DRAFT Technical Memorandum

Water Operations Model Work Plan

December 14, 2007

Table of Contents

1.0 Introduction 1-1

1.1 Background 1-1

1.2 Purpose of this Technical Memorandum 1-2

2.0 Water Operations Model Strategy 2-1

2.1 Expectations for Operations Modeling 2-1

2.2 Proposed Work Plan 2-1

2.2.1 Use of CalSim for PEIS/R 2-2

2.2.2 Use of Existing Spreadsheet Model for Initial Program Alternatives Development 2-2

2.2.3 Tentative Model Rollout Schedule 2-3

3.0 Review of Existing and Developing Water Operations Models 3-1

3.1 Model Description 3-1

3.1.1 FWUA-NRDC Water Supply Study Spreadsheet Model 3-1

3.1.2 FWUA Litigation and Settlement Spreadsheet Model 3-2

3.1.3 Resource Management Coalition Spreadsheet Model 3-2

3.1.4 KRWA-MWD Exchange Spreadsheet Model 3-3

3.1.5 FWUA-MWD Exchange Spreadsheet Model 3-5

3.1.6 FWUA-MWD Exchange Spreadsheet Model, with Integration 3-6

3.1.7 Friant-MWD Exchange CalSim Model 3-6

3.1.8 CalSim-II Common Assumptions Model 3-6

3.1.9 USJRBSI CalSim Model 3-7

3.1.10 CalSim-LITE 3-7

3.1.11 CalSim III Hydrology Development Project Model 3-7

3.2 Simulation Requirements Matrix 3-8

4.0 References 4-1

Tables

Table 3-1 Program Operations Modeling Requirements 3-8

Figures

Figure 2-1 Tentative Model Development Schedule 2-3

List of Abbreviations and Acronyms

Br	bromide
DFG	California Department of Fish and Game
CalEPA	California Environmental Protection Agency
CVPM	Central Valley Planning Model
CVP	Central Valley Project
C2VSIM	California Central Valley Planning Model
D-1641	SRWCB Water Right Decision 1641
Delta	Sacramento-San Joaquin Delta
DWR	California Department of Water Resources
EPP	Edmonston Pumping Plant
EWA	Environmental Water Account
FWUA	Friant Water Users Authority
KRWA Model	KRWA Exchange Spreadsheet Model
KRWA	Kings River Water Account
MBR	Multi-Benefit Reservoir
MWD	Metropolitan Water District of Southern California
NMFS	National Marine Fisheries Services
NRDC	Natural Resources Defense Council
PEIS/R	Program Environmental Impact Statement/Report
SJRRP	San Joaquin River Restoration Program
Reclamation	United States Department of the Interior, Bureau of Reclamation
RMC Model	Resource Management Coalition Model
Settlement	San Joaquin River Stipulation of Settlement
SWP	State Water Project
SWRCB	State Water Resources Control Board
TDS	total dissolved solids
TM	Technical Memorandum
TOC	total organic carbon
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
USJRBSI	Upper San Joaquin River Basin Storage Investigation

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This Draft Technical Memorandum (TM) was prepared by the San Joaquin River Restoration Program (SJRRP) Team as a draft document in support of preparing a Program Environmental Impact Statement/Report (PEIS/R). This TM defines the role of, expectations for, strategy and selection of water operations modeling for the San Joaquin River Restoration Program, focusing on completion of the PEIS/R being prepared for the SJRRP.

The purpose for circulating this document at this time is to facilitate early coordination regarding initial concepts and approaches currently under consideration by the Program Team with the Settling Parties, the Third Parties, other stakeholders, and interested members of the public. As such, the content of this document may not necessarily be included in the PEIS/R.

This Draft TM does not present findings, decisions, or policy statements of any of the Implementing Agencies. Additionally, all information presented in this document is intended to be consistent with the Settlement. To the extent inconsistencies exist, the Settlement should be the controlling document and the information in this document will be revised prior to its inclusion in future documents. While the Program Team is not requesting formal comments on this document, all comments received will be considered in refining the concepts and approaches described herein to the extent possible. Responses to comments will not be provided and this document will not be finalized; however, refinements will likely be reflected in subsequent program documents.

