related economic benefits would not change under Alternatives A1 and B1. Under Alternative A2, producer surplus would decline approximately $5,400 (-0.018 percent) in Region 8. However, producer surplus would increase for Region 8 in all other alternative plans, including about $5,100 (+0.017 percent) under Alternative B2, $22,300 (+0.076 percent) under Alternative C, and $24,500 (+0.084 percent) under Alternative D.

The economic benefits anticipated for most alternative plans in Region 8 are outweighed by the economic impacts of reduced water supplies south of the Delta in Region 14. Under Alternatives A2, B2, C, and D, producer surplus will decline in Region 14 approximately $60,100 (-0.069 percent), $104,300 (-0.119 percent), $994,400 (-1.139 percent), and $1.2 million (-1.437 percent), respectively, relative to the No-Action Alternative.

Dry Water Year Conditions In dry water years, about 4.4 million acres of Central Valley farmland would be irrigated and would generate an economic benefit of approximately $2.4 billion under the No-Action Alternative. Agricultural production and economic benefits would be unchanged under Alternatives A1 or B1 during dry water years, but would decrease under all other alternative plans relative to the No-Action Alternative. Under Alternatives A2 and B2, the annual economic benefits attributed to agricultural water supplies across the Central Valley are estimated to fall by $940,000 (-0.039 percent) and $819,000 (-0.034 percent), respectively. Under Alternative C, economic benefits related to agricultural production would fall by about $3.8 million annually (-0.157 percent), and under Alternative D, economic benefits would decline by about $8.5 million annually (-0.353 percent).

Economic impacts vary among regions in dry water years. Generally, the magnitude of these economic effects (both positive and negative) is greater during dry water years than in average water years. Based on producer surplus values in Regions 8 and 14, no change in agricultural production or related economic benefits would occur under Alternatives A1 and B1. Alternative A2 would generate the least economic benefits in Region 8, an increase of about $24,300 (+0.067 percent) in producer surplus value. These farm-level benefits in Region 8 increase to $31,100 (+0.085 percent) under Alternative B2, $139,900 (+0.384 percent) under Alternative C, and $257,700 (+0.708 percent) under Alternative D.

Similar to average water-year conditions, the economic benefits in Region 8 are outweighed by the economic impacts of reduced water supplies in Region 14. The smallest impacts are under Alternative B2, where producer surplus values would decline by about $899,100 (-3.102 percent), and under Alternative A2, where values would decline by $974,400 (-3.362 percent) compared to the No-Action Alternative. More pronounced impacts are expected in Alternatives C and D. Under Alternative C, producer surplus values are expected to fall by nearly $4.0 million (-13.784 percent), and under Alternative D, values would decline by approximately $8.3 million annually (-28.711 percent).

Urban Water Supplies and Reliability The Project's impacts on M&I water supply and reliability are expected to be minor, and therefore, not quantified. A conceptual discussion may be found in **Section J4.3**.

South Delta Water Levels Due to the lack of quantified information on how changes in south Delta water levels affect agricultural diversions, the Project's economic effects from improvements in south Delta water levels are not quantified. A conceptual discussion may be found in **Section J4.3**.

Groundwater Overdraft Due to the lack of quantified information on changes in groundwater levels, the Project's economic impacts from improvements in groundwater overdraft conditions are not quantified. A conceptual discussion may be found in **Section J4.3.**

Recreation The Project's recreational benefits would arise from Project-based changes in recreational use levels in the study area. These changes are expected to be very small, however. The average change in end-of-September storage levels at New Melones Reservoir ranges from an increase of 3,000 AF

