Appendix B

Water Operations Assessment

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Appendix B
Water Operations Assessment

B.1 Background

Hydrologic conditions, climatic variability, and regulatory requirements for operation of water projects commonly affect water supply availability in California. This variability strains water supplies, making advance planning for water shortages necessary and routine. In the past decades, water entities have been implementing water transfers to supplement available water supplies to serve existing demands and transfers have become a common tool in water resource planning.

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) manages the Central Valley Project (CVP), which includes storage in reservoirs (such as Shasta, Folsom, and Trinity reservoirs) and diversion pumps in the Sacramento-San Joaquin Delta (Delta) to deliver water to users in the San Joaquin Valley and San Francisco Bay area. When these users experience water shortages, they may look to water transfers to help reduce potential impacts of those shortages.

A water transfer involves an agreement between a willing seller and a willing buyer. To make water available for transfer, the willing seller must take an action to reduce the consumptive use of water or reduce reservoir storage. This water would be conveyed to the buyers' service area for beneficial use. Water transfers would only be used to help meet existing demands and would not serve any new demands in the buyers' service areas.

Reclamation and the San Luis & Delta-Mendota Water Authority (SLDMWA) are completing a joint Environmental Impact Statement/Environmental Impact Report (EIS/EIR), in compliance with the National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA), for water transfers from 2015 through 2024. Reclamation is serving as the Lead Agency under NEPA and SLDWMA is the Lead Agency under CEQA. Reclamation would facilitate transfers proposed by buyers and sellers. The SLDMWA, consisting of federal and exchange water service contractors in western San Joaquin Valley, San Benito, Santa Clara, and Stanislaus counties, helps negotiate transfers in years when the member agencies could experience shortages.

This EIS/EIR evaluates water transfers that originate from entities located upstream of the Delta. Purchasing agencies are in areas south of the Delta or in the San Francisco Bay Area. Water transfers are subject to federal and state law.

The transfers included in this EIS/EIR are only those involving CVP supplies or CVP facilities. These transfers require approval from Reclamation, which necessitates compliance with NEPA. Other transfers not involving CVP supplies or use of CVP facilities could occur during the same time period, subject to their own environmental review (as necessary). Non-CVP transfers are analyzed in combination with the potential alternatives in the cumulative analysis.

B.2 Purpose of Water Operations Analysis

An analysis of water operations is necessary to assist in evaluation of potential environmental impacts associated with the Long-Term Water Transfer Project (the Project). Water transfers have the potential to affect both the natural system and operation of the CVP and State Water Project (SWP). The purpose of this analysis is to simulate water made available by various sellers included in the Project, how that water moves through the system and potentially effects operations, and how and where transfer water is diverted by buyers. Output from the water operations analysis for parameters such as stream flow, reservoir storage, Delta outflow, and CVP and SWP Delta exports provides a basis for environmental assessment.

B.3 Analytical Approach

Water transfer analysis is performed with several analytical tools. Separate tools are used to evaluate the surface water and groundwater systems with information and results passed between the tools. Analysis relies on the use and interaction of three different models: CalSim II, the Sacramento Valley Finite Element Groundwater Model (SACFEM2013), and Transfer Operations Model (TOM). Model results of a baseline condition, the No Action/No Project Alternative, without proposed water transfers are compared to model results with proposed water transfers under each Project alternative to determine the extent and significance of any differences resulting from the Project.

CalSim II serves as the basis for simulating the surface water system. A baseline model of CVP/SWP operations for the Sacramento and San Joaquin river systems and the Delta was developed and provided by Reclamation. This model baseline represented the best available model assumptions developed by Reclamation as of January 2014.

Estimated groundwater pumping associated with groundwater substitution transfers was added to baseline groundwater pumping under existing conditions and input to SACFEM2013 to simulate the effects of groundwater substitution transfers on Sacramento Valley aquifers. SACFEM2013 also simulates interaction between groundwater and surface water systems at the streambed interface. Groundwater pumping can affect the surface water system because a hydraulic connection exists between the groundwater and surface water systems in the Sacramento Valley. SACFEM2013 was used to simulate effects on the groundwater system and the change in stream-aquifer interaction. SACFEM2013 model results for the change in stream-aquifer interaction were incorporated into the water operations analysis.

A separate model, TOM, was developed to simulate changes in the surface water system. TOM is a spreadsheet model developed by MBK Engineers to assess how water made available for transfer moves through the river system and is diverted by buyers. Additionally, TOM analyzes how changes in stream-aquifer interaction due to groundwater substitution transfers affect the CVP and SWP. TOM was developed to quickly and effectively assess changes from a variety of transfer sources and mechanisms to a variety of different buyers.

TOM relies on the CalSim II baseline simulation of CVP and SWP operations and then layers on operational changes of water transfers. Post-processing CalSim II results allows for simulation of specific water transfers and their associated constraints while maintaining compliance with the regulatory requirements simulated in CalSim II. TOM uses output from both CalSim II and SACFEM2013 to simulate the operational changes that result from water transfers.

Figure B-1 illustrates the models, input information, and output flow used to in the water operations analysis.

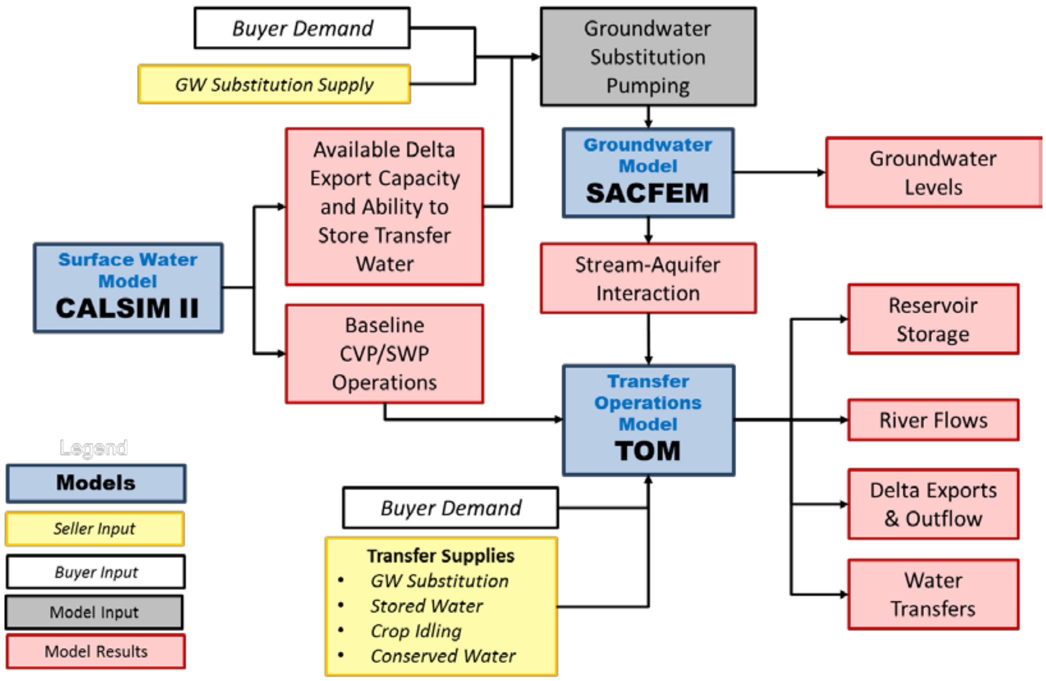

Figure B-1. Analytical Process and Modeling

B.4 Model Descriptions

A description of models used in water operations analysis, primarily CalSim II and TOM, and their underlying assumptions are outlined in more detail in the following sections. A brief description of SACFEM2013 is also provided. Additional documentation and results from SACFEM2013 are presented in Appendix D.

B.4.1 CalSim II

CalSim II is a planning model designed to simulate operations of CVP and SWP reservoirs and water delivery systems. CalSim II simulates flood control operating criteria, water delivery policies, in-stream flow requirements, Delta outflow requirements, and CVP/SWP (Project) Delta export operations. CalSim II is the best available tool for modeling CVP and SWP operations and is the primary system-wide hydrologic model used by Reclamation and the California Department of Water Resources (DWR) to conduct planning and impact analyses of potential projects.

CalSim II is a simulation by optimization model. CalSim II simulates operations by solving a mixed-integer linear program to maximize an objective function for each month of the simulation. CalSim II was developed to simulate operation of the CVP and SWP for defined physical conditions and a set of regulatory requirements. CalSim II simulates these conditions using 82 years of historical hydrology from water year 1922 through 2003.

CalSim II modeling conducted for the Long Term Water Transfer Project is built upon the Common Assumption model package, developed jointly by Reclamation and DWR. This model package has been revised and updated to reflect the operational requirements contained in the U.S. Fish and Wildlife Service (USFWS) 2008 Biological Opinion (BO) on delta smelt and the National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries) 2009 BO on Chinook salmon. Regulatory requirements included in baseline CalSim II simulation, including those specified in the BOs, are summarized in Attachment 1.

Reclamation provided the project team the CalSim II baseline studies in January 2014. The Reclamation study was at a projected future level of development and was consistent with Reclamation's operating assumptions at that time. The project team worked collaboratively with Reclamation modelers to revise the baseline study for an existing level of development, requirements, and projects. This existing level study is used as the baseline and the basis for TOM.

B.4.2 SACFEM2013

SACFEM2013 is a full water budget based, transient groundwater flow model that incorporates all groundwater and surface water budget components on a monthly time-step over the period of simulation. SACFEM2013 provides very high resolution estimates of groundwater levels and stream flow effects due to groundwater pumping within the Sacramento Valley. SACFEM2013 is an application of the MicroFEM© groundwater modeling package. SACFEM2013 simulates a 41-year period, corresponding to historical hydrology from water year 1970 through 2010, on a monthly time-step. Additional information and description of SACFEM2013 can be found in Appendix D.

B.4.3 TOM

TOM was developed to analyze effects of the Long-Term Water Transfer Project on the CVP, SWP, major rivers, and the Delta. TOM was developed to quickly and effectively simulate water made available from various sellers as it moves through the system, the effects on CVP and SWP operations, and diversion of transfer water by buyers. TOM simulates operations on a monthly time-step for the 34-year period, water year 1970 through 2003, common to both CalSim II and SACFEM2013. TOM relies on output from both SACFEM2013 and CalSim II.

Facilitating water transfers in actual operations presents numerous challenges. In real-time operations, transfer water cannot be tracked separately as it moves through the system in the same way it can be tracked and accounted for in a model. Water made available for transfer is released into the system, or not diverted from the system, and managed as part of the total available water within the system at any given time. This requires an increased level of coordination between CVP and SWP operators. When facilitating actual water transfers, CVP and SWP operators identify the volume of transfer water to be made available in advance of the actual transfer. This volume of water is considered when determining operations before, during, and after the transfer period. Transfer water becomes co-mingled with CVP/SWP water and unregulated flows in the system and re-diverted at downstream locations such as CVP and SWP pumping facilities in the south Delta. Transfer water affects accounting under the Coordinated Operation Agreement (COA) between the CVP and SWP, and can require COA accounting adjustments. Transfer water can also change the timing of when CVP and SWP Project water is moved. A portion of transfer water is typically used as carriage water to maintain Delta water quality when transfer water is moved through the Delta. This requires initial estimates for carriage water that must later be verified and adjusted. All the additional accounting and adjustments for transfers are layered onto the already complex task of operating the CVP and SWP for numerous in-stream flow, water temperature, water quality, and water supply constraints.

TOM was developed in consultation with Reclamation and with an understanding of both actual operations and CalSim II model assumptions. Rules used in TOM to simulate operational responses to water transfers and changes in stream-aquifer interaction were reviewed with CVP operations staff. Assumptions and logic used in TOM are described in the following sections.

B.4.3.1 TOM Operations and Assumptions

TOM begins with a baseline CalSim II simulation of the CVP/SWP system and Delta operations, and then layers on water transfer operations. TOM uses information on the timing and volume of transfer water to be made available from various transfer sources as input and simulates the effects of those transfers.

B.4.3.1.1 Buyer Demands and Seller Supplies

The Project team developed estimates of both buyer’s demand for transfer water and seller’s supplies of transfer water. CVP contractors identified as buyers include East Bay Municipal Utility District (MUD), Contra Costa Water District (WD), and the SLDMWA. Annual transfer demands for East Bay MUD were provided directly by the agency. The volume of annual transfer demand for Contra Costa WD was provided the district and the years when demand for transfer water were identified and discussed with the district.

SLDMWA demand for transfer water often exceeds the available capacity to move the water through the Delta. Therefore, an estimate of annual available Delta export capacity was developed from baseline CalSim II output. Available Delta export capacity was used as a surrogate for SLDMWA demand for transfer water from Sacramento Valley sellers. Additionally, water made available by Merced Irrigation District (ID) can be moved to SLDMWA through a variety of facilities that connect the lower San Joaquin River with the Delta-Mendota Canal (DMC) without going through CVP or SWP Delta export facilities. Therefore, additional demands were assumed for SLDMWA in years when CVP south-of-Delta agricultural water service contract allocations were less than 65 percent. In these years, SLDMWA demand for transfer water exceeded Merced ID's available transfer supply and was assumed to be all of the available supply.

Figure B-2 illustrates the annual demands simulated in TOM for each potential buyer with demands for SLDMWA limited by available Delta export capacity and available supply.

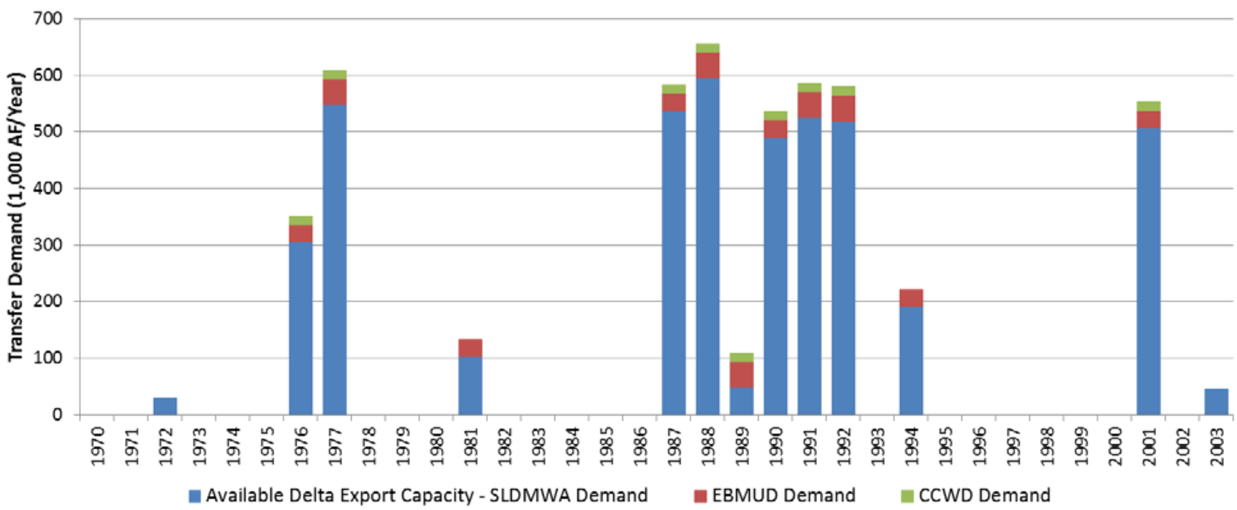

Figure B-2. Annual Demand for Transfer Water by CVP Buyers

The Project team also developed estimates of water supplies that can be made available for transfer from willing sellers interested in participating in the Project. Estimates of available supply were developed in consultation with potential sellers. Sellers include CVP contractors and non-CVP contractors with the ability to provide water to the buyer's points of diversion. Sellers can make water available through several different transfer mechanisms including groundwater substitution, crop idling, conserved water, and reservoir release. Available water transfer supply is typically less than demand for transfer water, and can be less than the available capacity to move the water from seller to buyer. Therefore, the volume of water transferred on an annual basis is typically limited by available water transfer supply. Different alternatives were developed to analyze effects of making transfer water available with different mechanisms. Figure B-3 illustrates annual available supplies for the alternative that includes all transfer mechanisms.

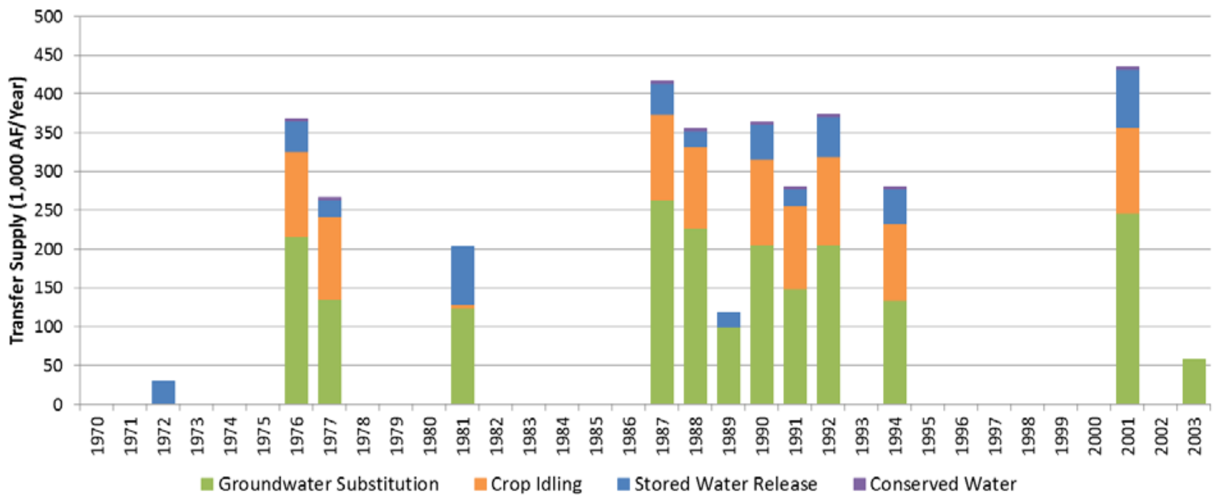

Figure B-3. Annual Available Water Transfer Supply

Comparison of Figure B-2 and Figure B-3 shows demand for transfer water frequently exceeds the available water transfer supply.

B.4.3.1.2 Transfer Operations and Priorities

TOM uses an assumed priority for transfer mechanisms used to make water available under Project alternatives. Transfer mechanisms are prioritized based on the likelihood of the mechanism being utilized and the operational flexibility inherent in the mechanism. For example, groundwater substitution and reservoir release are more likely transfer mechanisms than crop idling and are therefore a higher priority. Groundwater substitution has less operational flexibility than reservoir releases and is given a higher priority. TOM simulates the four transfer mechanisms in the following order:

- Groundwater substitution – for alternatives that include this mechanism
- Reservoir release
- Conserved water
- Crop idling – for alternatives that include this mechanism

Priorities for transfer mechanisms are necessary to develop groundwater pumping inputs to SACFEM2013 and simulate all transfers in TOM. Priorities were developed solely for this purpose.