1.0 Introduction

1.1 Background

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and the Central Valley Project (CVP) Friant Division contractors. After more than 18 years of litigation of this lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, agreement was reached on September 13, 2006, by the "Settling Parties" on the terms and conditions of the Stipulation of Settlement (Settlement), which was subsequently approved by the United States District Court on October 23, 2006. The Settling Parties include NRDC, Friant Water Users Authority (FWUA), and the United States Departments of the Interior and Commerce.

The Settlement is based on two parallel goals:

- Restoration Goal – To restore and maintain fish populations in "good condition" in the main stem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.

- Water Management Goal – To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors resulting from the Interim Flows and Restoration Flows provided for in the Settlement.

The SJRRP will implement the Settlement. The Implementing Agencies responsible for management of the SJRRP include the United States Department of the Interior, through the Bureau of Reclamation (Reclamation) and the Fish and Wildlife Service (USFWS), United States Department of Commerce through the National Marine Fisheries Service (NMFS), and the State of California through the Department of Water Resources (DWR), the Department of Fish and Game (DFG), and the California Environmental Protection Agency (CalEPA). Consistent with the memorandum of understanding between the Settling Parties and the State, which was signed concurrently with the Settlement, the State, through DFG, DWR, the Resources Agency, and CalEPA, will play a major, collaborative role in planning, designing, funding, and implementing of the actions called for in the Settlement.

1.2 Purpose of this Technical Memorandum

To satisfy the condition in the Settlement for allowing release of Interim Flows in October 2009, the PEIS/R is scheduled for completion on July 31, 2009. To assist completion of the PEIS/R, the SJRRP will develop milestone reports, including an Initial Program Alternatives Report (scheduled for April 30, 2008; draft in January/February 2008), and Program Alternatives Report (scheduled for October 29, 2008).

The SJRRP Program Management Plan, completed by Reclamation in 2007, envisioned that the information contained in the Initial Program Alternatives Report would be derived mostly from existing information and data, if possible; these data were generated during the litigation and subsequent settlement processes. During the same period of time, the scope, strategy, and analytical approach for the PEIS/R will be developed. Similar model selection processes to those documented herein are ongoing for all aspects of SJRRP analytical needs.

Results from the water operations model will (1) depict the operation of the Friant Division of the CVP and other water management systems under the Settlement, (2) provide the basis for comparing actions contributing to meeting the Water Management Goal, and (3) provide input to many subsequent analyses for impact assessments, such as fishery, water quality, and economics. To meet the aggressive schedule, a conservative estimate for the time when the basic analytical tools, such as a water operations model, need to be in place by April 2008, for subsequent alternative evaluation.

2.0 Water Operations Model Strategy

This section provides the strategy for developing a water operations model for the SJRRP to meet different stages of planning objectives, and summarizes recommendations on model use.

2.1 Expectations for Operations Modeling

Implementation of the Settlement will reestablish the connection between the Friant system and the rest of the Central Valley water system, including the CVP and SWP. Changes to the pattern, volume, and timing of releases along the San Joaquin River are likely to affect water releases throughout the California Central Valley. It will be necessary for the SJRRP to evaluate subsequent, reactive operation changes of the CVP, SWP operations, and other water Central Valley water systems, and their associated impacts.

In summary, expected functions of the water operations model should include the following:

- Simulation of Friant Division and San Joaquin River operations under the Settlement's Restoration Goal
- Evaluation of options and alternatives for meeting the Settlement's Water Management Goal
- Quantification of effects from implementing Interim Flows and Restoration Flows to the CVP, SWP, and other affected systems
- Establishment of hydrologic and operations information for subsequent analyses to support PEIS/R development
- Quantification of the storage and flow effects of Settlement Restoration Flows, including buffer flow application and hydrograph shifting on the upper San Joaquin River and downstream systems
- Evaluation of Restoration Flow applications and options for the restoration of the San Joaquin River fishery

2.2 Proposed Work Plan

Based on the technical and scheduling criteria set forth previously, a review of existing and developing water operation models for their applicability in the SJRRP was completed. The following provides a summary, and details are provided in Section 3.

Note that model specifications would depend on the exact water management options that would be included in the SJRRP. As previously mentioned, discussion continues on this topic to provide additional guidance to SJRRP development. Therefore, the strategy and recommendation below reflect primarily the direction of model selection.