(Alternative A2) to 9,000 AF (Alternatives C and D).[10] Based on a storage capacity at New Melones Reservoir of 2.4 million AF, the potential increases in water storage (and indirectly, reservoir levels) under the Project are between 0.1 and 0.4 percent of storage capacity. Further, relative to Stanislaus River flows, New Melones Reservoir releases for water quality would decrease by approximately 2,000 AF/year (Alternatives A2, B2, and C) and 5,000 AF/year (Alternative D). Thus, the Project is expected to result in decreased average daily flow releases from 2.8 cubic feet per second (cfs) to 6.9 cfs across the alternative plans. Such declines represent about 0.2-0.5 percent of average daily flow releases from New Melones Reservoir in 2007 (1,422 cfs). Overall, based on the small magnitude of estimated changes in water storage, water levels, and flow releases relative to the No-Project Alternative and the No-Action Alternative, a detailed analysis of the impacts on recreational use and values of the action alternative plans is not undertaken for this Project. Accordingly, the economic effects, as measured by changes in consumer surplus for recreational activities, are expected to be negligible and are not quantified as part of this analysis.

Hydropower Generation The Project's net effects on hydropower generation are presented in **Appendix I**. The Project's hydropower impacts are expected to differ among alternative plans. For each, net economic impacts related to energy consider both additional CVP energy generation and the Project's energy demands. In turn, the change in net generation of energy at all CVP facilities is valued based on the estimated purchase cost of replacement energy by preference customers, which represents foregone energy revenues for CVP under alternative plans that result in a decline in energy generation. Conversely, where net generation would increase, the Project is expected to generate economic benefits. The gross unit cost of energy is estimated at $53-$87 per MWH, which is used to calculate both hydropower benefits and costs.

Table J-9 shows the expected change in energy generation at CVP/SWP power facilities and change in energy use at pumping facilities, as well as associated benefits and costs for all alternative plans relative to the No-Action Alternative. As shown, average long-term net generation would decline for Alternatives A1, A2, B1, B2, and C, by a maximum of 5.24 MWH. Conversely, net hydropower generation with the Project would increase for Alternative D over the long run, by a maximum of 0.61 MWH. Net energy generation during dry periods would decline for all alternative plans, by a maximum of 10.00 MWH.

From an economic standpoint, reductions in net hydropower generation with the Project result in economic costs, while increases in energy generation are economic benefits. Based on market prices, the Project would result in a net increase in energy costs for Alternatives A1, A2, B1, B2, and C, by a maximum of $312,820 annually over the long run. However, costs would decrease for Alternative D, by approximately $62,860 over the long run, which is considered

[10] Project effects on surface-water *elevations* at New Melones Reservoir have not been quantified.

an economic benefit of the Project. Under dry conditions, energy costs would increase for all alternative plans, by a maximum of $600,390.

Project Implementation Costs

As indicated above, the Project would entail capital outlays related to improvements to the wasteway conveyance facilities. These capital costs have not been quantified to date, but are expected to be comparable for all alternative plans. In addition, recirculation activities would also entail ongoing expenditures related to O&M activities, which may vary by alternative plan. Estimates of O&M costs have not yet been developed. Based on the lack of information on the Project's implementation costs, strict comparison of net economic benefits across the alternative plans is not possible. Once this cost information becomes available, it can be integrated into the economic analysis to more comprehensively evaluate the economic merits of the alternative plans.

J5.2 Regional Economic Development Analysis

The RED analysis focuses on changes in agricultural production and related regional economic impacts attributable to changes in surface-water deliveries with the Project. Other potential drivers of RED effects directly attributable to the Project include construction and O&M expenditures. Indirectly, the Project's implementation could also generate RED impacts based on various effects considered in the NED analysis, including changes in fishery harvests, agricultural production (from water quality improvements), drinking water treatment costs, urban water supplies, recreational spending, and energy production. However, the Project's costs and many NED impacts have not been quantified due either to lack of data or the small magnitude of potential impacts; therefore, they have been excluded from the RED analysis.

For this analysis, RED benefits (and impacts) associated with changes in agricultural production are calculated at both the state and regional levels. The state-level analysis is included based on the large size of the study area, which extends across the Central Valley and Delta regions of California. The regional-level analysis captures the Project's anticipated economic impacts in those regions of the state that are directly affected by changes in water supplies. The key measures of RED impacts are changes in economic production (or output), labor income, and employment.