TOM simulates water made available under each transfer mechanism, subject to various constraints. The following sections describe each transfer mechanism and associated constraints and operational considerations.

B.4.3.1.3 Groundwater Substitution Transfers

Groundwater substitution transfers involve pumping groundwater to meet a demand for water that would otherwise be met from surface water diversion. Surface water not diverted is then available for transfer. The volume of water made available for transfer is the volume of groundwater pumped during the transfer period. Groundwater substitution transfers allow a limited degree of flexibility in the timing of transfer because the transfer period starts and ends based on when groundwater pumping occurs. The Project includes groundwater substitution transfers in the Sacramento Valley. Figure B-4 illustrates annual groundwater substitution transfer supply identified by the sellers for years with available export capacity/transfer demand.

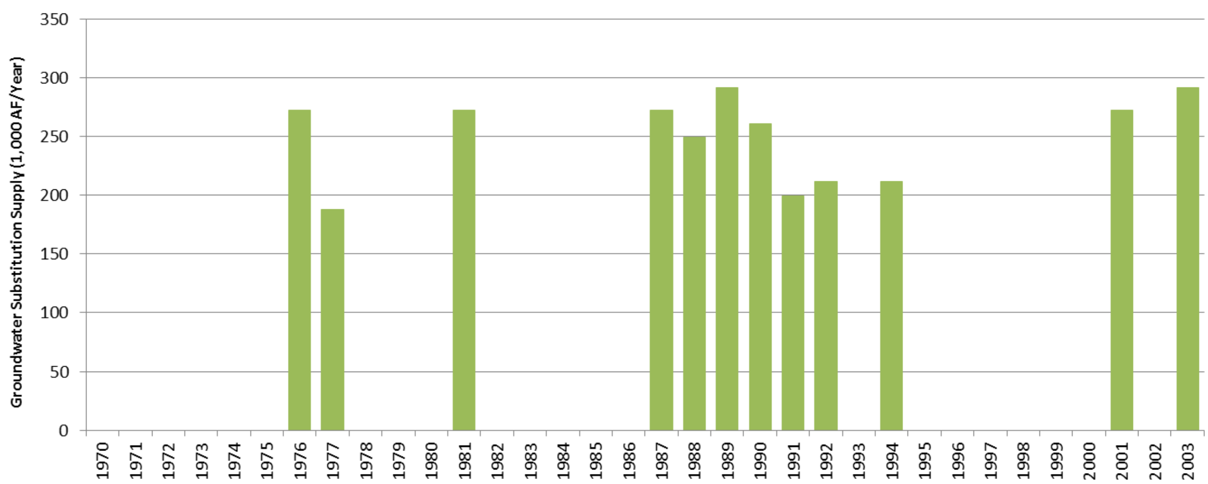

Figure B-4. Annual Groundwater Substitution Transfer Supply

Groundwater substitution transfers included in the analysis were developed based on input from sellers, buyer demand, capacity to convey the water, and an analysis of the ability to potentially store water pumped from April through June in upstream CVP/SWP reservoirs. The ability to store water pumped April through June is described in greater detail in a subsequent section. The result of this analysis is a time-series of pumping that varies by month and year and is significantly less than the volumes illustrated in Figure B-4. Figure B-5 illustrates the range of monthly pumping simulated, and the average monthly pumping for the 12 years when groundwater substitution transfers are simulated. Additional detail on the monthly volume of groundwater substitution transfer simulated for each seller is provided in Attachment 2.

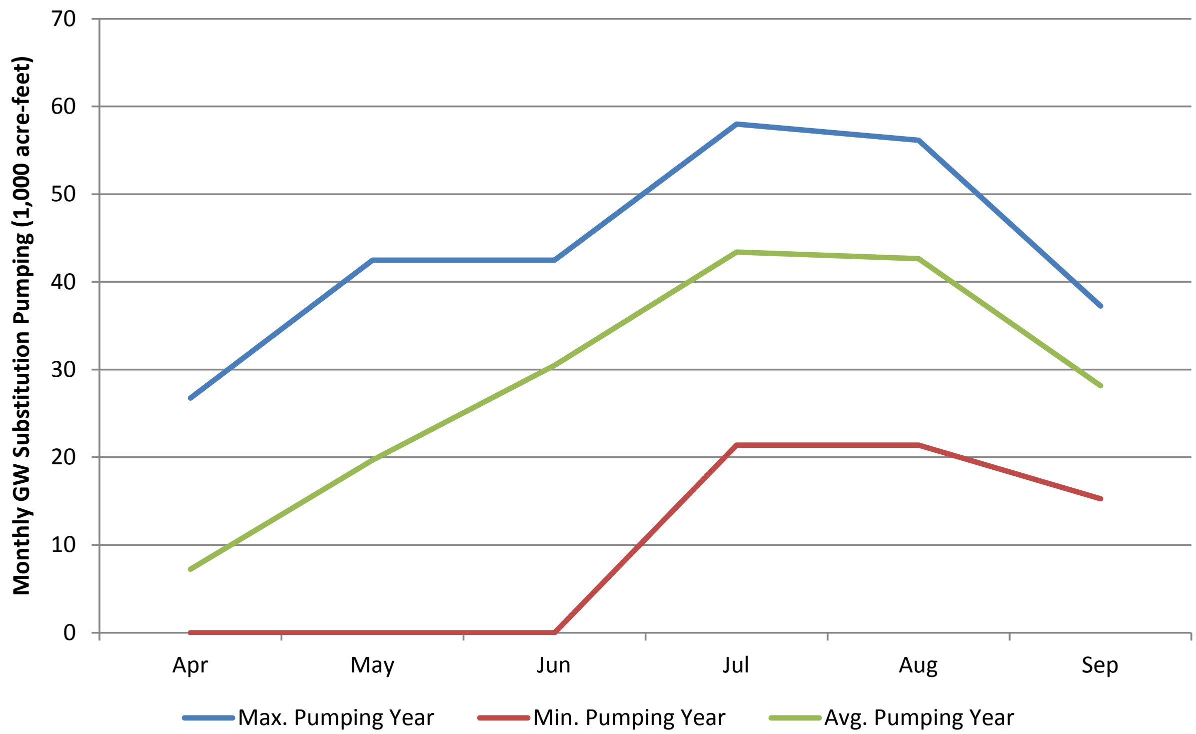

Figure B-5. Range of Monthly Groundwater Substitution Transfers Analyzed

Groundwater substitution transfers from the Sacramento Valley have the potential to create changes in stream-aquifer interaction that affect other parts of the water delivery system. Change in stream-aquifer interaction can be determined by comparing SACFEM2013 results from a baseline, without-transfer simulation to a with-transfer simulation that includes groundwater substitution pumping. Change in stream-aquifer interaction is calculated at each stream node for rivers and streams explicitly modeled in SACFEM2013. Changes are aggregated for nodes above specific locations that affect CVP/SWP operations, such as Wilkins Slough on the Sacramento River or total Delta inflow. Changes in stream-aquifer interaction due to groundwater substitution transfers include increased stream loss to the aquifer and decreased aquifer contribution to stream flow.

Figure B-5 illustrates the time-series of total change in stream-aquifer interaction in the Sacramento Valley (at the Delta) that result from groundwater substitution transfers proposed in the Project. Change in stream-aquifer interaction illustrated in Figure B-~~5~~ 6 is a reduction in Delta inflow.

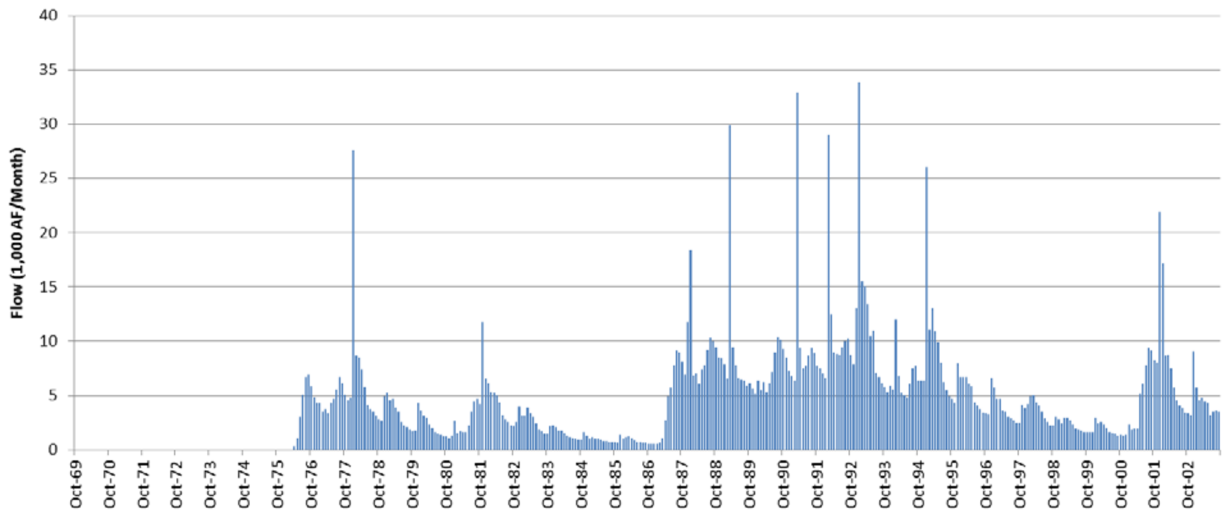

Figure B-~~5~~6. Total Change in Stream-Aquifer Interaction due to Groundwater Substitution Transfers

The timing of when changes in stream-aquifer interaction reduce stream flow is the key to understanding and simulating how changes may affect CVP/SWP operations. CVP/SWP operations will change in response to reduced stream flows under two conditions:

- When stream flow at minimum flow compliance locations (such as the Sacramento River at Wilkins Slough, the lower Feather River, or the American River at H Street) is at minimum levels and controlling upstream reservoir release.
- When the Delta is in balanced conditions.

The Delta can be in either a balanced or surplus condition. Balanced conditions, as defined in COA, are those periods when DWR and Reclamation agree that releases from upstream reservoirs plus unregulated flow approximately equals the water needed to meet Sacramento Valley in-basin uses plus exports. Conversely, excess or surplus conditions are periods when it is agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses plus exports. Sacramento Valley in-basin uses include Delta water quality.

TOM simulates how changes in stream-aquifer interaction affect CVP and SWP operations. Time-series of the change in stream-aquifer interaction calculated from SACFEM2013 results for specific locations that affect CVP/SWP operations are input to TOM. Logic in TOM simulates changes in CVP/SWP operations that occur as a result of these changes in stream flow.

Stream flow reductions when the Delta is in surplus and river flows exceed minimum flow requirements will not affect CVP/SWP operations. During these periods TOM simulates the reduction in stream flow in the major river systems and Delta outflow. Surplus conditions occur approximately half of the time. Figure B-~~6~~ 7 illustrates changes in stream-aquifer interaction that occur during Delta balanced and surplus conditions.

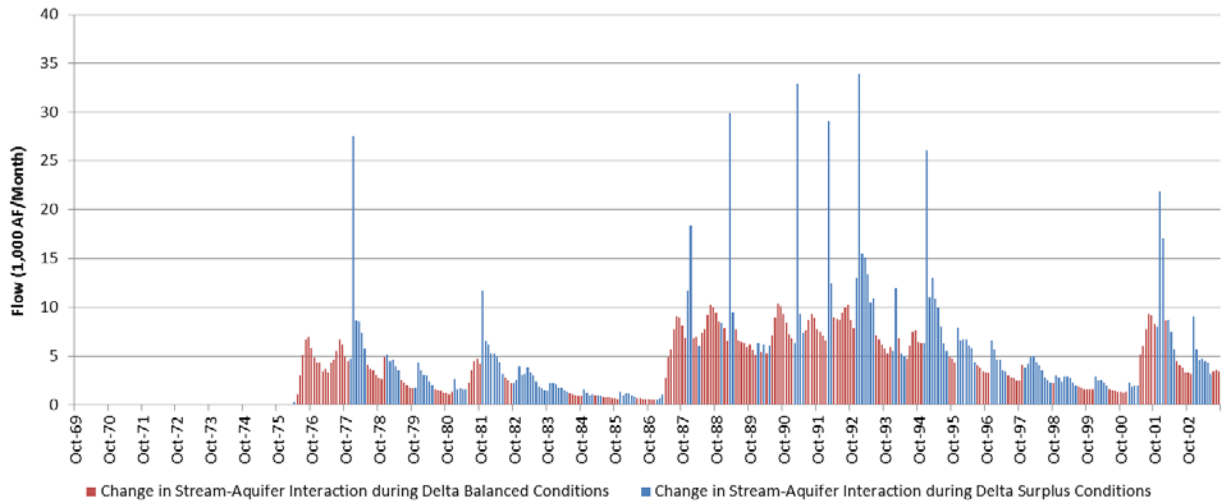

Figure B-~~6~~7. Change in Stream-Aquifer Interaction during Delta Balanced and Surplus Conditions

During periods when the Delta is in balanced conditions and/or flows on affected rivers and streams are at minimum flow requirements the CVP/SWP would respond to stream flow reductions that result from groundwater substitution transfers. TOM assumes the CVP/SWP will fully compensate for changes during these periods to maintain compliance with regulatory requirements. TOM includes logic to simulate the CVP/SWP operational response based on the location of the change in stream flow and CVP/SWP conditions. For example, the CVP would respond to reductions in Sacramento River flow at Wilkins Slough by increasing release from Shasta to comply with minimum flow requirements at that location. TOM simulates these types of operational responses.

There can be a variety of operational responses to changes in Delta inflow. TOM uses assumptions based reservoir storage conditions, minimum flow requirements, the portion of CVP and SWP water in the Delta, COA accounting, and Delta exports to simulate these operational responses by the CVP and SWP. Operational responses include increased release from upstream reservoirs and decreased Delta exports.

Changes in Delta inflow affect the CVP and SWP differently based on system conditions at the time and COA accounting. The obligation of each project to respond to reductions in Delta inflow is generally governed by the accounting split illustrated below in Figure B.7-8. However, during some periods the CVP may already be providing water in excess of the COA obligation and the CVP's ability to export CVP water at Jones. In these instances, the effects of reductions in Delta inflow as a result of groundwater substitution transfers primarily affect the SWP.

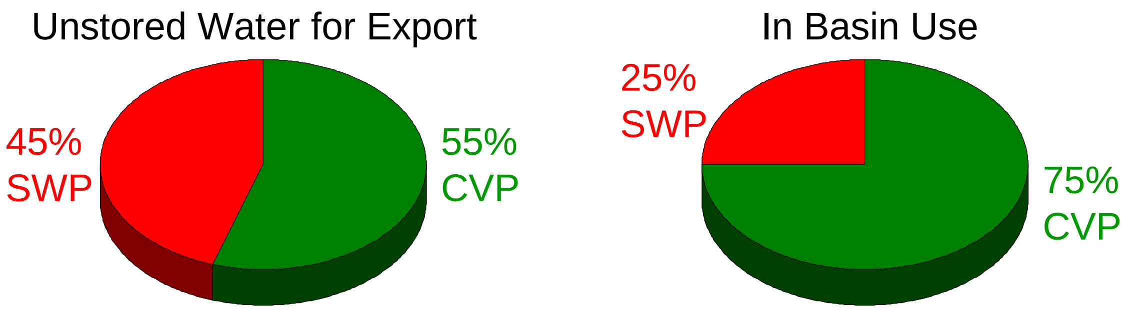

Figure B-78. COA Accounting

B.4.3.1.4 Reservoir Release

The Long-Term Water Transfer Project includes reservoir release transfers from four water districts who own and operate reservoirs that can provide water to CVP buyers. These agencies and associated reservoirs are Placer County Water Agency and the Middle Fork Project (MFP) reservoirs of French Meadows and Hell Hole on the American River upstream of Folsom Reservoir, South Sutter WD and Camp Far West Reservoir on the Bear River, Browns Valley ID and Merle Collins Reservoir on French Dry Creek a tributary to the Yuba River, and Merced ID and Lake McClure on the Merced River.

In most instances, reservoir release transfers offer a higher degree of flexibility than other transfer mechanisms. Reservoir releases can be timed to coincide with available capacity and modified to accommodate other regulatory restrictions.

Annual volumes of water available through reservoir release transfers were developed and provided by the sellers. Annual time-series were input to TOM. TOM simulates operation of the seller's reservoirs to analyze the effects on reservoir storage, flow downstream, and reservoir refill. Figure B-8 9 illustrates the annual volume of reservoir release water available from each seller in years with available export capacity/transfer demand.

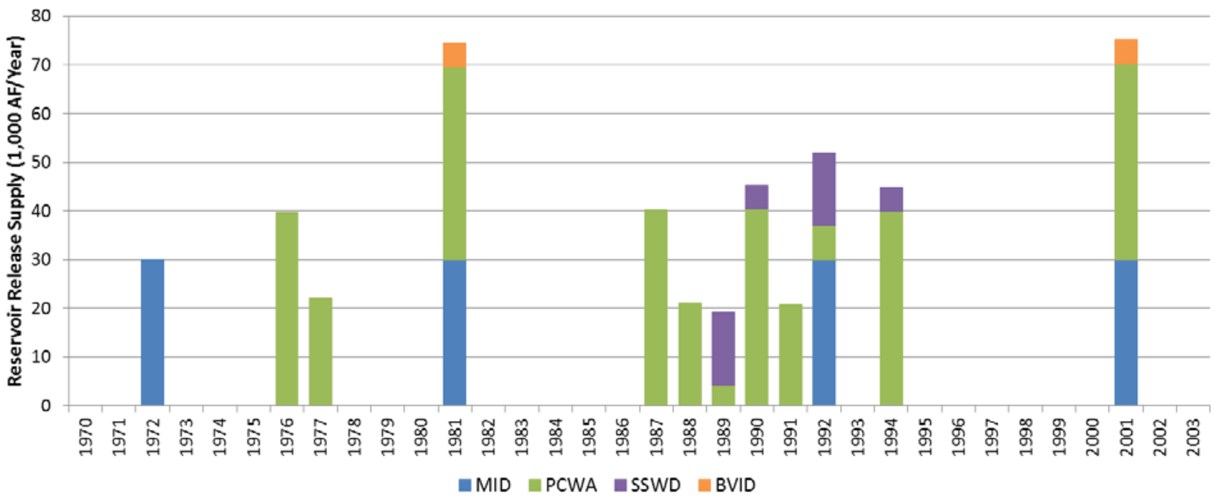

Figure B-~~8~~9. Annual Reservoir Release Transfer Supply

Transfer water released from Placer County Water Agency's MFP reservoirs flows into and through Folsom Reservoir. Transfer water made available from Placer County Water Agency must be in Folsom before being released for transfer, or moved through Folsom during the transfer, i.e. transfer water is not released from Folsom before being released from Placer County Water Agency reservoirs. Placer County Water Agency provided output from their MFP model for both a baseline and with-transfer scenario. Output included reservoir storage in French Meadows and Hell Hole and North Fork American River flow into Folsom. This model output was used to determine when transfer water flowed into Folsom and when MFP reservoirs refilled. Logic in TOM releases transfer water out of Folsom without bypassing hydropower generation.