2.2.1 Use of CalSim for PEIS/R

At present, the Reclamation/DWR system operations model, CalSim, is the only model presenting a comprehensive depiction of the CVP/SWP water system, including Delta management and operations. As a standard platform of water operation modeling for statewide water management programs and projects, many versions of CalSim are available, and continue to be improved through various programs and project development. As previously mentioned, implementation of the Settlement will reconnect the Friant Division to the broader CVP/SWP system more directly. Thus, it is necessary that the final alternatives analysis be based on the most appropriate version of the CalSim tool in terms of completeness and acceptance.

Among the CalSim versions under review, the most promising CalSim version candidate is the being developed by Reclamation and DWR as part of the Upper San Joaquin River Basin Storage Investigation (USJRBSI). This version of CalSim will evaluate the potential integrated system operation of the CVP, including Friant Division, and the SWP. This version of CalSim-II would incorporate efforts from the exchange discussion between FWUA and the Metropolitan Water District of Southern California (MWD), covering many major water management options, of which some may be considered in the SJRRP. USJRBSI modeling work is ongoing, and scheduled for completion by February 2008 to support development of the Plan Formulation Report for the USJRBSI. The context and schedule for USJRBSI CalSim development are compatible with the SJRRP, providing additional monetary and consistency advantages. However, it is anticipated that some additional adjustments may be required for SJRRP use. Therefore, it is recommended that the progress of USJRBSI efforts be reassessed in January 2008, and the version of CalSim to be used for the SJRRP be finalized.

2.2.2 Use of Existing Spreadsheet Model for Initial Program Alternatives Development

It is recommended that existing spreadsheet model(s), especially those used in the Settlement process, should be used to develop information for the Initial Program Alternatives Report. Several benefits of such an approach include (1) meeting the required schedule for Initial Program Alternative Report development, and (2) providing bridging and consistency with the Settlement discussion.

As previously mentioned, CalSim will be the platform for performing water operations modeling assessments for the PEIS/R. Therefore, the use of spreadsheet model(s) is a temporary strategy to maintain the SJRRP progress. It is anticipated that the information derived from these spreadsheet model(s) will be used in other program documents that contribute to development of the Initial Program Alternatives Report.

2.2.3 Tentative Model Rollout Schedule

A water operations model will be required by the following dates, for the listed purposes:

- **Mid-December 2007** - Publish tools and results to assist development of the Initial Program Alternatives Report, as shown in Figure 2-1

- **Late April 2008** - Publish tool for PEIS/R analyses, as shown in Figure 2-1

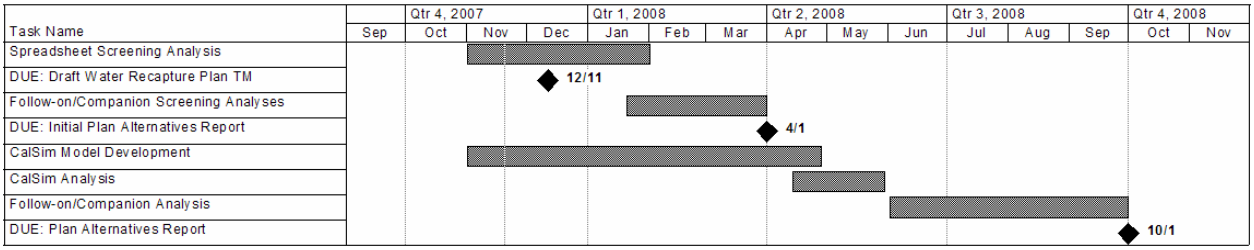

Figure 2-1
Tentative Model Development Schedule

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3.0 Review of Existing and Developing Water Operations Models

The following section discusses the field of existing water operations models that overlap with the analysis needed to accomplish the modeling identified in the previous section.

3.1 Model Description

The expedited schedule of this evaluation requires the efficient use of existing completed and ongoing efforts to the extent possible. To date, the Settlement forum has preliminarily evaluated hydrologic aspects of the Settlement, and several other forums have investigated hydrologic and facility elements that are also the subject of the planning analysis surrounding Settlement implementation. The following summarizes these other efforts, and existing tools that will be considered during development of the water operations model used for this investigation.