Table J-9. Expected Change in Economic Values of Energy Generation Compared to No-Action Alternative

	Time Period [1,2]	Alt. A1	Alt. A2	Alt. B1	Alt. B2	Alt. C	Alt. D
Power Facilities							
Total Energy Generation of all Facilities (GWH)	Long-Term	0.00	0.23	0.10	0.49	0.89	0.88
	Driest Periods	0.00	(0.36)	0.18	(0.11)	0.96	(1.48)
Pumping Facilities							
Total Energy Use of all Facilities at load center (GWH)	Long-Term	3.21	3.63	4.85	5.74	1.93	0.27
	Driest Periods	4.86	6.47	7.39	9.89	6.47	0.42
Net Energy Generation							
Net Generation of all Facilities (GWH)	Long-Term	(3.21)	(3.39)	(4.75)	(5.24)	(1.04)	0.61
	Driest Periods	(4.86)	(6.82)	(7.21)	(10.00)	(5.51)	(1.90)
Economic Value							
Power Benefits (Costs) ($1,000)	Long-Term	($203.36)	($213.23)	($291.80)	($312.82)	($44.68)	$62.86
	Driest Periods	($302.62)	($416.86)	($437.46)	($600.39)	($305.79)	($70.36)

[1] Long-Term is the average quantity for Calendar Years 1922–2002.

[2] Driest period is the average quantity for Calendar Years 1929–1934, 1976–1977, and 1987–1992.

Key:

GWH = gigawatt-hour(s)

Value of Agricultural Production

The Project's agricultural impacts vary by region across the state. The value of agricultural output (i.e., gross crop revenue) is expected to increase in CVPM Region 8 (primarily San Joaquin County) because the Project would increase water supplies to that area. As a result, new land may be brought into production and/or less cropland would be idled for water transfers to environmental and urban water users. Conversely, agricultural production is expected to decline in Region 14 (primarily Fresno and King counties) due to a reduction in water supplies south of the Delta. Indirectly, agricultural production in other parts of the Central Valley is also affected based on linkages among regions. The results of the CVPM analysis include changes in irrigated acreage, net economic value (i.e., consumer and producer surplus), and gross revenue (i.e., value of agricultural production) in affected CVPM regions. Changes in gross revenues represent the direct output impact under the RED analysis and are used as inputs to the IMPLAN model to estimate total changes in regional output, income, and employment, which take into account indirect and induced effects. The annual value of agricultural output under 2030 conditions, by CVPM region and alternative plan, is presented in **Tables J-10 and J-11**. Agricultural output for the entire Central Valley (i.e., all CVPM regions) is presented in **Table J-12**.

In Region 8, where the Project generates additional water supplies, the value of agricultural production increases slightly under Alternatives A2, B2, C, and D relative to the No-Action Alternative. Under average water year conditions, agricultural production value is estimated at $802.1 million under the No-Action Alternative and is expected to increase by up to $485,700 per year (0.06 percent) under Alternative D. Similarly, under dry water year conditions, agricultural production value is estimated to increase by up to $878,300 per year (0.11 percent) under Alternative D relative to the No-Action Alternative. For Alternatives A2, B2, and C, increases in the value of agricultural production are lower than Alternative D in both average and dry years.

Agricultural production values are expected to decrease in Region 14 due to water supply reductions under Alternatives A2, B2, C, and D. In average water years, agricultural values decline by as much as $10.8 million annually (-1.14 percent) under Alternative D relative to the No-Action Alternative, where the value of agriculture is estimated at $947.3 million. Substantially larger declines are expected in dry water years, where agricultural production values under Alternative D are anticipated to fall by as much as $66.4 million per year (-13.45 percent). Estimated decreases in the value of agricultural production in Region 14 for Alternatives A2, B2, and C are lower than Alternative D.