Transfer water released from South Sutter WD's Camp Far West Reservoir flows down the Bear River, into the Feather River and eventually the Delta. There are no operational constraints that limit South Sutter WD's ability to release transfer water and therefore TOM assumes these transfers occur when there is demand, available capacity to divert the water, and the Delta is in balanced conditions. Logic in TOM for the operation of Camp Far West is based on a CalSim II module of the Bear River and is used to determine when Camp Far West refills.

Reservoir release transfers from Browns Valley ID's Merle Collins Reservoir are simulated in TOM. Browns Valley ID provided a baseline operation of Merle Collins Reservoir from a spreadsheet model owned by the district. Browns Valley ID also provided guidance on the years and conditions when the district would consider making a reservoir release transfer. This information was incorporated into TOM and logic developed to simulate the operation of Merle Collins Reservoir for a with-transfer scenario.

A reservoir release transfer from Merced ID's Lake McClure flows down the Merced River and is conveyed to SLDMWA. There are a variety of potential conveyance options to move transfer water from the Merced River to SLDMWA. Conveyance options include:

- Diversion at Merced ID's Crocker-Huffman Diversion Dam on the Merced River, conveyance through Merced ID's canals and distribution system to the Eastside Canal, through new conveyance facilities and into Turner Island WD and San Luis Canal Company, SLDMWA member agencies.
- Release down the Merced River to the lower San Joaquin River and diversion into facilities that connect the lower San Joaquin River and the Delta-Medota Canal. Three different facilities exist across the following districts: Patterson ID, West Stanislaus ID, and Banta Carbona ID. Connections through Patterson ID and West Stanislaus ID are located off the San Joaquin River upstream of the confluence with the Tuolumne River. The connection through Banta Carbona ID is located on the San Joaquin River downstream from Vernalis.
- Release down the Merced River, into the San Joaquin River for diversion at CVP, SWP, or Contra Costa WD's diversion facilities.

Assumptions input to TOM prioritize utilizing these conveyance options on an upstream to downstream priority, subject to physical capacities. A greater degree of flexibility exists for transfers from Merced ID because transfers can be scheduled based on available capacity to convey the water, and because there are multiple options for conveying transfer water without going through CVP/SWP facilities in the south Delta. However, transfers that affect water quality in the San Joaquin River are limited to periods when New Melones Reservoir is not releasing to meet water quality requirements at Vernalis.

B.4.3.1.5 Conserved Water

Conserved water is made available by Browns Valley ID from their pre-1914 Yuba River water rights. In 1990, Browns Valley ID implemented the Upper Main Water Conservation Project for the purpose of conserving water. Details of this project and documentation of the 3,100 acre-feet of annual conserved water are contained in the report *Analysis of Water Conserved Under the Upper Main Water Conservation Project* (MBK Engineers, 2002). Browns Valley ID's conserved water is available for transfer every year, but is only simulated as transferred in years with demand and available Delta export capacity (see Figure B-3). Conserved water is stored in Yuba County Water Agency's New Bullards Bar Reservoir and released for transfer in years with demand and capacity.

TOM simulates operation of New Bullards Bar Reservoir and Yuba River flow below New Bullards Bar to analyze effects on reservoir storage, Yuba River flow, and reservoir refill.

B.4.3.1.6 Crop Idling

Water can be made available through crop idling by not growing and irrigating a crop with available surface water and instead making that water available for transfer. The volume of water that may be transferred with a crop idling transfer is limited to the evapotranspiration of applied water (ETAW) that would have been consumed by the crop. The ETAW limit is intended to help protect third parties in the area of the seller. Crop idling transfers analyzed for the Project are from the Sacramento Valley only.

Annual volumes of crop idling water to be made available were provided by individual sellers. The volume of crop idling water to be made available can vary between Project alternatives. Figure B-~~9~~ 10 illustrates the maximum annual volumes identified by sellers in the Sacramento Valley for years with available export capacity/transfer demand.

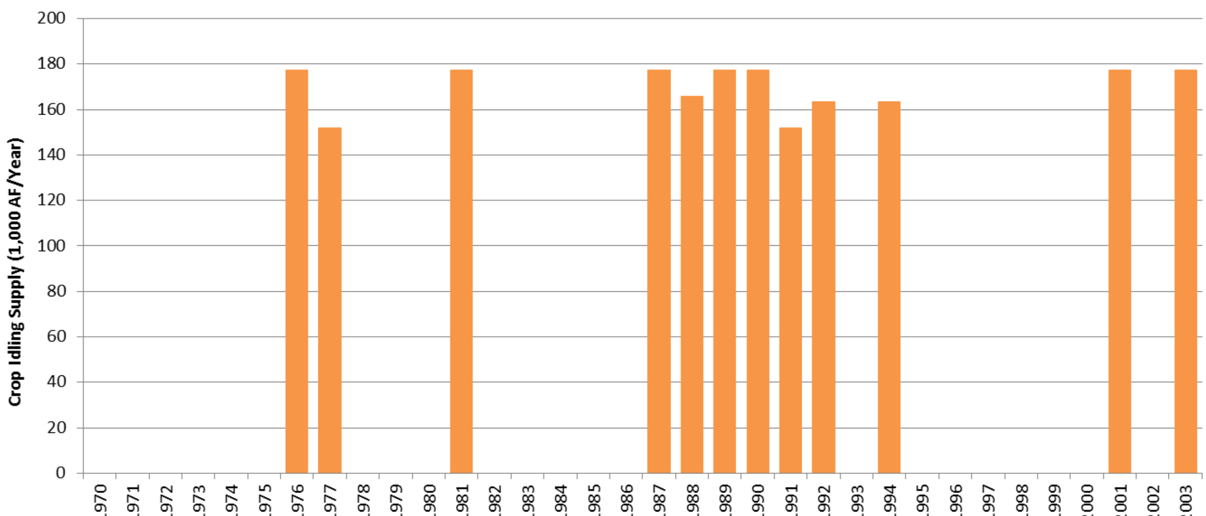

Figure B-~~9~~10. Maximum Annual Crop Idling Transfer Supply

Annual volumes were assumed to be made available on a monthly pattern based on the ETAW of rice, the assumed crop to be idled. Figure B-~~10~~ 11 illustrates the monthly ETAW pattern for rice. This monthly ETAW pattern has been used in the execution of water transfers for numerous years and is referenced in “Cropland Idling, Issue No. 1 – DRAFT Rice Water Transfer Pattern” (Reclamation 2009).

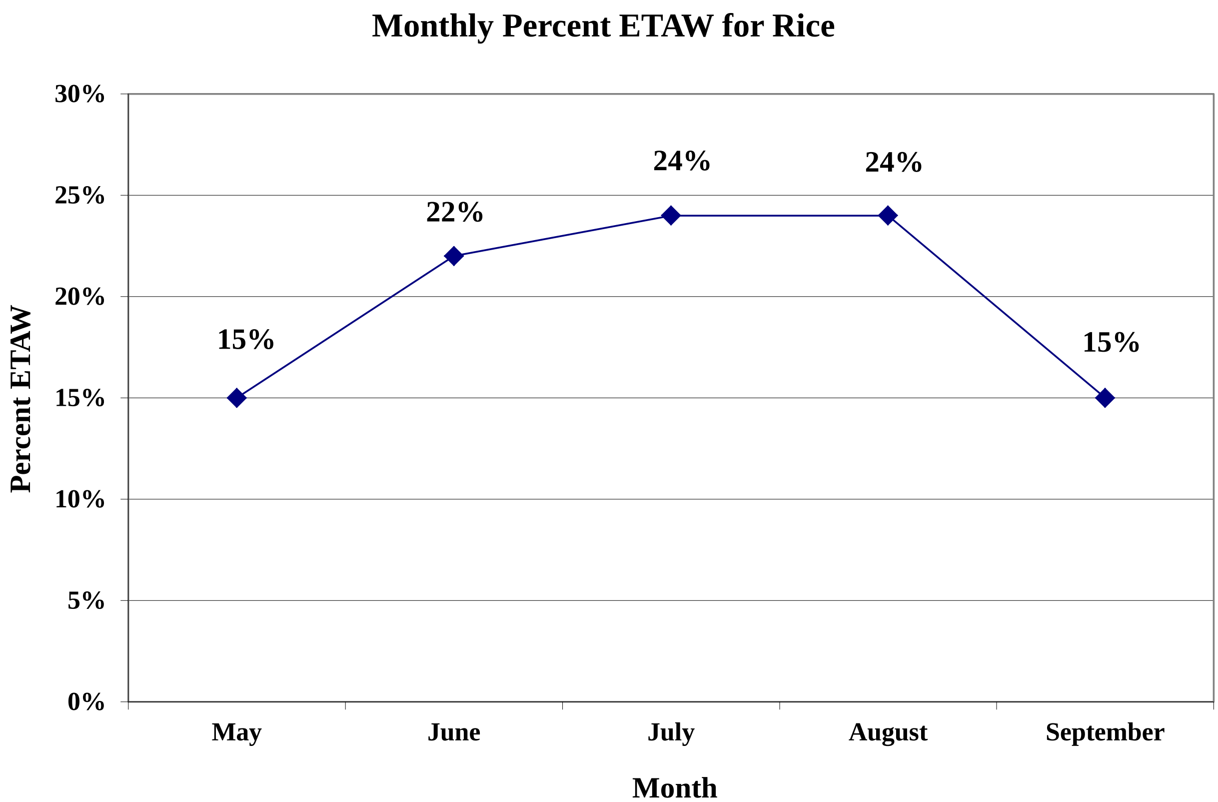

Figure B-1011. Monthly ETAW Pattern for Rice

Crop idling transfers offer the least flexibility of all transfer mechanisms. The decision to enter into crop idling transfers is typically made in spring months when there is still considerable uncertainty in the water supply forecast and the ability to convey water through the Delta. Crop idling transfers make water available on the fixed schedule illustrated in Figure B-1011. Therefore, transfer water made available in May and June, a total of 37 percent of the annual volume, can be lost or not diverted by the seller because there is rarely available export capacity at CVP or SWP pumping plants in those months and it may not be held in upstream storage.

B.4.3.1.7 Storing Transfer Water in CVP/SWP Reservoirs Upstream of the Delta

The BOs limit the season for water transfers through the Delta for export at CVP/SWP pumping facilities to July through September (NOAA Fisheries 2009, USFWS 2008). However, it may be possible to make water available prior to July and that water may be stored temporarily in CVP/SWP reservoirs upstream of the Delta. Transfer water stored prior to July would be released and moved through the Delta from July through September. It is difficult to predict when these conditions may occur, and therefore it is not possible to guarantee the ability to store water in every year.

In order for transfer water to be stored in upstream reservoirs two conditions must be met: 1) there must be surplus flow (flow in excess of minimum requirements for flow and temperature) upstream from where the transfer water is made available (the point of non-diversion), and 2) the CVP/SWP reservoir where the water will be stored must be operated to meet a requirement downstream from the point of non-diversion. Under these conditions it may be possible to temporarily store transfer water in CVP or SWP reservoirs. Transfer water would be stored in upstream reservoirs by reducing releases from those reservoirs when transfer water is made available.

Analysis of the baseline CalSim II simulation of CVP and SWP operations was performed to identify potential opportunities to store both groundwater substitution and crop idling transfer water made available from April through June in upstream CVP and SWP reservoirs. This information was used to determine months when groundwater substitution pumping was simulated in SACFEM2013. These same assumptions were incorporated into TOM to simulate the resulting changes in river flows, reservoir levels, and operations. These assumptions are made only for the purpose of analysis conducted for the environmental document to provide a conservative estimate of potential environmental impacts and may not be appropriate or applicable under actual operations in a particular year.

B.4.3.1.8 Shift in CVP/SWP Exports to Facilitate Transfers

As previously described, there are numerous considerations and adjustments made by Project operators to facilitate water transfers through CVP and SWP export facilities. One such adjustment can be to shift the timing of when Project water is moved from north-of-Delta reservoirs through the Delta. The timing of Project water movement can shift to assist in making export capacity for transfers available on a pattern that better matches the period of transfer. These shifts are more common at SWP facilities because the larger capacity at Banks provides greater flexibility.

TOM simulates shifts in timing of Project water movement at SWP facilities by adjusting baseline Oroville releases and Banks pumping from July through September of some years. Logic in TOM adjusts Oroville releases and Banks pumping to create a more regular monthly pattern of available export capacity.

B.4.3.1.9 Diversion of Transfer Water by Sellers

Water made available by sellers is conveyed through the system and diverted by CVP buyers. Diversions by buyers are made at existing points of diversion. A buyer’s ability to divert transfer water is subject to available capacity and regulatory constraints as described in the following section.

B.4.3.1.9.1 East Bay MUD

East Bay MUD diverts both CVP Project water and transfer water at the Freeport Regional Water Project on the Sacramento River near Freeport. The location of these diversion facilities may provide additional flexibility for when transfer water may be diverted to East Bay MUD. Diversions at Freeport do not affect the Delta in the same way as CVP/SWP diversions in the southern Delta. Therefore, it may be possible for East Bay MUD to divert transfer water in months when there is typically no available export capacity at CVP/SWP facilities. East Bay MUD's Freeport diversions are limited to 155 cubic feet per second (cfs) capacity, East Bay MUD's share of the total Freeport Regional Water Project capacity.

Additionally, East Bay MUD diversions at Freeport are not subject to a "carriage water" adjustment to the volume of water made available for transfer. Carriage water is defined as the extra water needed to carry a unit of water across the Delta to CVP/SWP export facilities while maintaining a constant salinity. Because the transfer water is made available and diverted at the upstream edge of the Delta it is assumed that there is no change in Delta salinity associated with the transfer.

B.4.3.1.9.2 Contra Costa WD

Contra Costa WD diverts water under existing water rights, a CVP water service contract, and transfer water from multiple points of diversion in the Delta. The baseline CalSim II simulation includes diversions under Contra Costa WD's water rights and CVP contract. Diversion of transfer water is simulated in TOM to occur at three locations: Rock Slough, Old River, and Victoria Canal. Transfer diversions are simulated to occur at the location with the best water quality and available capacity after diversions under Contra Costa WD's water rights and CVP contract. Assumptions on the specific location of transfer diversions are necessary for analysis of Delta water quality performed in the Delta Salinity Model 2. Transfers to Contra Costa WD assume a 20 percent carriage water adjustment to maintain Delta salinity.

B.4.3.1.9.2 SLDMWA

SLDMWA member agencies receive water diverted at CVP/SWP export facilities in the southern Delta. Transfer water purchased by SLDMWA is conveyed through available export capacity at Jones and Banks pumping plants. Transfers from the Sacramento River assume a 20 percent carriage water adjustment to maintain Delta salinity. Transfers from Merced ID that enter the Delta from the San Joaquin River assume a ten percent carriage water adjustment.

Additionally, water made available by Merced ID can be conveyed directly to SLDMWA member agencies through facilities that connect to Merced ID's internal conveyance system and facilities that join the lower San Joaquin River and the DMC without going through CVP/SWP export facilities.

B.4.4 Level of Development

The Long Term Water Transfer Project is intended to provide environmental assessment for water transfers over a ten-year period. Therefore, analysis conducted to support environmental assessments was conducted at an existing level of development with consideration of reasonably foreseeable projects that may be constructed over the next ten years.

CalSim II simulations at a projected Level of Development (LOD) are used to depict how the modeled water system might operate with an assumed physical and institutional configuration imposed on a long-term hydrologic sequence. An existing LOD study assumes that current land use, facilities, and operational objectives are in place for each year of simulation (water year 1922 through 2003). The results are a depiction of the current environment which provides a basis for comparison of project effects for the impact analysis under CEQA. A future LOD study is needed to explore how the system may perform under an assumed future set of physical and institutional conditions and is used for the Future No Action Condition for NEPA analysis. The Project’s ten-year period allows simulation of a single level of development under the assumptions that conditions are not likely to change significantly over such a short time horizon.

B.5 Model and Analysis Limitations

There are limitations in the ability of models to accurately address all of the intricacies of complex water management operations. Professional judgment is required to interpret results and determine benefits and impacts. Analysis for the Long Term Water Transfer Project is based on three primary models: CalSim II, SACFEM2013, and TOM. The overall analysis is therefore subject to the individual and combined limitations of all three models. While it is important to recognize and acknowledge the limitations of models as they are applied for this analysis, collectively these three models represent the best available tools for performing the analysis to serve as the basis for determining environmental impacts.

Model limitations and uncertainty for SACFEM2013 is described in Appendix D. Model limitations in CalSim II and TOM stem primarily from challenges of using computer models and fixed algorithms to simulate human decision-making processes. CVP/SWP operations are based on numerous regulatory requirements, a multitude of real-time data, and some degree of discretion on the part of operators. Numerous simplifying assumptions are necessary to simulate these complex operations. Computer models are capable of simulating many, but not all, regulatory requirements. Computer models are typically based on a more limited set of available data and use generalized rules that attempt to represent typical operator decisions. Computer models are far from perfect. However, these imperfections and simplifications do not render models useless. The regular and continued use of CalSim II for planning studies and environmental assessment by Reclamation, DWR, and others indicates the model is adequate for these purposes.

B.6 Project Alternatives and Results

B.6.1 Alternative 1: No Action/No Project Alternative

CEQA requires an EIR to include a No Project Alternative. The No Project Alternative allows for a comparison between the impacts of the proposed project with future conditions of not approving the proposed project. The No Project Alternative may include some reasonably foreseeable changes in existing conditions and changes that would be reasonably expected to occur in the foreseeable future if the project were not approved.

Under the No Action/No Project Alternative CVP related water transfers through the Delta would not occur from 2015-2024. However, other transfers that do not involve the CVP could occur under the No Action/No Project Alternative. Additionally, CVP transfers within basins could continue and would still require Reclamation's approval. Some CVP entities may decide that they are interested in selling water to buyers in export areas under the No Action/No Project Alternative; however, they would need to complete individual NEPA and Endangered Species Act compliance for each transfer to allow Reclamation to complete the evaluation of the transfers for approval.