3.1.1 FWUA-NRDC Water Supply Study Spreadsheet Model

This long-term hydrologic spreadsheet model (Water Supply Study Model) was used to analyze various alternatives and mechanisms designed to meet river restoration and Friant Division water supply requirements. The Water Supply Study Model was constructed as part of the 2002 Water Supply Study, which was prepared by URS at the direction of the FWUA and the NRDC Coalition (2002). Much of the operations logic within the Water Supply Study Model stems from a precursor "gaming" tool that identified alternative features, mechanisms, and operational protocols occurred.

The Water Supply Study provided information to guide planning efforts surrounding restoration of the San Joaquin River. The Water Supply Study Model also provided a prereconnaissance performance analysis of alternatives for supplying sufficient water to support restoration of San Joaquin River habitat and fisheries, while not adversely impacting Friant Division water supplies.

The operational requirement of the long-term model was to meet the demands for both restoration needs, and water deliveries to Friant Division water users. As water demands for restoration caused potential water supply impacts to Friant Division water users, these impacts were ameliorated with water supply alternatives and mechanisms. These alternatives and mechanisms included water purchases, and conveyance and storage facilities such as groundwater conjunctive use and conservation. The model either directly or indirectly provided estimations for capital and operational costs.

The model also captured hydrologic elements for the geographical area of the Friant Division, and the San Joaquin River basin to the Sacramento-San Joaquin Delta (Delta). An interface with results from CalSim was used to depict the San Joaquin River basin, and Delta export and conveyance facilities.

3.1.2 FWUA Litigation and Settlement Spreadsheet Model

This spreadsheet model (Settlement Model) was used by FWUA during the most recent litigation and settlement phase of the Court action, as was the tool used by FWUA in its submittal of expert reports to the Court.

The Settlement Model is a streamlined version of the Water Supply Study Model described above, with only the hydrologic and operational elements of the "existing" system incorporated. This model provides a tool that can depict current Friant Division water diversions and operations during a long-term simulation period (1922 through 2006). Canal diversions vary from year to year based on an annually variable water supply. The monthly distribution of an annual diversion is based on the historical delivery practices of the contractors. Minimum required releases below Friant Dam for riparian and contractor uses are modeled as a constant annual requirement, consistent with recent records of operations. Flood management operations for Millerton Lake and the lower San Joaquin River are based on rain-flood space reservation requirements specified by the United States Army Corps of Engineers (USACE). Flood control operations during the snowmelt runoff period recognize the competing objectives of water supply and flood control. The operations attempt to maximize water supply carryover storage (into summer) while reducing the potential for downstream flooding.

Model input can be populated with alternative assumptions for downstream releases from Friant Dam, such as required Restoration Flows. With such changes to operational requirements, the model will dynamically alter simulated operations to provide a viable reservoir operation through revising water deliveries to Friant Division water users. Revising water deliveries is in accordance with the same operational and water allocation protocols used for current operations. Hydrologic parameters such as month-to-month river hydrology, canal diversions, and reservoir operation are provided by the model. For additional information concerning the model and its results, refer to the SJRRP draft TM titled Water Operations Existing and Future Without-Project Conditions (August, 2007).

A postprocessor spreadsheet was also developed by FWUA concerning the potential hydrologic effects of changed river flows downstream from Friant Dam. This spreadsheet layered Friant Dam releases onto the simulated operation and river flows of the San Joaquin River, as depicted by CalSim-II.

3.1.3 Resource Management Coalition Spreadsheet Model

The Resource Management Coalition Model (RMC Model) spreadsheet integrates hydrographs developed by the Resource Management Coalition (RMC) into a water supply analysis that evaluates the water system's ability to provide water supply for river restoration. The RMC Model relies on the same core operation simulation logic developed for the Friant Division models, as described above.