Looking at agricultural production across the entire Central Valley, estimated at $13.5 billion annually, the net value of production in Alternatives B2, C, and D is lower than the No-Action Alternative in average water years, with production losses in Region 14 outweighing production increases in Region 8 and other CVPM regions. Specifically, agricultural values fall by as much as $9.7 million annually (-0.07 percent) under Alternative D. Minor increases in agricultural production are expected under Alternative A2 in average years. In dry years, however, adverse impacts on agricultural production are expected under all alternative plans and are generally greater than in average years. In fact, agricultural production values under Alternative D are anticipated to fall by as much as $59.1 million per year (-0.5 percent) relative to the No-Action Alternative. Projected declines in the value of agricultural production for Alternatives A2, B2, and C are lower than Alternative D.

Table J-10. Annual Value of Agricultural Output in Central Valley Production Model Region 8, by Alternative Plan (in $millions)[1,2]

	Average Conditions			Dry Conditions		
Alternative Plan	Gross Crop Revenue	Difference from No-Action Alternative	Percent Change from No-Action Alternative	Gross Crop Revenue	Difference from No-Action Alternative	Percent Change from No-Action Alternative
No-Action Alternative	$802.08	--	--	$811.30	--	--
A1	$802.08	$0.00	0.00%	$811.30	$0.00	0.00%
A2	$802.17	$0.09	0.01%	$811.44	$0.14	0.01%
B1	$802.08	$0.00	0.00%	$811.30	$0.00	0.00%
B2	$802.22	$0.14	0.02%	$811.49	$0.19	0.02%
C	$802.56	$0.48	0.06%	$811.99	$0.69	0.09%
D	$802.56	$0.49	0.06%	$812.18	$0.88	0.11%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.
[2] Values in table are reported in millions of 2007 dollars.

Table J-11. Annual Value of Agricultural Output in Central Valley Production Model Region 14, by Alternative Plan (in $millions)[1,2]

	Average Conditions			Dry Conditions		
Alternative Plan	Gross Crop Revenue	Difference from No-Action Alternative	Percent Change from No-Action Alternative	Gross Crop Revenue	Difference from No-Action Alternative	Percent Change from No-Action Alternative
No-Action Alternative	$947.32	--	--	$493.86	--	--
A1	$947.32	$0.00	0.00%	$493.86	$0.00	0.00%
A2	$946.89	-$0.44	-0.05%	$488.78	-$5.08	-1.03%
B1	$947.32	$0.00	0.00%	$493.86	$0.00	0.00%
B2	$946.43	-$0.89	-0.09%	$488.80	-$5.06	-1.03%
C	$938.76	-$8.57	-0.90%	$463.02	-$30.85	-6.25%
D	$936.52	-$10.81	-1.14%	$427.42	-$66.44	-13.45%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.
[2] Values in table are reported in millions of 2007 dollars.

Table J-12. Annual Value of Agricultural Output in the Central Valley, by Alternative Plan (in $millions)[1,2]

	Average Conditions			Dry Conditions		
Alternative Plan	**Gross Crop Revenue**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Gross Crop Revenue**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	$13,478.32	--	--	$12,933.02	--	--
A1	$13,478.32	$0.00	0.00%	$12,933.02	$0.00	0.00%
A2	$13,478.77	$0.46	0.00%	$12,928.02	-$5.00	-0.04%
B1	$13,478.32	$0.00	0.00%	$12,933.02	$0.00	0.00%
B2	$13,477.62	-$0.71	-0.01%	$12,928.79	-$4.22	-0.03%
C	$13,470.70	-$7.62	-0.06%	$12,905.91	-$27.11	-0.21%
D	$13,468.60	-$9.72	-0.07%	$12,873.94	-$59.08	-0.46%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.
[2] Values in table are reported in millions of 2007 dollars.

State Level Regional Economic Development Analysis

Economic impacts are calculated at the state level using California's IMPLAN model. Direct effects are based on net changes in the value of agricultural production (output) throughout the Central Valley. As described above, changes in agricultural production are expected to occur primarily in two distinct regions of the state, but production effects also occur in other regions as estimated by the CVPM model. The net changes in agricultural production values across all regions were input into the statewide economic model to estimate total changes in economic production (output), labor income, and employment in all sectors of California's economy based on inter-industry linkages. The results of the statewide RED analysis are shown in **Table J-13**, **Table J-14**, and **Table J-15**, respectively.