Alternative 1 is simulated with the baseline CalSim II model provided by Reclamation and other information and model results provided by buyers and sellers. These results represent reasonably foreseeable conditions for the 2015-2024 period and are used for comparison with results from each of the project alternatives.

B.6.2 Alternative 2: Full Range of Transfer Measures

Alternative 2 would involve transfers from potential sellers upstream from the Delta to buyers in the Central Valley and Bay Area. Alternative 2 includes transfers under all potential transfer measures: groundwater substitution, reservoir release, conserved water, and crop idling/crop shifting. The order in which transfer measures are prioritized and simulated to occur is described in previous sections. The following section summarizes the results of Alternative 2 with comparisons to and changes from the No Project Alternative.

Figure B-~~11~~ 12 is a summary of the quantity of transfer water made available (Transfer Supply) under Alternative 2 on an annual basis and illustrates where the water is diverted or used (Transfer Use). A percentage of water to be transferred through the Delta becomes carriage water to maintain Delta water quality. Unused transfer water is from two different sources/transfer measures. In some years there can be unused crop idling water during May and June because there is no ability to store it upstream or available capacity at the export pumps. A second source is reservoir release transfers from Placer County Water Agency that are held in Folsom but spill prior to being delivered to East Bay MUD. Results are summarized by water year and show small amounts of water in wetter years such as 1978, 1982, 1993, etc. These are transfers from Placer County Water Agency to East Bay MUD that extend past September of the year when the transfer begins. East Bay MUD may begin taking delivery of transfer water from Placer County Water Agency as early as March and extend into February of the following year.

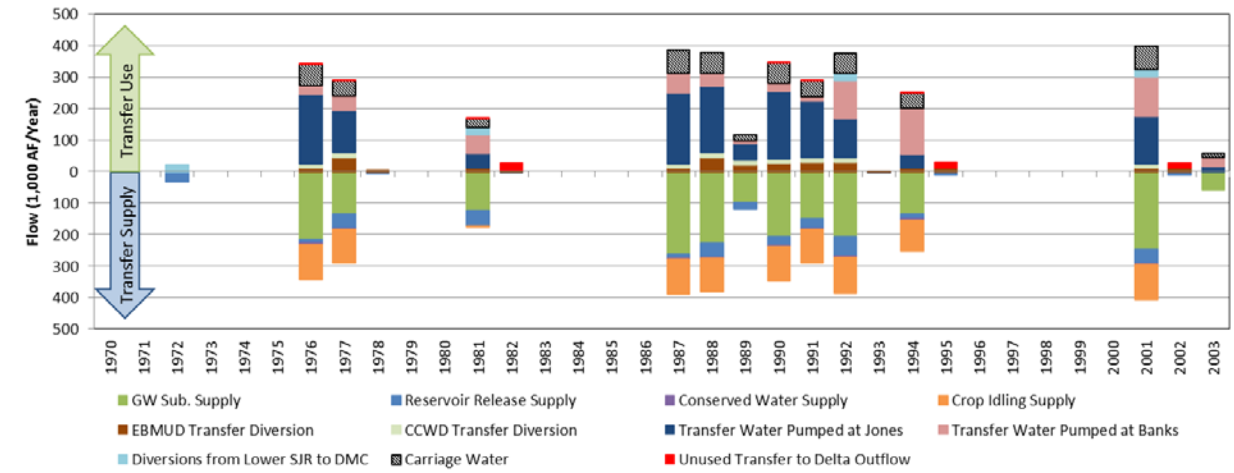

Figure B-~~11~~12. Annual Transfer Summary for Alternative 2

TOM simulates transfer water made available and moved through the system and produces results under each Project alternative for comparison with baseline, without transfers, results. TOM simulates the effects of transfers on reservoir storage, river flows, Delta outflow and exports, and diversions by Contra Costa WD and East Bay MUD. The following sections describe and illustrate these effects for Alternative 2.

B.6.2.1 Storage

Figure B-~~12~~ 13 illustrates the change in operations at Shasta with the Project. Under Alternative 2 release from Shasta can increase or decrease. Decreased releases occur when transfer water is stored in Shasta during the April through June period and create higher storage conditions than under Alternative 1 (Baseline). Releases increase during the July through September period when stored transfer water is released for delivery. These releases bring storage back to Baseline levels. Releases also increase because groundwater substitution transfers reduce stream flow on the Sacramento River, and during times of low-flow, stored water must be released from the reservoir to meet minimum flow requirements at Wilkins Slough.

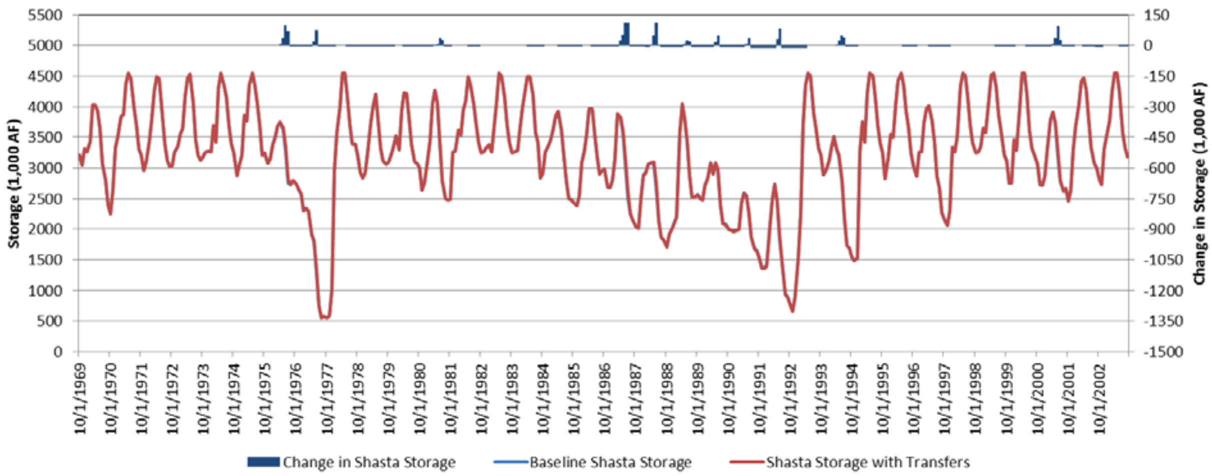

Figure B-~~12~~13. Shasta Operations with and without Alternative 2 Transfers

Operations at Folsom are illustrated below in Figure B-~~13~~14. Transfer water can be temporarily stored in Folsom for release and delivery in subsequent months. This includes transfers from groundwater substitution in the American River Basin, crop idling in the Sacramento Valley, and reservoir release from upstream Placer County Water Agency reservoirs. Releases from Folsom can increase to maintain minimum flow requirements downstream on the American River at H Street.

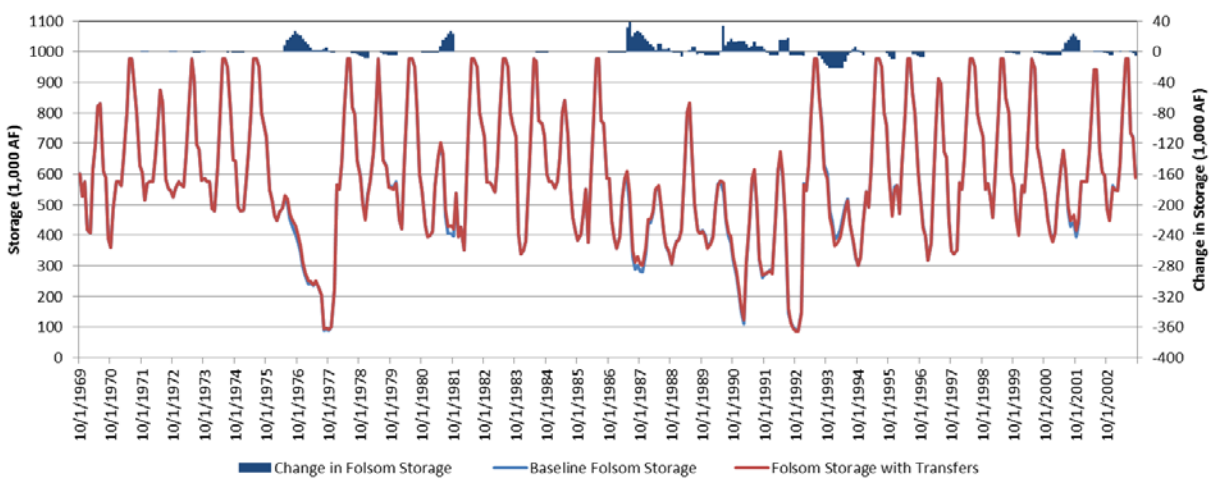

Figure B-~~13~~14. Folsom Operations with and without Alternative 2 Transfers

Figure B-~~14~~ 15 illustrates changes in Oroville storage with and without the Project. Larger changes in Oroville storage result from shifting the timing of delivery of SWP water to accommodate transfers. There are also decreases in storage when additional water is released to maintain minimum flow requirements on the Lower Feather River. These additional releases from

Oroville are made to account for reductions in Feather River flows due to groundwater substitution transfers.

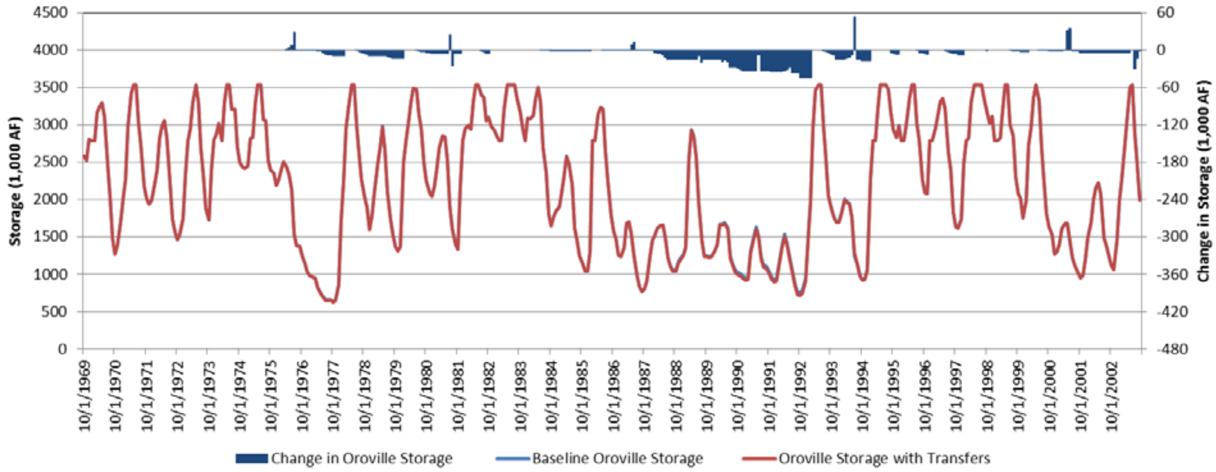

Figure B-~~14~~15. Oroville Operations with and without Project

South Sutter WD releases water from Camp Far West Reservoir to participate in reservoir release transfers. Figure B-~~15~~ 16 illustrates the only change in reservoir storage from baseline conditions as the quantity released for transfer, a volume of five or 15 thousand acre-feet (TAF). Camp Far West Reservoir storage returns to baseline levels when the reservoir refills.

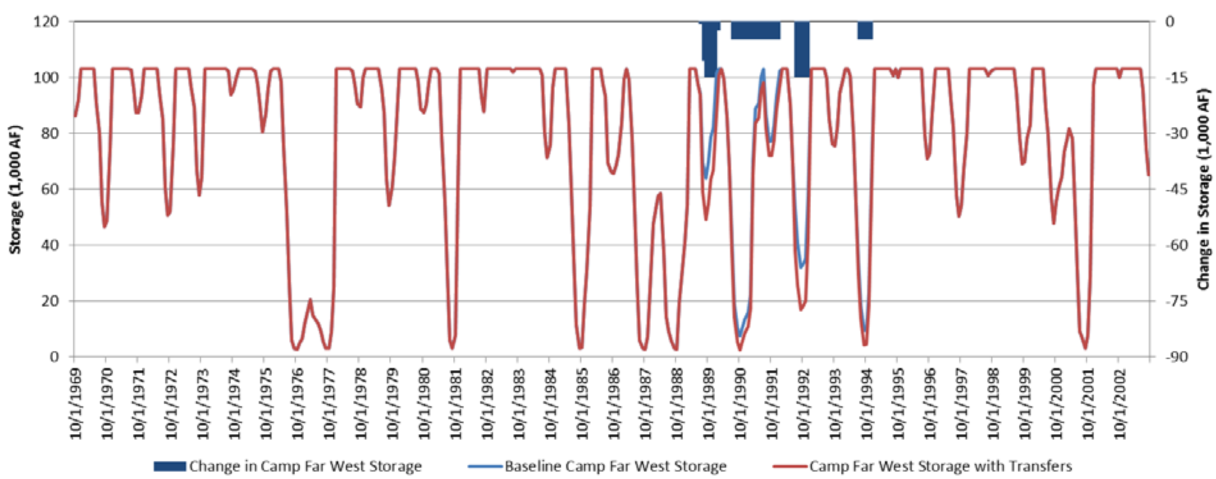

Figure B-~~15~~16. Camp Far West Operations with and without Alternative 2 Transfers

Browns Valley ID releases water from Merle Collins Reservoir to participate in reservoir release transfers. Figure B-~~16~~ 17 illustrates the only change in reservoir storage from baseline conditions as the quantity released for transfer, up to five TAF in any year. Merle Collins Reservoir storage returns to baseline levels when the reservoir refills.

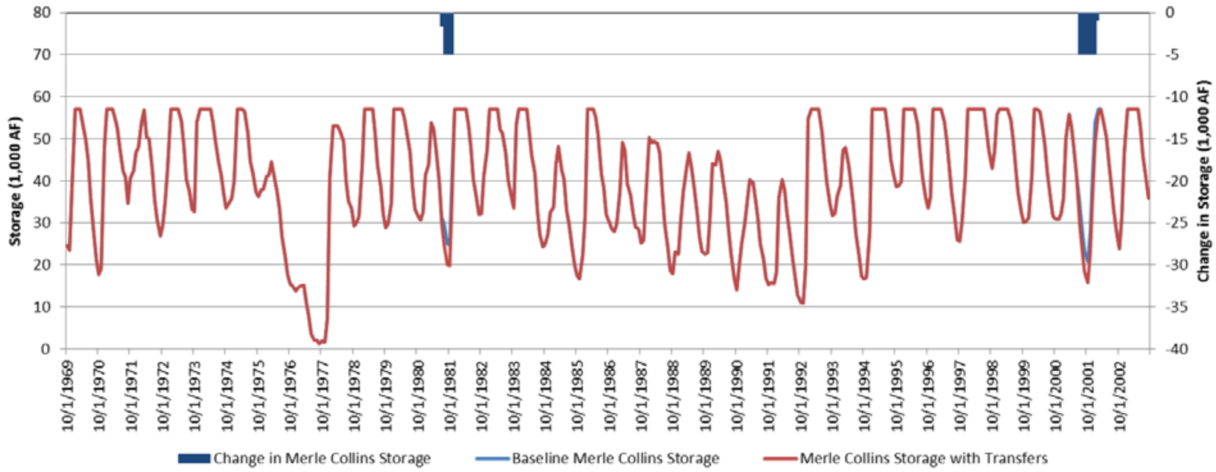

Figure B-~~16~~17. Merle Collins Reservoir Operations with and without Alternative 2 Transfers

Placer County Water Agency releases water from MFP reservoirs of French Meadows and Hell Hole to participate in reservoir release transfers. Figure B-~~17~~ 18 illustrates the combined storage in these two reservoirs under both baseline and with Project operations. MFP reservoir storage returns to baseline levels when the reservoirs refill.

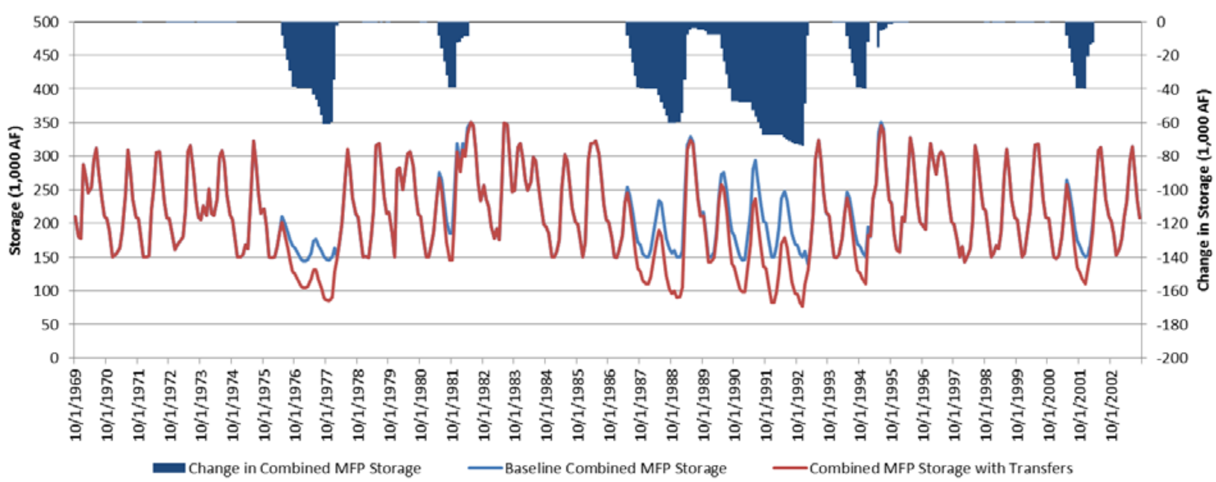

Figure B-~~17~~18. MFP Operations with and without Alternative 2 Transfers

Figure B-~~18~~ 19 illustrates Merced ID operations of Lake McClure with and without reservoir release transfers. Reservoir release transfers of up to 30 TAF reduce reservoir storage until the reservoir refills in subsequent wet years.