The RMC analysis was performed to identify a potential flow regime below Friant Dam that is viable under various water system configurations, assumed constraints, and downstream flow objectives. The evaluation gave the magnitude and frequency of flow regimes that could be provided from "new" water developed by additional facilities and modified operations. The RMC water supply study performed analyses on the following system scenarios:

- Existing water system
- Existing water system, plus release recapture opportunities
- Additional storage
- Additional storage, plus release recapture opportunities

The approach of the analysis involved modeling Friant Division operations under different assumptions for river release objectives and available facilities. The geographical reach and breadth of facilities assumed in the analysis included the following:

- Friant Division facilities
- San Joaquin River to the Mendota Pool
- San Joaquin River Exchange Contractors facilities
- San Joaquin River below Mendota Pool
- Delta-Mendota Canal/California Aqueduct
- San Luis Reservoir
- Cross-Valley Canal

In each scenario, the existing ("baseline") water supply deliveries of the Friant Division contractors were maintained as a requisite. The potential changes in water supply conditions address the addition of reservoir storage (surrogated as an increase in Millerton Lake storage capacity) and the use of river release recapture at Mendota Pool (operational opportunity) for return and use by the Friant Division contractors. The result of the analysis was the identification of viable river release regimes from Friant Dam under the four different water supply scenarios.

3.1.4 KRWA-MWD Exchange Spreadsheet Model

The Kings River Water Association (KRWA)/MWD Exchange Spreadsheet Model (KRWA Model) was developed to explore opportunities to exchange waters between the Kings River basin and SWP supplies. Additional benefits of managing Arroyo Pasajero flood flows were also explored. Independently derived, "fixed" system conditions (e.g., Delta conditions and CVP/SWP operations) were preprocessed and incorporated into the model. The hydrology of the Arroyo Pasajero was also preprocessed and incorporated into the model. Operation of Pine Flat Dam and deliveries is dynamic or fixed in the model. On this baseline, simulation of alternative operations occurs as a subsequent layer. Operations are determined by a series of rules and constraints, and a limited number of predetermined assumed factors such as the availability of surplus water. The viability of a set of operating rules is evaluated by running a simulation over the long-term hydrologic record of the system that includes periods of flood and prolonged drought.

The major system components of the model are discussed in the following subsections.

Kings River

The Kings River is modeled as a reservoir system operated to manage the flows of the Kings River for delivery to KRWA entities. This component of the model includes the impairment of the natural flow of the river, upstream from Pine Flat Dam, due to operations of the Pacific Gas

and Electric Company hydroelectric facilities. At Pine Flat Dam, operations are guided by USACE flood control requirements and conservation objectives for delivery of water to KRWA entities. Water deliveries to KRWA entities are established by a water supply delivery protocol that mimics recent historical practice. At times, flood control operations require releases in excess of the water users' ability to use all of the releases. These surplus flows are modeled to escape from the Tulare Lake basin into the San Joaquin River.

Friant-Kern Canal

Although potentially incorporated, Millerton Reservoir and the Friant-Kern Canal are not operated in the model. Results concerning a simulation of the Friant Division were incorporated into the model for information purposes only. The Friant-Kern Canal was incorporated into the model as a conveyance device to transport water from the Kings River (via an assumed pump-in facility) to the southern San Joaquin Valley, where subsequently the water was conveyed east-to-west to the California Aqueduct. The east-to-west conveyance is assumed to be the combination of available capacity within the Cross-Valley Canal and indirect connection facilities.

Multi-Benefit Reservoir

The Multi-Benefit Reservoir (MBR) was a potential storage facility integrated into the project. The MBR was modeled to provide reservoir storage for the Environmental Water Account (EWA), Arroyo Pasajero, and water quality exchange operations. The reservoir was assumed to be constructed downhill from the California Aqueduct near Kettleman City. Water conveyance and control systems would allow the storage and extraction of water. The range of capacity for the reservoir was between 45,000 and 145,000 acre-feet. Water ownership in the MBR was tracked.

Central Valley Project / State Water Project / Delta / Delta Drainage Area

The operation of the CVP, SWP, Delta, and entire Delta drainage area is simulated using the CalSim-II planning simulation model. Water available for exchange and for MBR operation was based on the conditions of the SWP and Delta, with results from CalSim integrated into the simulation model.

Environmental Water Account

The EWA was simulated in this model as a participant. EWA operations were integrated with MBR operations in the model. EWA assets gained from EWA's use of MBR would alter both north-of-Delta and south-of-Delta water acquisition, and would allow the EWA to increase its ability to implement fish protection actions.