Reductions in agricultural production are expected to be highest under Alternative D, and accordingly, it would have the largest adverse effect on regional economic activity of the alternative plans. Implementation of Alternative D would result in a reduction in total annual output throughout California of $16.7 million (-0.07 percent) in average water years and $96.5 million (-0.45 percent) in dry water years compared to the No-Action Alternative; these effects capture changes across all economic sectors that are linked to the agricultural industry. When evaluated relative to total statewide output of approximately $3.2 trillion annually, reductions in total output attributed to the Project are minor (i.e., less than 0.01 percent). Estimated reductions in regional economic activity under Alternatives B2 and C are lower than Alternative D, while regional economic benefits are expected with Alternative A2. Patterns for labor income and employment are similar, with the greatest adverse impacts expected under Alternative D.

Table J-13. Statewide Economic Impacts
Total Annual Output Value Agricultural Production in the Central Valley (in $millions)[1,2]

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Value of Output**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Value of Output**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	$22,516.90	--	--	$21,604.99	--	--
A1	$22,516.90	$0.00	0.00%	$21,604.99	$0.00	0.00%
A2	$22,517.69	$0.79	0.00%	$21,596.89	-$8.10	-0.04%
B1	$22,516.90	$0.00	0.00%	$21,604.99	$0.00	0.00%
B2	$22,515.69	-$1.21	-0.01%	$21,598.10	-$6.88	-0.03%
C	$22,503.83	-$13.08	-0.06%	$21,560.72	-$44.27	-0.20%
D	$22,500.23	-$16.68	-0.07%	$21,508.52	-$96.47	-0.45%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.
[2] Values in table are reported in millions of 2007 dollars.

Table J-14. Statewide Economic Impacts
Total Annual Labor Income from Agricultural Production in the Central Valley (in $millions)[1,2]

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Labor Income**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Labor Income**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	$7,242.50	--	--	$6,946.00	--	--
A1	$7,242.50	$0.00	0.00%	$6,946.00	$0.00	0.00%
A2	$7,242.86	$0.36	0.00%	$6,943.31	-$2.69	-0.04%
B1	$7,242.50	$0.00	0.00%	$6,946.00	$0.00	0.00%
B2	$7,242.18	-$0.33	-0.00%	$6,943.70	-$2.30	-0.03%
C	$7,238.92	-$3.59	-0.05%	$6,931.28	-$14.72	-0.21%
D	$7,237.92	-$4.59	-0.06%	$6,913.84	-$32.16	-0.46%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.
[2] Values in table are reported in millions of 2007 dollars.

Table J-15. Statewide Economic Impacts
Total Employment from Agricultural Production in the Central Valley[1]

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Employment**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Employment**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	174,597	--	--	169,072	--	--
A1	174,597	0	0.00%	169,072	0	0.00%
A2	174,603	5	0.00%	169,025	-47	-0.03%
B1	174,597	0	0.00%	169,072	0	0.00%
B2	174,589	-8	-0.00%	169,030	-42	-0.03%
C	174,509	-89	-0.05%	168,799	-273	-0.16%
D	174,484	-113	-0.06%	168,477	-595	-0.35%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.

Regional Analyses

Two additional RED analyses were conducted for this study to evaluate localized economic effects associated with changes in agricultural production with the Project. IMPLAN models were developed for the following areas:

- CVPM Region 8: San Joaquin County
- CVPM Region 14: Fresno and King Counties

The direct impacts on agricultural production in CVPM Regions 8 and 14 are outlined in **Tables J-10 and J-11**, respectively. These effects are included in the statewide analysis above, but in this section, localized effects on agricultural production are considered separately for each region using regional level models.

CVPM Region 8 The Project would cause agricultural production to increase in Region 8, resulting in economic benefits to San Joaquin County in increased total output, labor income, and employment (see **Table J-16**, **Table J-17**, and **Table J-18**, respectively). The greatest benefits would occur under Alternative D, which is described below; no benefits are expected under Alternatives A1 and B1 as they do not generate increased in local water supplies.