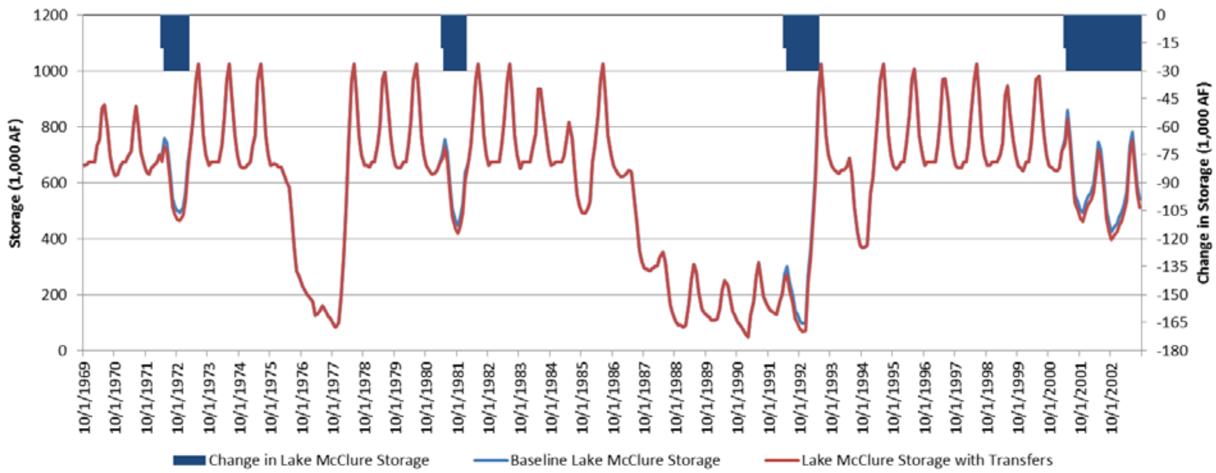

Figure B-~~18~~19. Lake McClure Operations with and without Alternative 2 Transfers

Conserved water is stored in Yuba County Water Agency's New Bullards Bar Reservoir and released for transfer in years with demand and capacity. The effect of these releases is illustrated below in Figure B-~~19~~20. New Bullards Bar Reservoir storage returns to baseline levels when the reservoir refills.

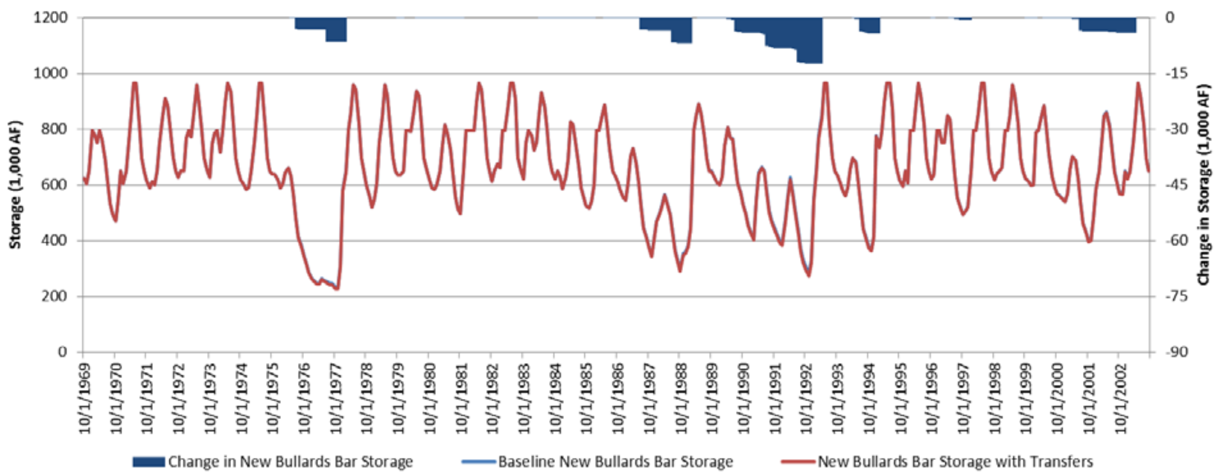

Figure B-~~19~~20. New Bullards Bar Operations with and without Alternative 2 Transfers

B.6.2.2 Stream Flow

Releases from Keswick Dam, as illustrated below in Figure B-~~20~~21, reflect the changes in Shasta storage seen in Figure B-~~12~~13. A reduction in release corresponds to an increase in Shasta storage. Reduced releases typically occur in the April through June period when it may be possible to store transfer water made available downstream in Shasta. Months of reduced releases are followed by increased releases as transfer water is released to be moved through the Delta during the July through September period.

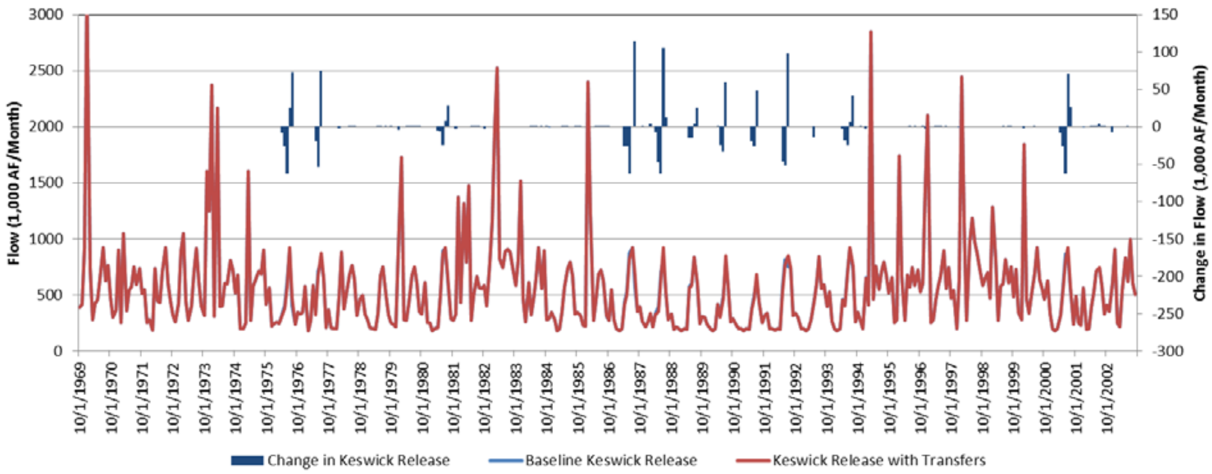

Figure B-~~20~~21. Keswick Dam Release with and without Alternative 2 Transfers

Figure B-~~21~~ 22 illustrates the effect of Alternative 2 transfers to the Sacramento River at Wilkins Slough. Increased flows result from changes in Keswick release, plus water made available by groundwater substitution and crop idling transfers upstream of Wilkins Slough. Decreases occur when transfer water is stored upstream in Shasta.

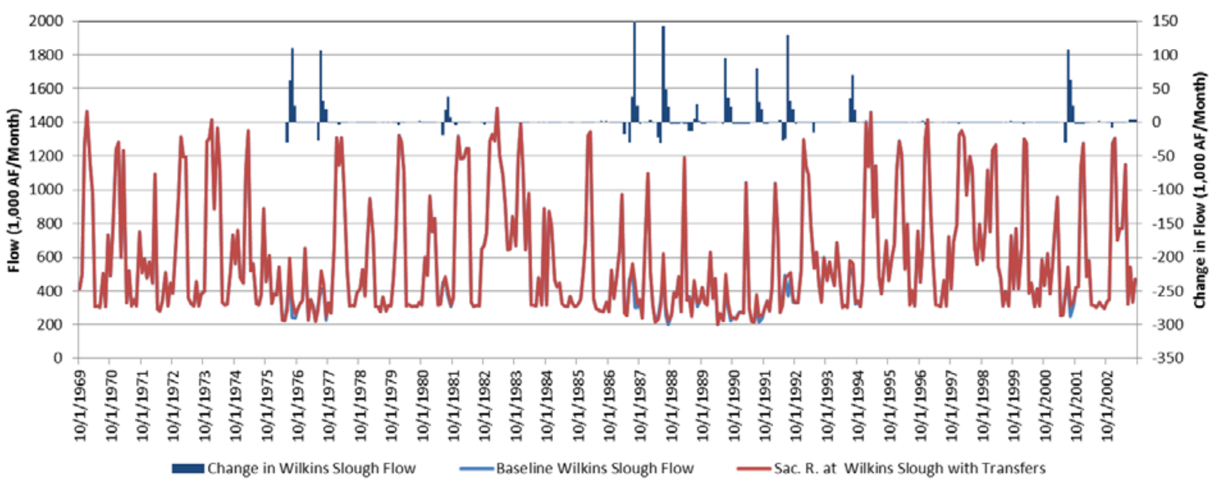

Figure B-~~21~~22. Sacramento River at Wilkins Slough with and without Alternative 2 Transfers

Figure B-~~22~~ 23 illustrates Nimbus Dam releases. Nimbus releases reflect CVP operations of Folsom Reservoir. Increases in release of approximately five TAF are water made available by Placer County Water Agency being released for re-diversion by East Bay MUD. Larger increases are typically preceded by decreases as transfer water made available downstream is stored in Folsom. Large releases occur when stored transfer water is release to be conveyed through the Delta. Decreases also occur when Placer County Water Agency's upstream reservoirs refill, typically during times when Folsom is also spilling water to maintain flood space requirements.

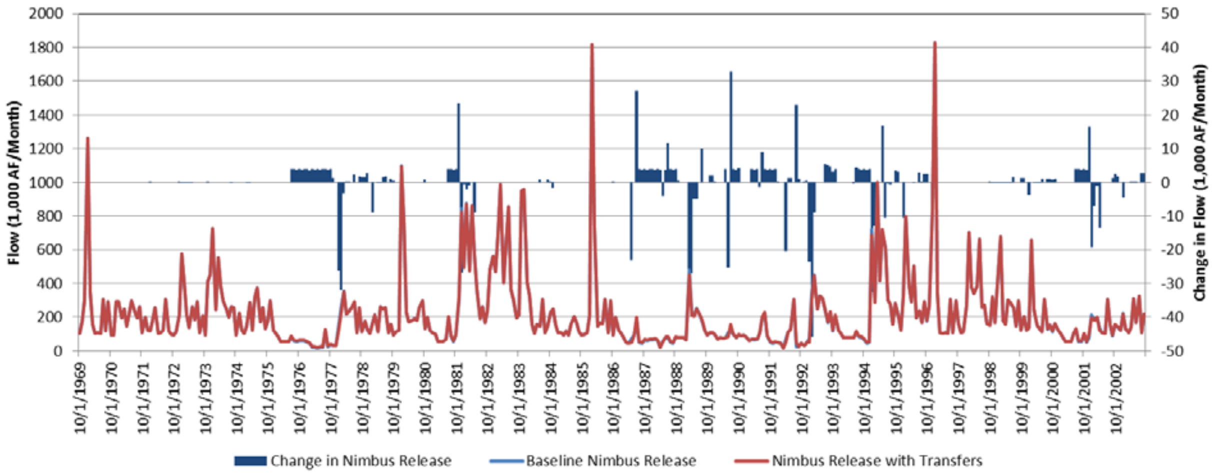

Figure B-~~22~~23. Nimbus Dam Release with and without Alternative 2 Transfers

Flows on the American River at H Street, illustrated in Figure B-~~23~~24, show similar changes as flows at Nimbus. Flow at H Street also increases from water made available by groundwater substitution transfers by Sacramento Suburban WD and the City of Sacramento.

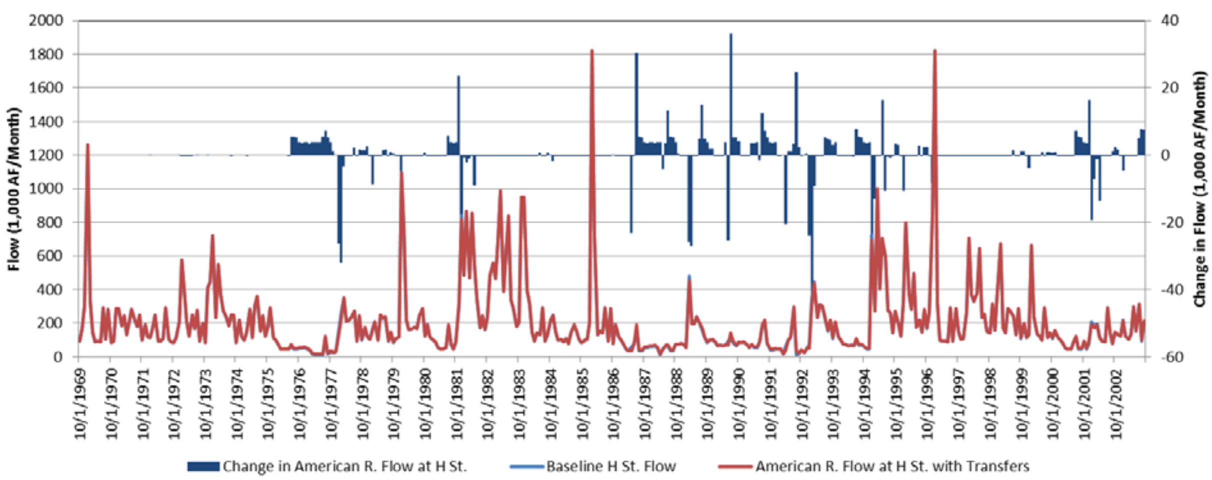

Figure B-~~23~~24. American River at H Street with and without Alternative 2 Transfers

Figure B-~~24~~ 25 illustrates change in Feather River flow below Thermalito. Flow in the Feather River below Thermalito changes due to changes in the operation of Oroville. Transfer water made available on the Feather River downstream from Thermalito can be temporarily stored in Oroville for release and transfer during the July through September period. Water stored prior to

July reduces Feather River flow. Increases and decreases in flow on the Feather River below Thermalito also occur from shifts in timing of SWP water to accommodate transfers. The magnitude of some of these differences is affected by model nuances within CalSim II that can create variations from month-to-month in release of SWP water from Oroville for movement through the Delta.

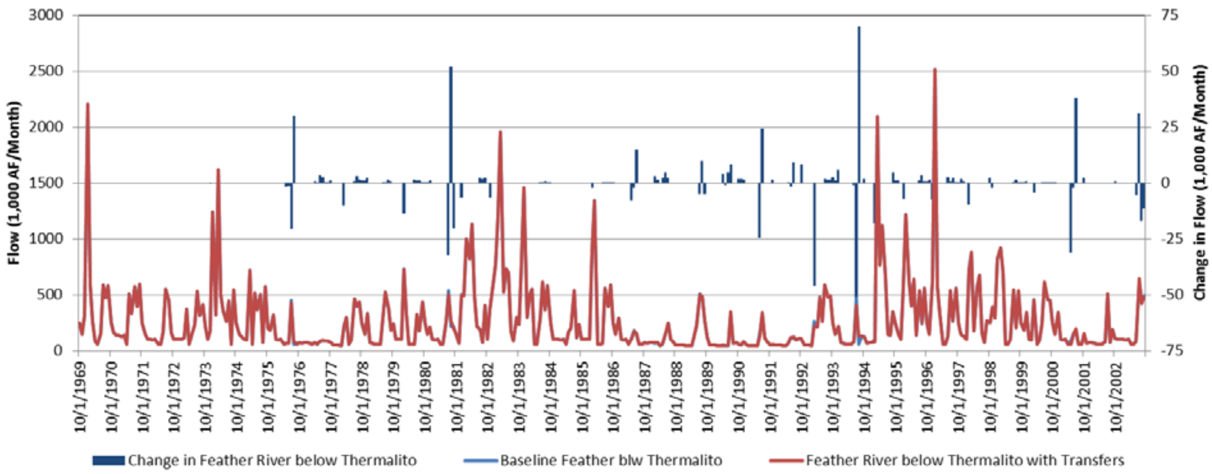

Figure B-~~24~~25. Feather River below Thermalito with and without Alternative 2 Transfers

Figure B-~~25~~ 26 illustrates changes in flow on the Yuba River at Marysville as a result of Browns Valley ID's transfers of conserved water from New Bullards Bar Reservoir and reservoir release from Merle Collins Reservoir. Increases indicate transfer water moving downstream for re-diversion and decreases indicate upstream reservoir refill.

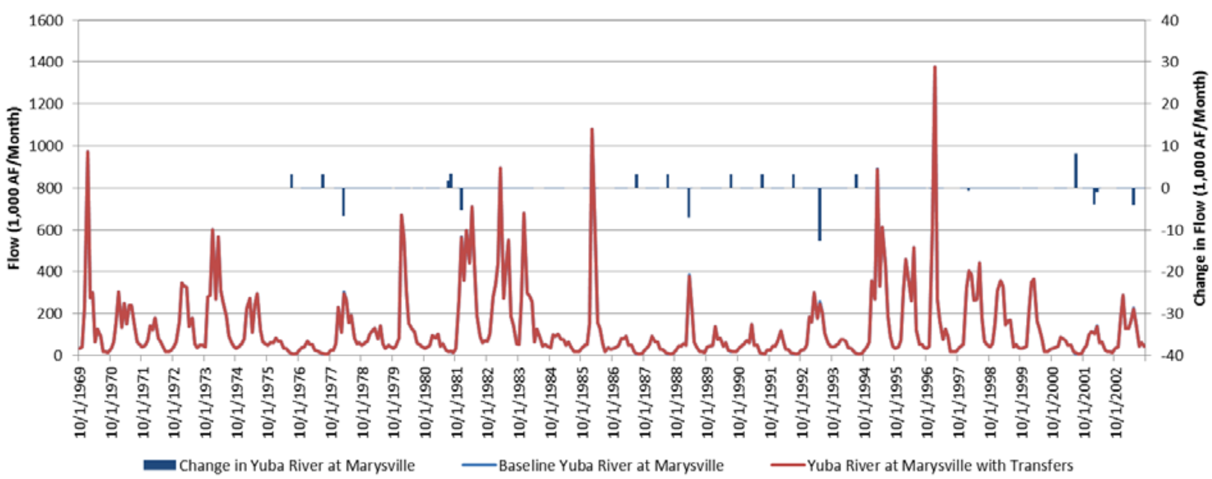

Figure B-~~25~~26. Yuba River at Marysville with and without Alternative 2 Transfers

Figure B-~~26~~ 27 illustrates the response of Bear River flows into the Feather River as a result of South Sutter WD reservoir release transfers from Camp Far

West Reservoir. Flows increase when water is released for transfer and decrease when Camp Far West refills.