Total output in San Joaquin County generated by local agricultural production is expected to increase by up to $735,000 per year (0.06 percent) in average water years relative to the No-Action Alternative. In dry water years, the change in total output is more pronounced, increasing by up to $1.3 million (0.11 percent) compared to the No-Action Alternative. Increases in total output value in average and dry water years represent less than 0.01 percent of the total value of output produced in San Joaquin County.

Labor income and employment benefits are also anticipated in San Joaquin County with the Project. Specifically, labor income is estimated to increase by up to approximately $242,000 per year in average water years and up to $428,000 in dry water years relative to the No-Action Alternative. In terms of employment, the Project would generate an additional 6 to 10 jobs in average and dry years, respectively.

**Table J-16. San Joaquin County
Total Annual Output from Agricultural Production in Central Valley Production Model Region 8 (in $millions)[1,2]**

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Value of Output**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Value of Output**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	$1,225.96	--	--	$1,239.49	--	--
A1	$1,225.96	$0.00	0.00%	$1,239.49	$0.00	0.00%
A2	$1,226.10	$0.14	0.01%	$1,239.71	$0.21	0.02%
B1	$1,225.96	$0.00	0.00%	$1,239.49	$0.00	0.00%
B2	$1,226.18	$0.22	0.02%	$1,239.78	$0.29	0.02%
C	$1,226.70	$0.73	0.06%	$1,240.53	$1.04	0.08%
D	$1,226.70	$0.74	0.06%	$1,240.81	$1.31	0.11%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.

[2] Values in table are reported in millions of 2007 dollars.

**Table J-17. San Joaquin County
Total Annual Labor Income from Agricultural Production in Central Valley Production Model Region 8 (in $millions)[1,2]**

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Labor Income**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Labor Income**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	$417.64	--	--	$421.72	--	--
A1	$417.64	$0.00	0.00%	$421.72	$0.00	0.00%
A2	$417.68	$0.05	0.01%	$421.79	$0.07	0.02%
B1	$417.64	$0.00	0.00%	$421.72	$0.00	0.00%
B2	$417.71	$0.07	0.02%	$421.82	$0.09	0.02%
C	$417.88	$0.24	0.06%	$422.06	$0.34	0.08%
D	$417.88	$0.24	0.06%	$422.15	$0.43	0.10%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.

[2] Values in table are reported in millions of 2007 dollars.

**Table J-18. San Joaquin County
Total Employment from Agricultural Production in Central Valley Production Model Region 8[1]**

	Average Conditions			Dry Conditions		
Alternative Plan	Total Employment	Difference from No-Action Alternative	Percent Change from No-Action Alternative	Total Employment	Difference from No-Action Alternative	Percent Change from No-Action Alternative
No-Action Alternative	10,607	--	--	10,709	--	--
A1	10,607	0	0.00%	10,709	0	0.00%
A2	10,608	1	0.01%	10,711	2	0.01%
B1	10,607	0	0.00%	10,709	0	0.00%
B2	10,609	2	0.02%	10,712	2	0.02%
C	10,614	6	0.06%	10,718	8	0.08%
D	10,614	6	0.06%	10,719	10	0.09%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.

CVPM Region 14 The economic benefits outlined in Region 8 are outweighed by adverse economic impacts anticipated in Region 14. All three economic measures, total output, labor income, and employment, are expected to decrease in Fresno and King counties with the Project (see **Table J-19**, **Table J-20**, and **Table J-21**, respectively). The largest changes are expected under Alternative D; no economic impacts are anticipated under Alternatives A1 and B1.

In Fresno and King counties, total output lost due to decreases in local agricultural production is estimated to be as large as -$17.7 million per year (-1.20 percent) in average water years and -$100.5 million (-13.02 percent) in dry water years relative to the No-Action Alternative. The declines in total output value are minor when evaluated relative to total output in these two counties, with declines of 0.03 percent of total output value in average years and 0.17 percent in dry years.