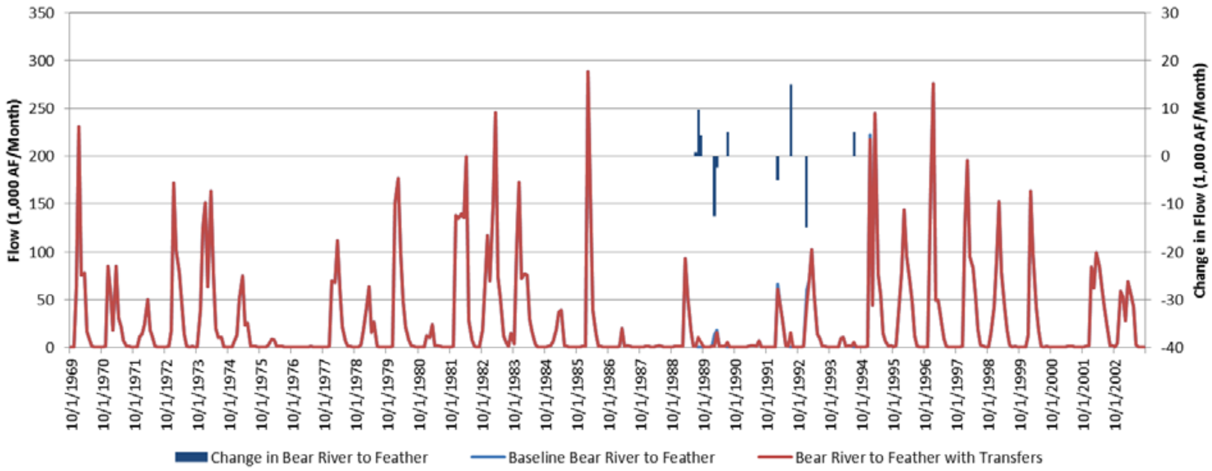

Figure B-~~26~~27. Bear River to the Feather River with and without Alternative 2 Transfers

The flow on the Lower Feather River represents an aggregation of flows on the Yuba River, Bear River, and upper portions of the Feather River. There are also increases due to water made available by groundwater substitution transfers along the Feather River between Thermalito and the confluence with the Sacramento. Figure B-~~27~~ 28 illustrates the effect to the Feather River.

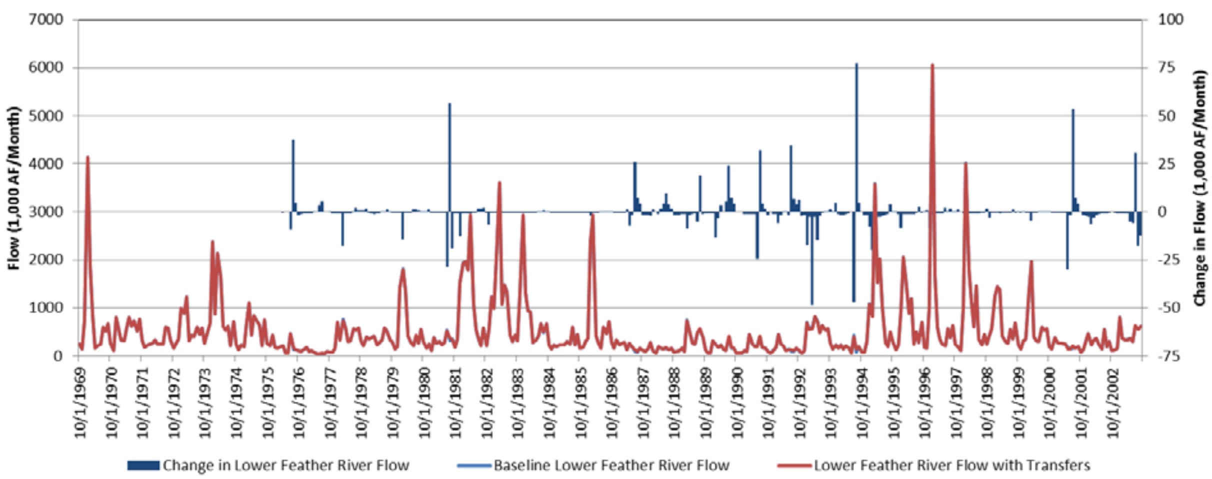

Figure B-~~27~~28. Lower Feather River with and without Alternative 2 Transfers

Figure B-~~28~~ 29 illustrates the flow of the Sacramento River at Freeport. This location is an aggregation of all changes on the Sacramento River at Wilkins Slough, the Lower Feather River, the American River at H Street, and changes between those locations and Freeport. Changes between those locations and Freeport include increases in flow due to water made available through groundwater substitution and crop idling transfers and decreases due to stream-aquifer interaction. Reductions in flow of approximately 50 TAF or more are a result of changes in stream and flood bypass flows during surplus conditions after one or more years of groundwater substation transfers. These changes are also illustrated above in Figure B-~~6~~7.

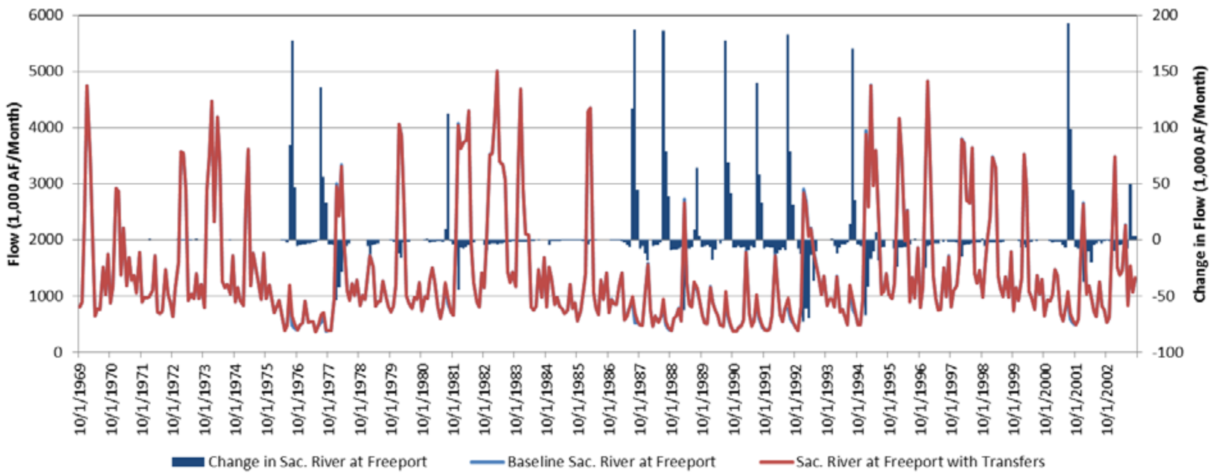

Figure B-~~28~~29. Sacramento River at Freeport with and without Alternative 2 Transfers

Figure B-~~29~~ 30 illustrates the changes on the Merced River at the confluence with the San Joaquin River. Increases in Merced River flow represent transfer water made available by reservoir releases at Lake McClure; decreases occur when Lake McClure refills.

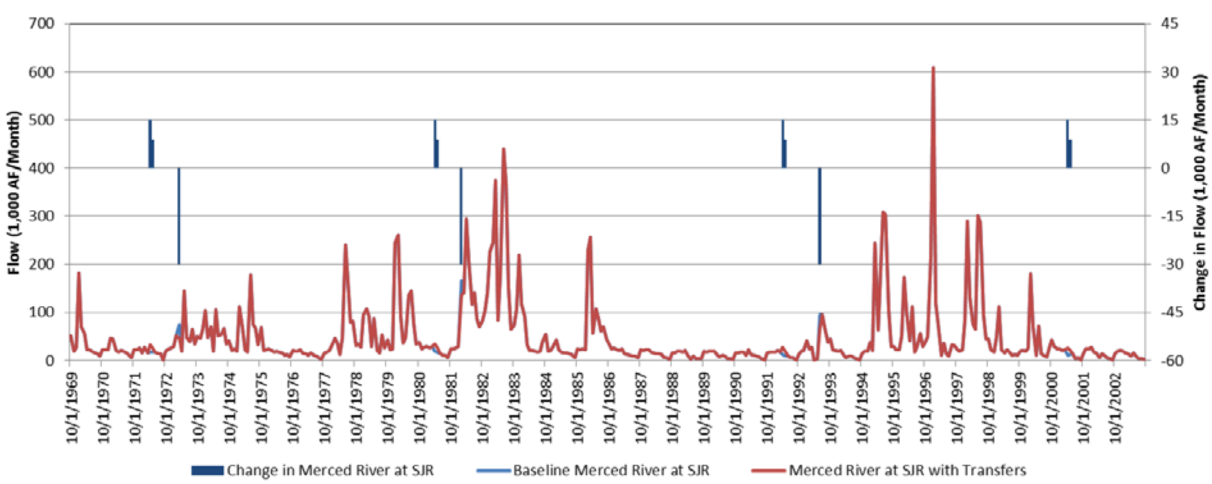

Figure B-~~29~~30. Merced River at the San Joaquin River with and without Alternative 2 Transfers

Figure B-~~30~~ 31 illustrates San Joaquin River flows at Vernalis. Increases in flow are Merced ID transfer water to be diverted at Banta Carbona ID and conveyed to the DMC. Decreases in flow occur when Lake McClure refills space vacated during reservoir release transfers.

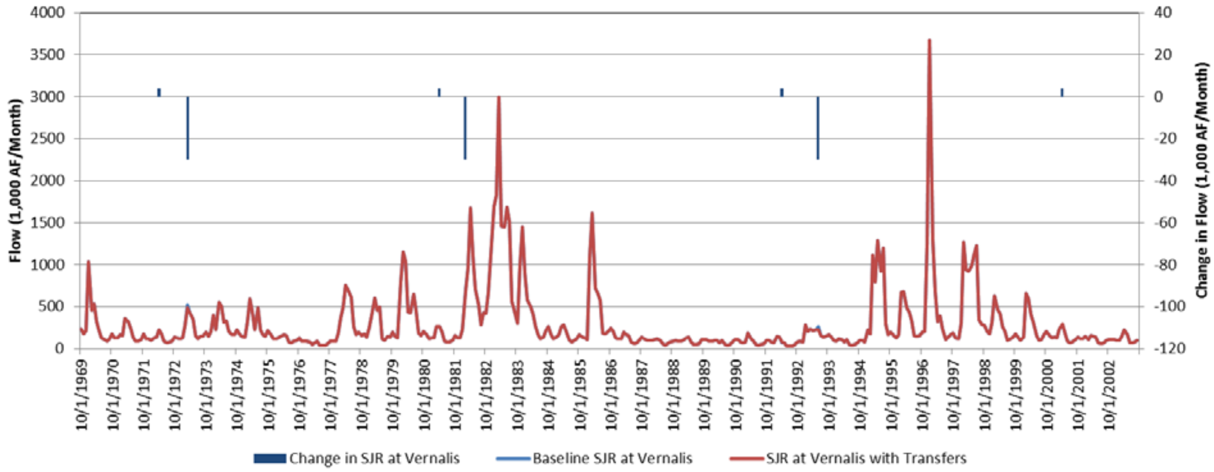

Figure B-~~30~~31. San Joaquin River at Vernalis with and without Alternative 2 Transfers

Changes to Delta outflow are illustrated below in Figure B-~~31~~32. Increases in Delta outflow are primarily due to carriage water to facilitate transfers through the Delta. Decreases in Delta outflow are attributed to reservoir refill upstream and changes in stream-aquifer interaction.

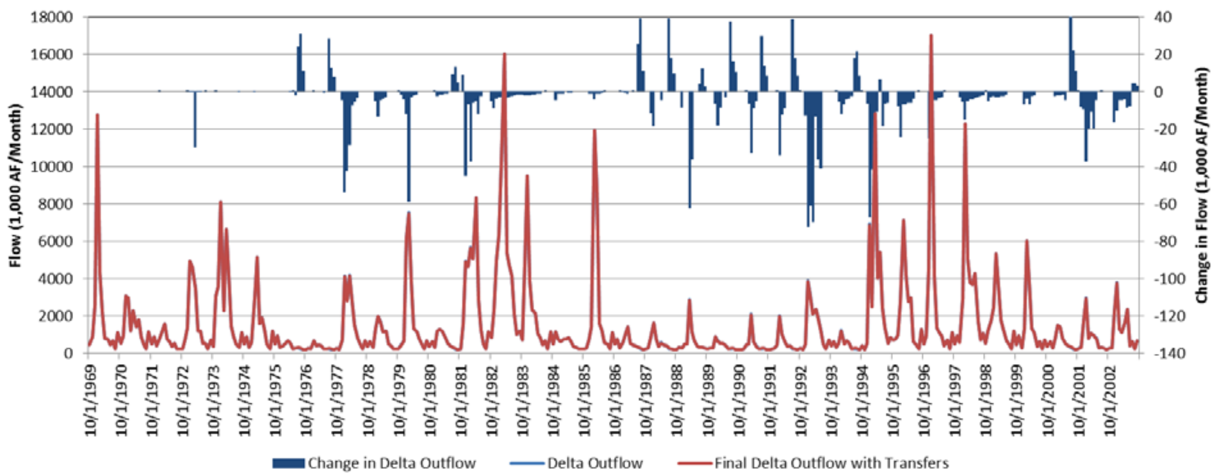

Figure B-~~31~~32. Delta Outflow with and without Alternative 2 Transfers

Table B-1 summarizes changes in Delta outflow on an average monthly basis. Average annual Delta outflow is decreased by approximately 31 TAF with decreases November through June and increases June through September.

Table B-1. Average Monthly Delta Outflow (TAF) for Alternative 2

Delta Outflow	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Baseline	393	867	1,490	3,260	3,312	3,278	1,753	1,381	816	546	297	638	18,031
With Transfers	393	867	1,485	3,250	3,300	3,268	1,748	1,378	813	554	303	641	18,000
Change	0	-1	-5	-10	-12	-10	-5	-3	-3	8	6	3	-31

B.6.2.3 Exports and Diversions

Figure B-~~32~~ 33 illustrates the change in exports at Jones Pumping Plant. Increases are generally due to export of transfer water for SLDMWA. Decreases in Jones exports are due to changes in Sacramento Valley stream-aquifer interaction that reduce Delta inflows.

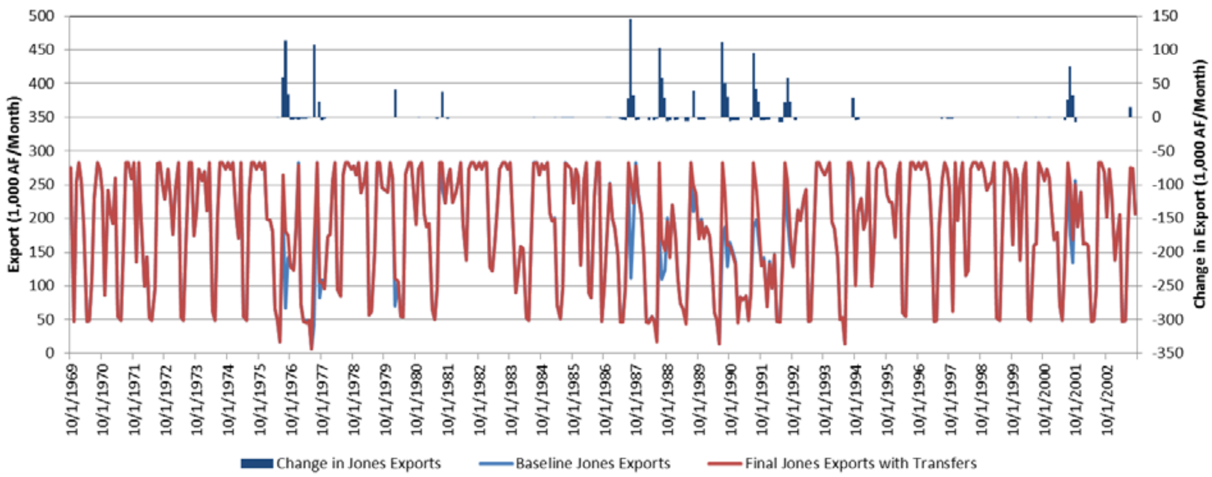

Figure B-~~32~~33. Exports at Jones Pumping Plant with and without Alternative 2 Transfers

Table B-2 summarizes the average monthly exports at Jones Pumping Plant for the baseline and with Project alternatives and the change. Increases occur during the transfer months of July, August, and September, with an average annual increase of 39 TAF.

Table B-2. Average Monthly Exports at Jones Pumping Plant (TAF) for Alternative 2

Jones Exports	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Baseline	222	212	235	197	186	198	69	65	153	256	252	223	2,268
With Transfers	221	211	235	197	187	198	69	65	152	272	270	231	2,306
Change	-1	-1	0	0	1	0	0	-1	-1	17	18	8	39

Transfer water can also be exported at Banks Pumping Plant. Banks exports also can be reduced when changes in stream-aquifer interaction affect the SWP. This is illustrated below in Figure B-~~33~~34.

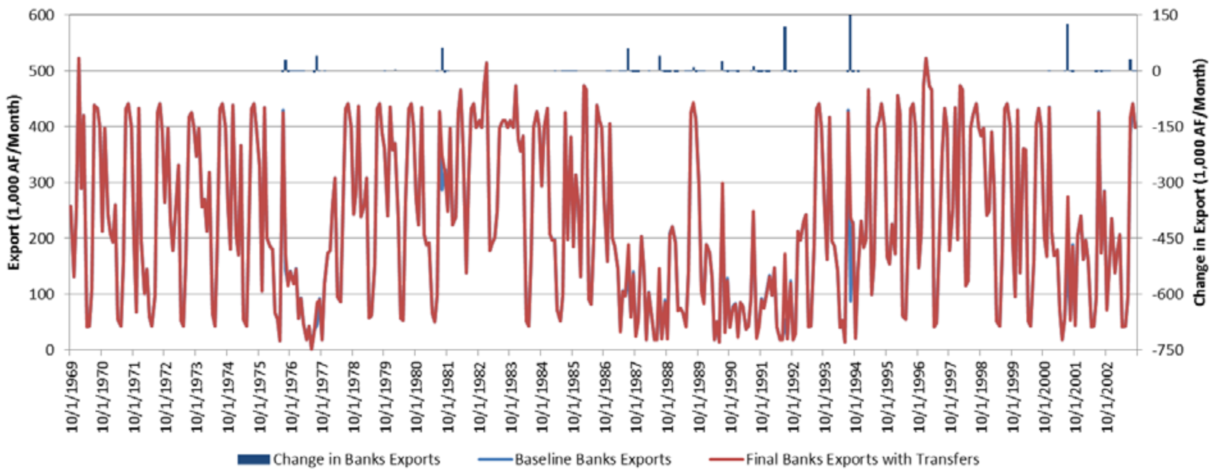

Figure B-~~33~~34. Exports at Banks Pumping Plant with and without Alternative 2 Transfers

Table B-3 summarizes the average monthly exports at Banks Pumping Plant for the baseline and with Project alternatives and the change. The average annual change is an increase of approximately 15 TAF.

Table B-3. Average Monthly Exports at Banks Pumping Plant (TAF) for Alternative 2

Banks Exports	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Baseline	202	212	307	222	239	261	70	62	156	363	316	320	2,731
With Transfers	201	211	307	221	239	261	70	62	156	375	324	319	2,746
Change	-1	-1	0	0	0	0	0	0	0	11	8	-1	15

Total CVP/SWP exports, the sum of exports at Jones and Banks Pumping Plants, are illustrated in Figure B-~~34~~35.

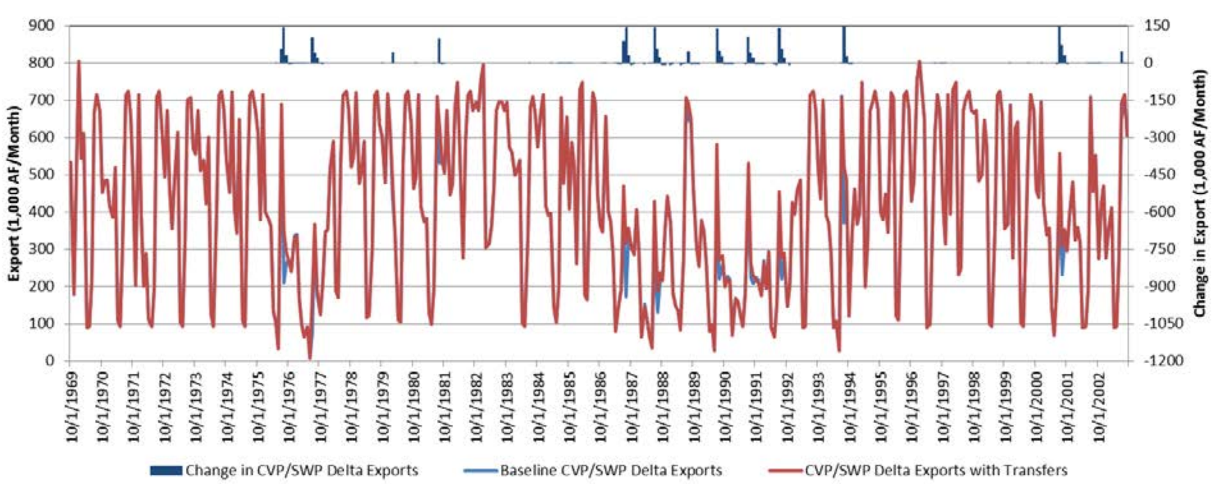

Figure B-~~34~~36. Total CVP/SWP Exports from the Delta with and without Alternative 2 Transfers

Table B-4 summarizes the average monthly combined CVP/SWP exports. The average annual change under Alternative 2 is approximately 54 TAF.

Table B-4. Average Monthly Combined CVP/SWP Exports (TAF) for Alternative 2

CVP/SWP Exports	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
Baseline	424	424	543	419	425	459	138	128	309	619	568	543	4,998
With Transfers	422	422	542	418	426	459	138	127	308	647	594	549	5,052
Change	-2	-2	-1	-1	1	0	0	-1	-1	28	26	6	54

Transfer water is also diverted by East Bay MUD at the Freeport Regional Water Project (Freeport) and by Contra Costa WD at their diversion facilities on Rock Slough, Old River, and Victoria Canal. Figure B-~~35~~ 36 illustrates changes in diversions by East Bay MUD at Freeport. Baseline East Bay MUD diversions represent diversion of CVP project water under East Bay MUD's existing contract. Diversion of transfer water occurs during months when East Bay MUD is also diverting CVP project water and increases the total East Bay MUD Freeport diversion up to the available capacity.

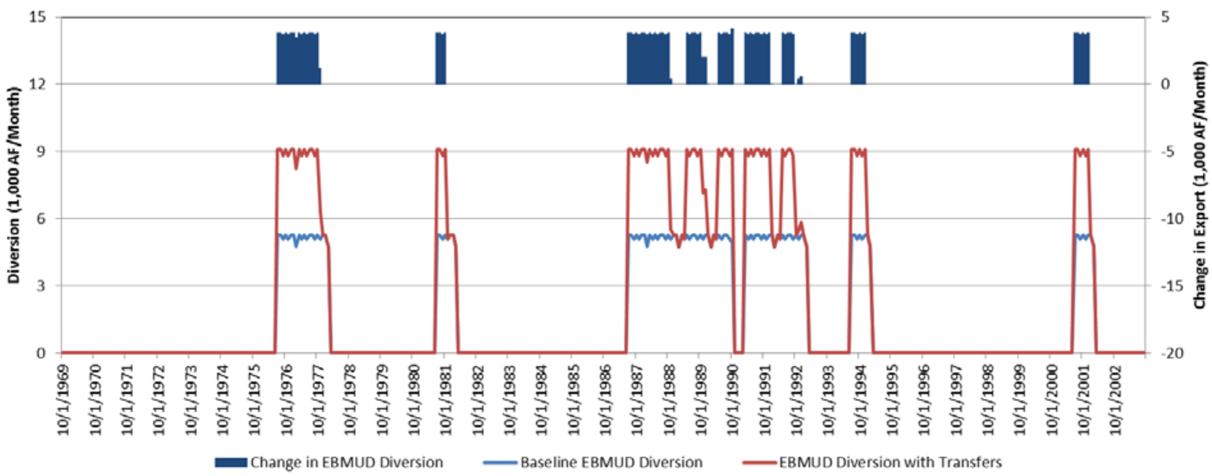

Figure B-~~35~~36. East Bay MUD Diversions with and without Alternative 2 Transfers

Contra Costa WD diversions increase to take delivery of transfer water as illustrated below in Figure B-~~36~~37. Contra Costa WD identified an annual transfer demand of up to 15 TAF and this volume of water diverted at a rate of five TAF per month during the July through September period. Contra Costa WD diversions of transfer water are assumed to occur at the point of diversion with the best water quality and available capacity.

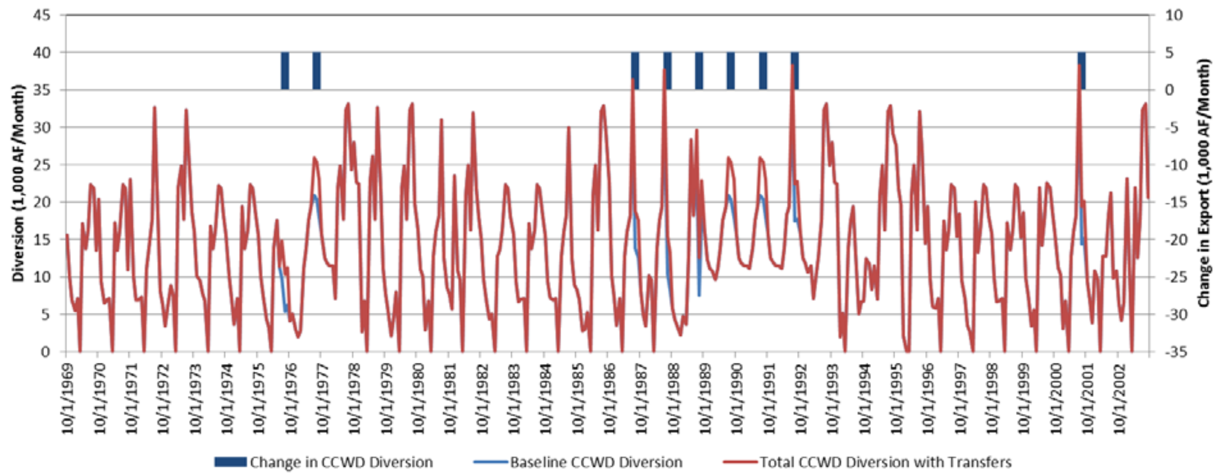

Figure B-~~36~~37. Contra Costa WD Diversions with and without Alternative 2 Transfers

B.6.3 Alternative 3: No Cropland Modifications

Alternative 3 would include transfers through groundwater substitution, stored reservoir release, and conservation. It would not include any cropland idling transfers.

Figure B-~~37~~ 38 summarizes the quantity of transfer water made available (Transfer Supply) under Alternative 3 on an annual basis, and illustrates where the water is diverted (Transfer Use). As in Alternative 2, a percentage of water to be transferred through the Delta becomes carriage water to maintain Delta water quality. Alternative 3 does not include crop idling transfer so there are no transfer supplies from that measure. Unused transfer water under this alternative is from the spill of Placer County Water Agency reservoir release water from Folsom before it can be released and re-diverted by East Bay MUD.

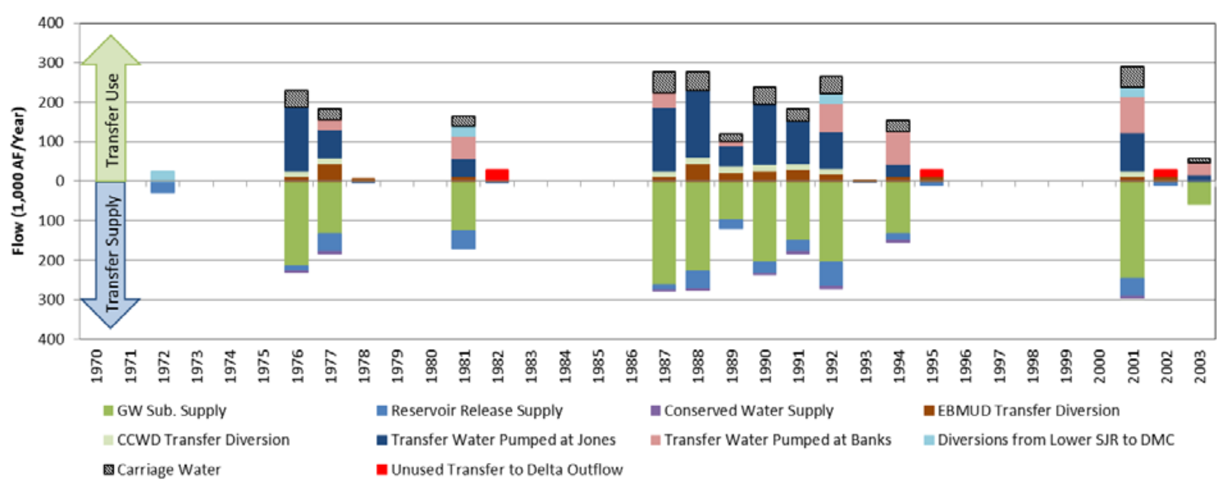

Figure B-~~37~~38. Annual Transfer Summary for Alternative 3

B.6.3.1 Storage

Changes in the operation of Shasta under Alternative 3 are similar to changes under Alternative 2 (see Figure B-~~38~~39). Increases in storage under Alternative 3 occur when groundwater substitution transfers start prior to July and transfer water is stored upstream. There are also small reductions in storage when additional releases are made to account for changes in Sacramento River flow as a result of groundwater substitution transfers.

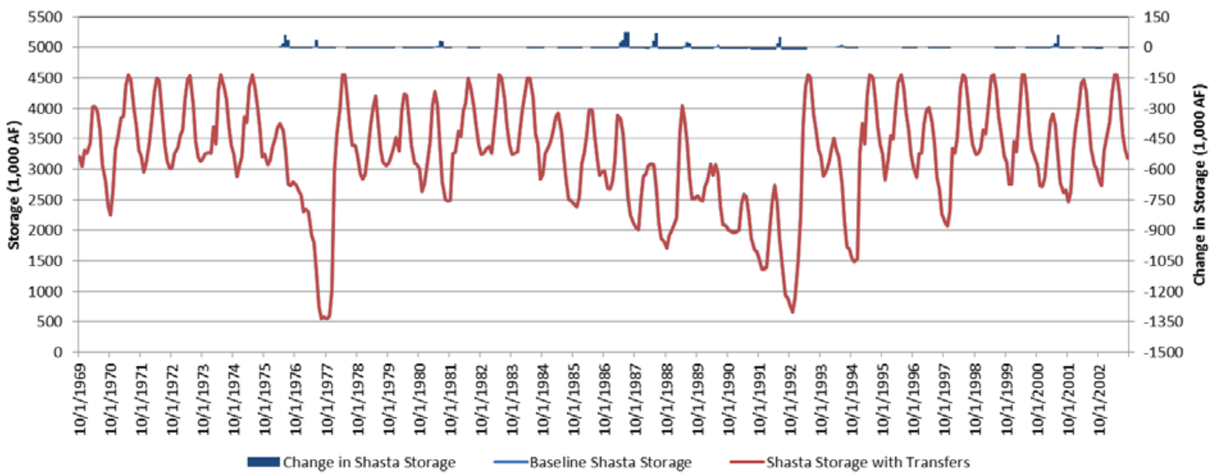

Figure B-~~38~~39. Shasta Operations with and without Alternative 3 Transfers

Folsom is used to regulate reservoir release transfers from Placer County Water Agency's upstream reservoirs before delivery to East Bay MUD. This operation can result in temporary changes in storage, as illustrated in Figure B-~~39~~40. Additional releases are also made out of Folsom to account for changes in river flows as a result of groundwater substitution transfers.

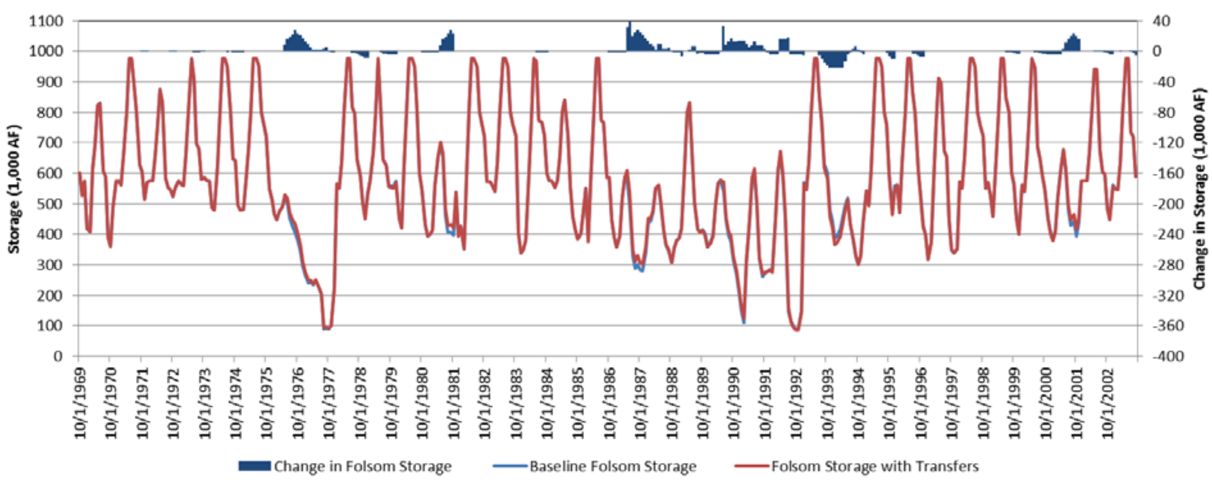

Figure B-~~39~~40. Folsom Operations with and without Alternative 3 Transfers

Figure B-~~40~~ 41 illustrates the change in operations at Oroville. Changes in Oroville operations result from shifting the timing of delivery of SWP water to accommodate transfers. There are also decreases in storage when additional water is released to maintain minimum flow requirements on the Lower Feather River. These additional releases from Oroville are made to account for reductions in Feather River flows due to groundwater substitution transfers.

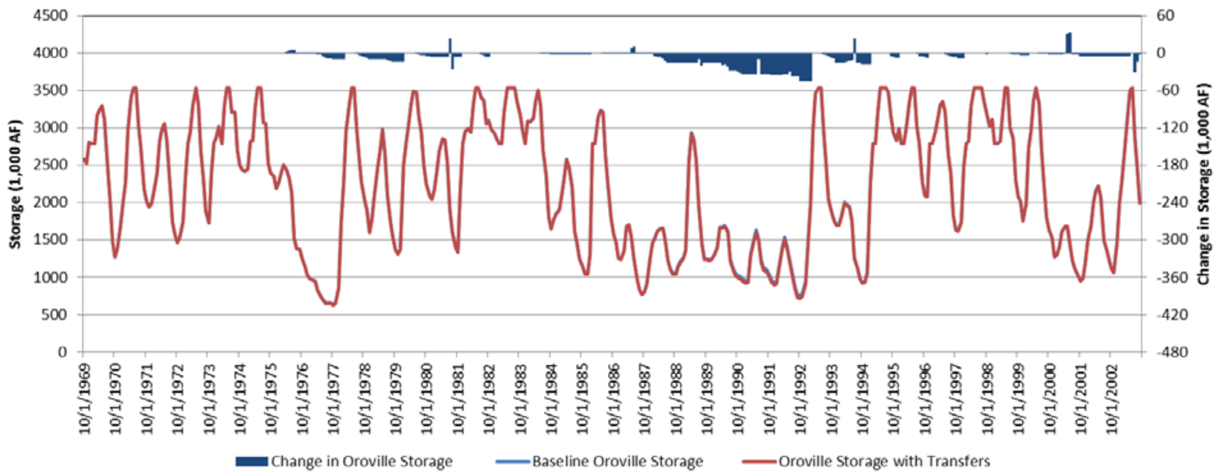

Figure B-~~40~~41. Oroville Operations with and without Alternative 3 Transfers

South Sutter WD releases water from Camp Far West Reservoir to participate in reservoir release transfers. Figure B-~~41~~ 42 illustrates the only change in reservoir storage from baseline conditions as the quantity released for transfer. Camp Far West Reservoir storage returns to baseline levels when the reservoir refills.

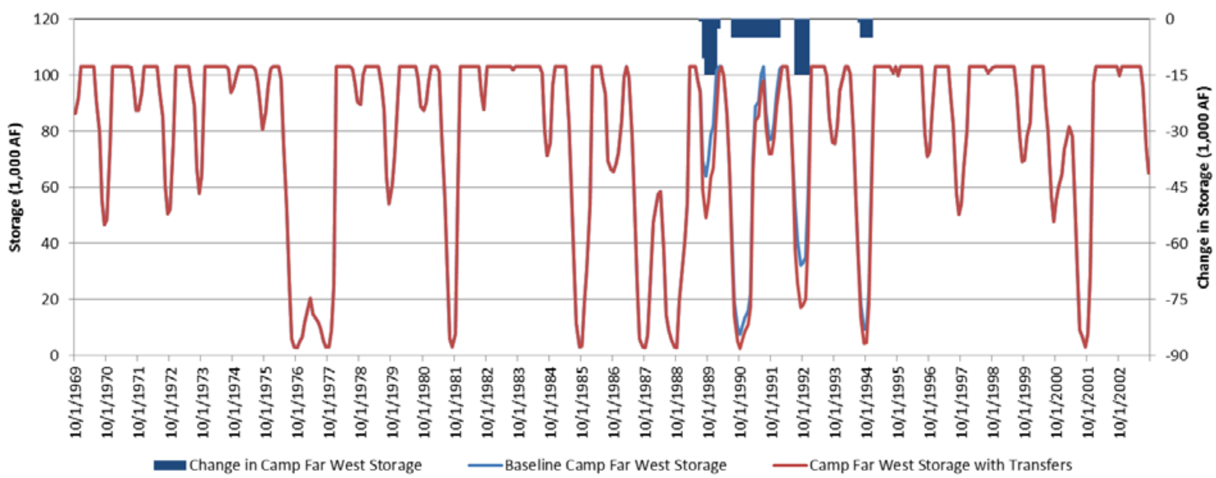

Figure B-~~41~~42. Camp Far West Operations with and without Alternative 3 Transfers

Browns Valley ID releases water from Merle Collins Reservoir to participate in reservoir release transfers. Figure B-~~42~~ 43 illustrates the only change in reservoir storage from baseline conditions as the quantity released for transfer, up to five TAF in any year. Merle Collins Reservoir storage returns to baseline levels when the reservoir refills.