Labor income and employment in Fresno and King counties would also be adversely affected by the Project. Labor income is estimated to decrease by up to approximately $5.0 million annually in average water years and up to $32.5 million in dry water years relative to the No-Action Alternative. Employment impacts include losses of 145 and 663 jobs in average and dry years, respectively.

**Table J-19. Fresno and King Counties
Total Annual Output from Agricultural Production in Central Valley Production Model Region 14 (in $millions)[1,2]**

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Value of Output**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Value of Output**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	$1,477.70	--	--	$771.43	--	--
A1	$1,477.70	$0.00	0.00%	$771.43	$0.00	0.00%
A2	$1,476.99	-$0.71	-0.05%	$763.75	-$7.69	-1.00%
B1	$1,477.70	$0.00	0.00%	$771.43	$0.00	0.00%
B2	$1,476.24	-$1.46	-0.10%	$763.78	-$7.66	-0.99%
C	$1,463.69	-$14.01	-0.95%	$724.78	-$46.66	-6.05%
D	$1,460.03	-$17.67	-1.20%	$670.97	-$100.47	-13.02%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.
[2] Values in table are reported in millions of 2007 dollars.

**Table J-20. Fresno and King Counties
Total Annual Labor Income from Agricultural Production in Central Valley Production Model Region 14 ($millions)[1,2]**

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Labor Income**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Labor Income**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action Alternative	$477.85	--	--	$261.26	--	--
A1	$477.85	$0.00	0.00%	$261.26	$0.00	0.00%
A2	$477.65	-$0.20	-0.04%	$258.77	-$2.49	-0.95%
B1	$477.85	$0.00	0.00%	$261.26	$0.00	0.00%
B2	$477.44	-$0.42	-0.09%	$258.78	-$2.48	-0.95%
C	$473.87	-$3.98	-0.83%	$246.19	-$15.06	-5.77%
D	$472.83	-$5.02	-1.05%	$228.78	-$32.48	-12.43%

[1] Based on projected level of development, environmental conditions, and water system operations for year 2030.
[2] Values in table are reported in millions of 2007 dollars.

**Table J-21. Fresno and King Counties
Total Employment from Agricultural Production in Central Valley Production Model Region 14[1]**

	Average Conditions			Dry Conditions		
Alternative Plan	**Total Employment**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**	**Total Employment**	**Difference from No-Action Alternative**	**Percent Change from No-Action Alternative**
No-Action alternative	11,949	--	--	6,657	--	--
A1	11,949	0	0.00%	6,657	0	0.00%
A2	11,943	-6	-0.05%	6,606	-51	-0.76%
B1	11,949	0	0.00%	6,657	0	0.00%
B2	11,937	-12	-0.10%	6,606	-51	-0.76%
C	11,834	-115	-0.96%	6,348	-309	-4.64%
D	11,804	-145	-1.21%	5,994	-663	-9.96%

[1] Based on projected level of development, environmental conditions, and water system operations or year 2030.

J6 Summary of Economic Impacts Among Alternative Plans

This section summarizes the expected economic impacts of the alternative plans and the No-Action Alternative. As noted in previous sections of this appendix, many benefits and all the Project's costs have not been quantified. Consequently, it is not possible either to develop benefit-cost ratios or to complete a separable costs-remaining benefits analysis among the alternative plans. **Table J-22** notes those characteristics that could be quantified (agricultural production and energy generation) and those for which only qualitative analyses were possible.