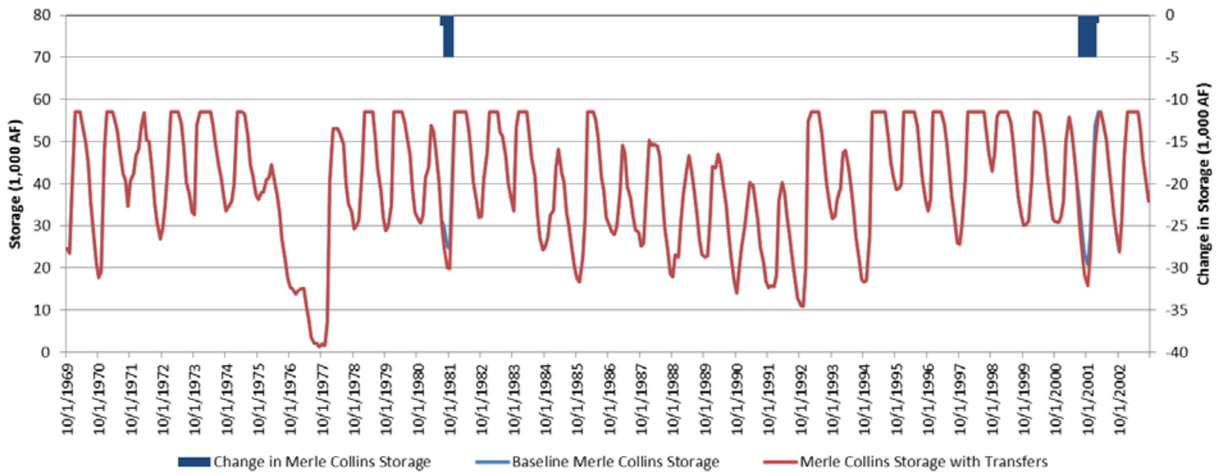

Figure B-~~42~~43. Merle Collins Operations with and without Alternative 3 Transfers

Placer County Water Agency releases water from MFP reservoirs of French Meadows and Hell Hole to participate in reservoir release transfers. Figure B-~~43~~ 44 illustrates the combined storage in these two reservoirs under both baseline and with Project operations. MFP reservoir storage returns to baseline levels when the reservoirs refill.

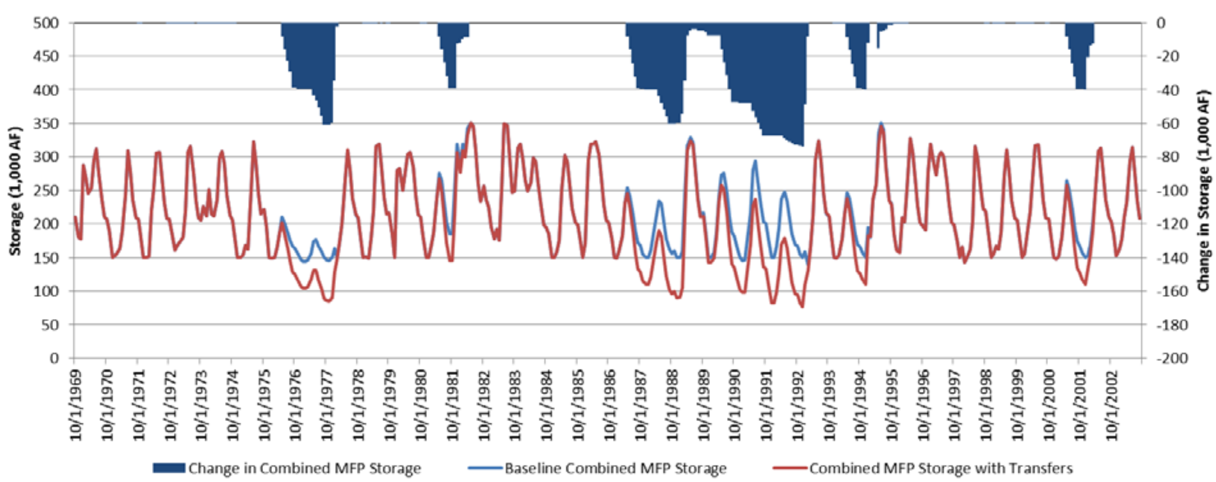

Figure B-~~43~~44. MFP Operations with and without Alternative 3 Transfers

Figure B-~~44~~ 45 illustrates change in storage of Lake McClure due to reservoir release transfers. Storage in Lake McClure can be lower by up to 30 TAF, the volume of reservoir release transfer, and returns to baseline levels when the reservoir refills with water that would otherwise have been released to maintain flood space requirements.

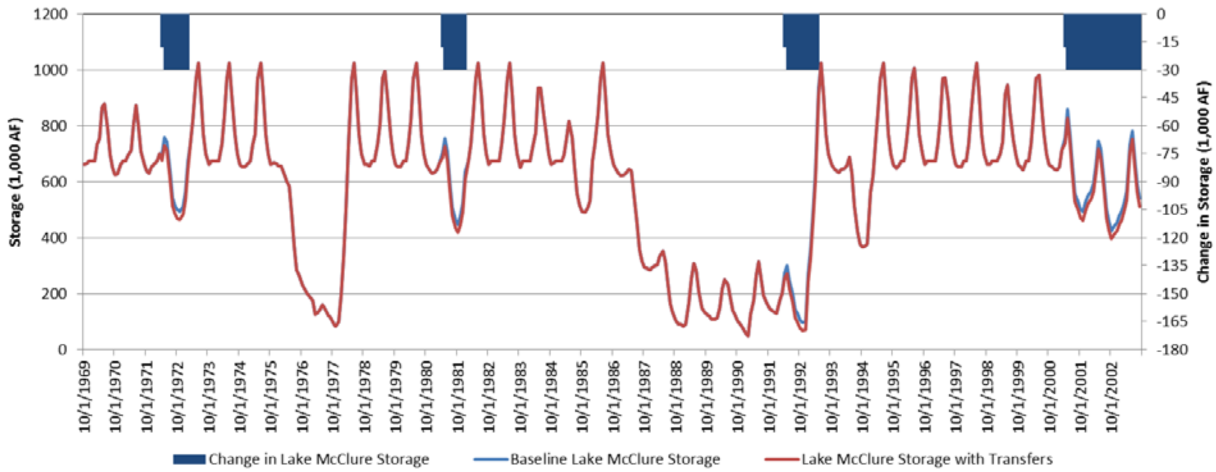

Figure B-~~44~~45. Lake McClure Operations with and without Alternative 3 Transfers

Conserved water from Browns Valley ID is stored in Yuba County Water Agency's New Bullards Bar Reservoir and released for transfer in years with demand and capacity. These releases of stored water are the primary effect to New Bullards Bar Reservoir as illustrated below in Figure B-~~45~~46.

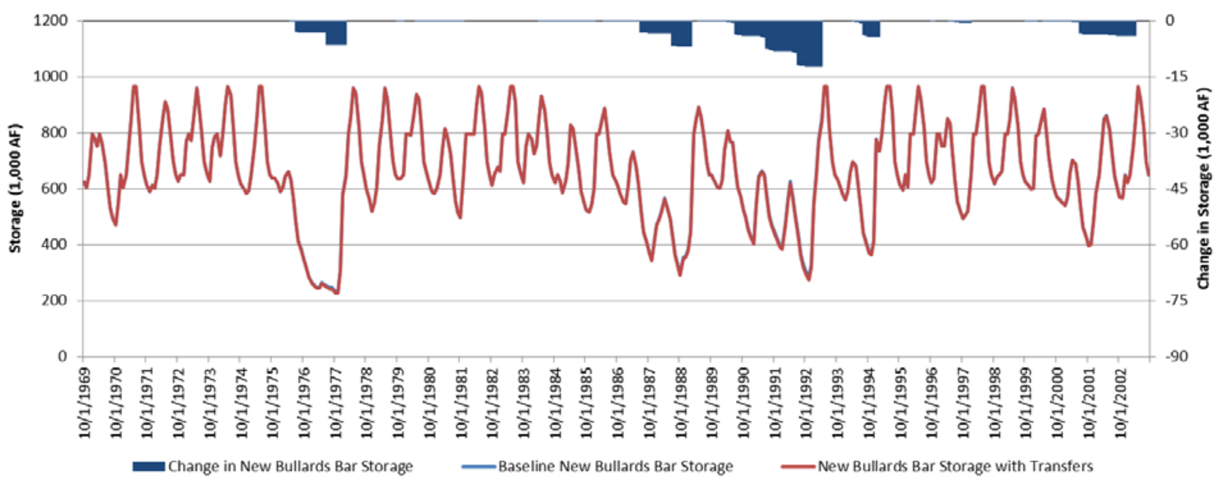

Figure B-~~45~~46. New Bullards Bar Operations with and without Alternative 3 Transfers

B.6.3.2 Stream Flow

Releases from Keswick Dam, as illustrated below in Figure B-~~46~~47, reflect changes in Shasta storage seen in Figure B-~~38~~39. A reduction in release corresponds to an increase in Shasta storage. Reduced releases typically occur in the April through June period when it may be possible to store transfer water made available downstream. Months of reduced releases are followed by increased releases as transfer water is released to be moved through the Delta during the July through September period.

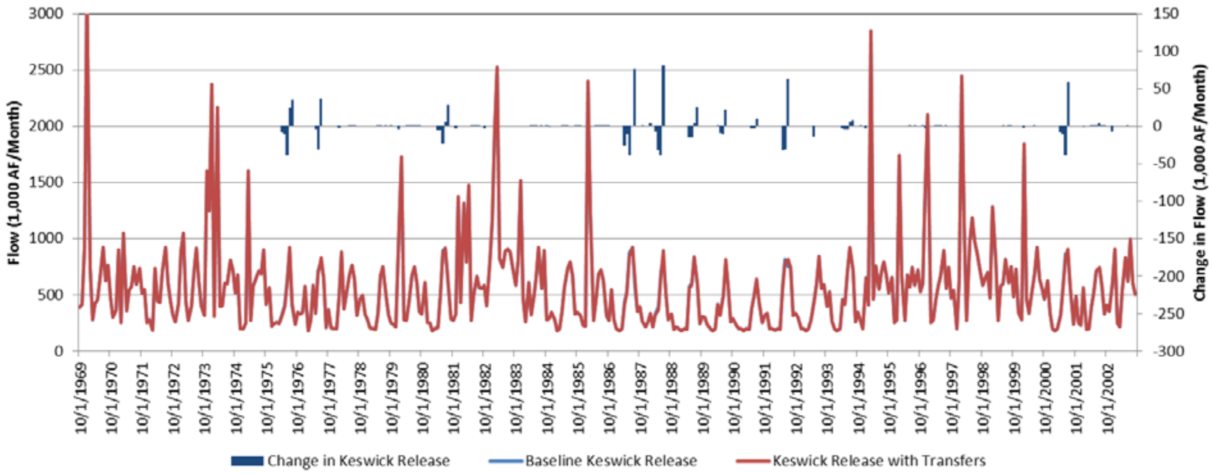

Figure B-~~46~~47. Keswick Dam Release with and without Alternative 3 Transfers

Figure B-~~47~~ 48 illustrates the effect to flows on the Sacramento River at Wilkins Slough. Flows are reduced when groundwater substitution transfers commence prior to July and are simulated as stored upstream in Shasta. Flows are increased in the July through September period when previously stored transfer water is released for delivery through the Delta, and additional groundwater substitution transfers occur upstream of Wilkins Slough.

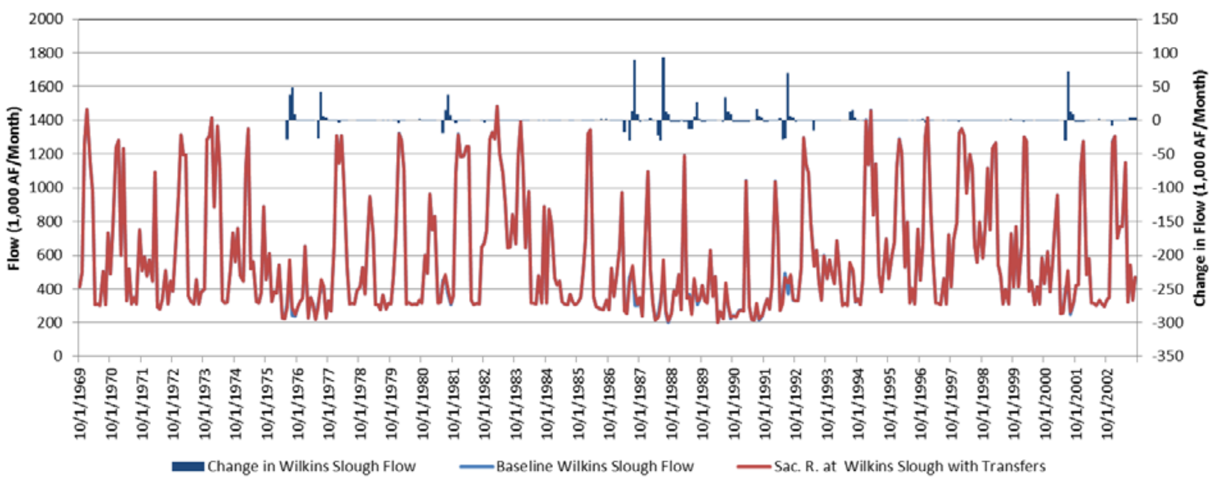

Figure B-~~47~~48. Sacramento River at Wilkins Slough with and without Alternative 3 Transfers

Figure B-~~48~~ 49 illustrates Nimbus Dam releases under baseline and with Alternate 3 transfers. Nimbus releases reflect CVP operations of Folsom

Reservoir. Increases in release of approximately five TAF are water made available by Placer County Water Agency and released from Folsom for re-diversion by East Bay MUD. Larger increases are typically preceded by decreases as transfer water made available downstream is stored in Folsom. Large releases occur when stored transfer water is release to be conveyed through the Delta. Decreases also occur when Placer County Water Agency's upstream reservoirs refill, typically during times when Folsom is also spilling water to maintain flood space requirements.

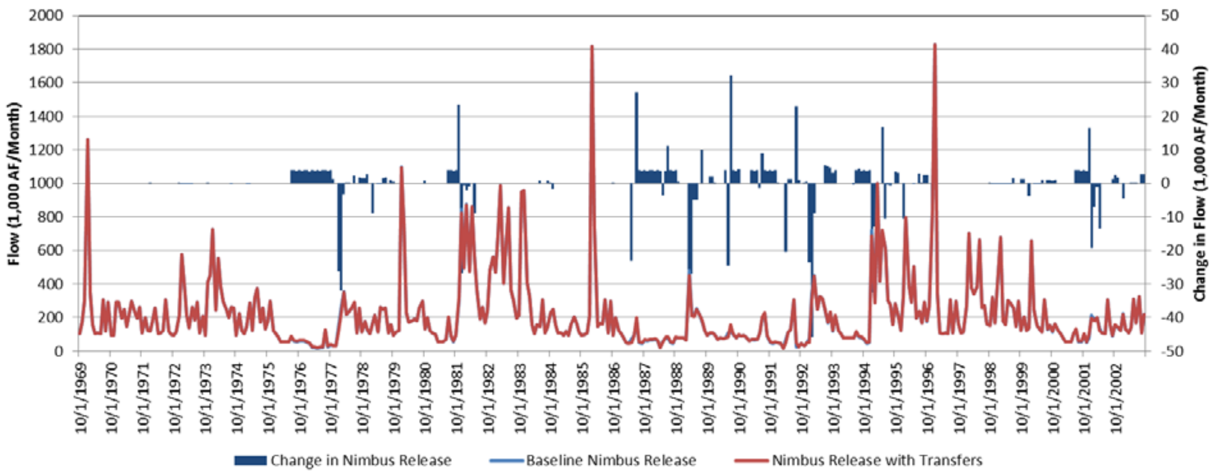

Figure B-~~48~~49. Nimbus Dam Release with and without Alternative 3 Transfers

The change in flow on the American River at H Street is similar as the change in release from Nimbus. Increases in flow are larger from July through September by the volume of groundwater substitution transfer made available by Sacramento Suburban WD and the City of Sacramento. Figure B-~~49~~ 50 is a comparison of flows under baseline and Alternative 3.

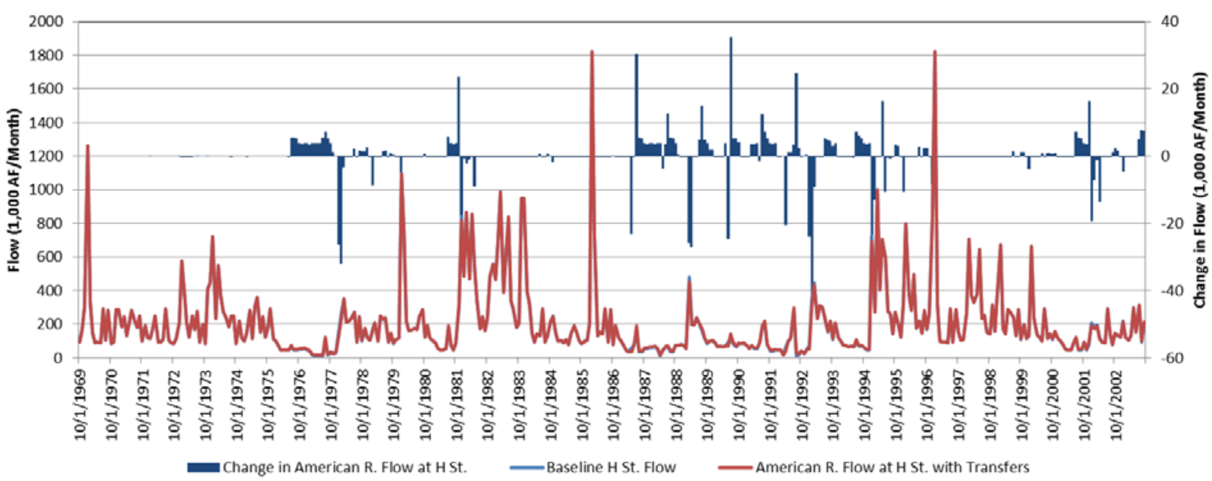

Figure B-~~49~~50. American River at H Street with and without Alternative 3 Transfers