J6.1 National Economic Development Economic Effects by Alternative Plan

Table J-22 shows the annual NED benefits expected by alternative plan relative to the No-Action Alternative. As noted and discussed previously, quantitative estimates are developed only for agricultural water supply and hydroelectric energy impacts. Water supply impacts are measured in terms of changes in economic surplus (i.e., sum of consumer and producer surplus) from agricultural production in CVPM Regions 8 and 14. Hydroelectric impacts are in terms of changes in the gross purchase costs of replacement energy by preference customers because of reductions in surplus energy. For the No-Action Alternative and the alternative plans, the sum of quantified economic impacts is negative, indicating the Project would result in economic costs from a NED perspective. In average years, the smallest decline in net annual benefits is expected from Alternative A2, while the biggest decline is expected with Alternative D. In dry years, the smallest and largest decline in net annual benefits is expected under Alternatives A1 and D, respectively. Overall, the analysis indicates that Alternative D has the potential to generate the greatest adverse economic effects out of the various alternative plans considered in the PFR. However, it is important to note that a number of potential benefits (costs) were not quantified as part of this study; therefore, the results cannot be used to compare the Project's costs and benefits, but instead as a tool to analyze the relative economic merits across alternative plans for those benefit categories considered.

Table J-22. Annual National Economic Development Benefits and Costs, by Alternative Plan ($ Millions)[1,2]

Benefits and Costs	Alternative Plan					
	A1	A2	B1	B2	C	D
Fisheries Enhancements	Not Quantified (Addressed Qualitatively)					
Water Supply (Agriculture)						
Average Years	$0.00	$0.16	$0.00	-$0.10	-$0.94	-$1.19
Dry Years	$0.00	-$0.94	$0.00	-$0.82	-$3.78	-$8.50
Water Supply (Urban)	Not Quantified (Addressed Qualitatively)					
Water Quality (Agriculture)	Not Quantified (Addressed Qualitatively)					
Water Quality (Urban)	Not Quantified (Addressed Qualitatively)					
South Delta Water Levels	Not Quantified (Addressed Qualitatively)					
Groundwater Overdraft	Not Quantified (Addressed Qualitatively)					
Recreation	Not Quantified (Addressed Qualitatively)					
Hydropower						
Average Years	-$0.20	-$0.21	-$0.29	-$0.31	-$0.04	$0.06
Dry Years	-$0.30	-$0.42	-$0.44	-$0.60	-$0.31	-$0.07
TOTAL ANNUAL NET BENEFITS						
Average Years	-$0.20	-$0.05	-$0.29	-$0.42	-$0.99	-$1.12
Dry Years	-$0.30	-$1.36	-$0.44	-$1.42	-$4.09	-$8.57

[1] National Economic Development benefits (costs) are measured relative to No–Action Alternative.
[2] Current dollars.

J6.2 Regional Economic Development Economic Effects by Alternative Plan

As presented in **Section J5.2**, the Project's RED effects vary by region and alternative plan. At the state level, reductions in the value of agricultural production in CVPM Region 14 outweigh production increases in Region 8 under Alternatives A2, B2, C, and D. As such, a net decrease in agricultural production value would occur across the state under these four alternative plans. No RED impacts would occur under Alternatives A1 and B1 because no changes in water supplies or agricultural production are anticipated. Of the alternative plans with agricultural impacts, Alternative D is expected to generate the largest reductions in total output, labor income, and employment at the state level under both average and dry water conditions. In fact, estimated economic impacts under all three measures (i.e., output, income, and employment) under Alternative D are more than twice as high as any other alternative plan in dry water years. Under average conditions, Alternative D is followed by Alternatives C, B2, and A2 in terms of the magnitude of all economic impact measures. This pattern is slightly altered under dry conditions, where Alternative D is followed by Alternatives C, A2, and B2.

At the regional level, economic benefits in Region 8 (San Joaquin County) and adverse economic impacts in Region 14 (Fresno and King Counties) are anticipated to be greatest under Alternative D for all economic measures.

In Region 8, Alternative C is expected to generate comparable levels of economic benefits relative to Alternative D in average water years, while Alternatives B2 and A2 are considerably lower. Under dry conditions, the difference between Alternatives D and C is larger, but the economic benefits anticipated under either of these alternative plans are still substantially higher than Alternatives B2 and A2.

In Region 14, the adverse economic effects of reduced water supplies are greatest under Alternative D as described above. However, these impacts are only slightly greater than Alternative C under average conditions, but more than twice the impacts of Alternative C in dry conditions. The magnitude of economic impacts under both of these alternative plans is significantly higher than for Alternatives A2 and B2 in either average or dry water years (**Table J-22**).

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