Arroyo Pasajero

The Arroyo Pasajero component is modeled as a monthly inflow (when occurring) to the California Aqueduct. These flows represent only the residual flood flows that are anticipated to exceed the detention capability of the local area system. These flows are modeled to enter, and be attenuated in, the MBR.

Water Quality

Several water quality parameters formed the basis for the MWD water quality exchange operation. Water quality parameters addressed in the model include bromide (Br), total dissolved solids (TDS), and total organic carbon (TOC). Water quality of both Jones and Banks

pumping plant exports were based on CalSim's simulation of Delta operations. The model performed a blending operation of water in O'Neill Forebay, San Luis Reservoir, and the California Aqueduct.

Metropolitan Water District of Southern California

MWD is indirectly modeled as an incremental operation at Edmonston Pumping Plant (EPP). An implied operation of MWD's storage in Southern California occurs when EPP's operation is modified from the baseline condition.

3.1.5 FWUA-MWD Exchange Spreadsheet Model

The system operations model for the FWUA/MWD partnership was developed to explore water exchange opportunities between Friant Division and SWP supplies. Operational rules embedded in the model, constrained by user-defined parameters, simulate system operations. Certain "fixed" system conditions are preprocessed for the entire period of simulation, and incorporated into the model. These conditions include Delta operations, CVP/SWP Westside, and California Aqueduct operations, and Friant Division deliveries. The simulation occurs as a subsequent layer of operation on this baseline condition.

Operations are determined by a series of rules, constraints, and a limited number of predetermined assumed factors, such as the availability of surplus water. The viability and accomplishments of a set of operating rules and assumed facilities are evaluated by running a simulation over the long-term hydrologic record of the system that includes periods of flood and prolonged drought.

Major system components of the model are discussed in the following subsections.

Friant Division

Simulation of the Friant Division is input to the model as a time series of deliveries and parameters. Some aspects of Millerton Lake operations are simulated by the model, but Class 1, Class 2, and Section 215 deliveries are set to "baseline" model results. The purpose in fixing the deliveries at baseline levels is to identify operations opportunities layered around existing operations. The baseline model of the Friant Division is derived from the same core logic described above for the other Friant Division models.

Central Valley Project / State Water Project / Delta / Delta Drainage Area

The same form of results derived from CalSim-II studies described for the KRWA Model is incorporated into this simulation model.

Conveyance Facilities

The Arvin-Edison Canal, Cross-Valley Canal, and Shafter-Wasco pipeline are three cross-valley conveyance facilities operated in the model to facilitate water exchanges. Desired volumes of exchanges are determined in the model and conveyed through these facilities, constrained by available capacity. In addition to cross-valley conveyance facilities, the Friant-Kern Canal and California Aqueduct are necessary conveyance components for the exchange of water. Unused capacity in these facilities is determined based on their preestablished baseline operation.

Water Quality

Water quality parameters addressed in the model include Br, TDS, and TOC. The model accounts for the blending of water in O'Neill Forebay, San Luis Reservoir, the California Aqueduct, and subsequently between the California Aqueduct and interconnections with the Friant system.

Metropolitan Water District of Southern California

MWD is indirectly modeled as a layer of an incremental operation at EPP. An implied operation of MWD's storage in Southern California occurs when EPP's operation is modified from the baseline condition. The month-to-month ability to increase or decrease MWD storage is determined based on MWD storage conditions.

3.1.6 FWUA-MWD Exchange Spreadsheet Model, with Integration

This spreadsheet model uses many of the features included in the FWUA/MWD Exchange Spreadsheet Model without integration, but includes new storage in the upper San Joaquin River basin, and expanded east/west conveyance, and integrates Friant Division operations with SWP operations, including San Luis Reservoir, Banks pumping and Delta conditions, and Oroville Reservoir.

3.1.7 Friant-MWD Exchange CalSim Model

This model application incorporates features from several spreadsheet models, and also features difficult to include in spreadsheets, into CalSim to simulate an integrated operation with the entire CVP/SWP system. This CalSim application is based on the Common Assumptions version of the model, but has modules to include the following:

- Friant-Kern Canal deliveries by reach
- Cross-valley conveyance
  - Arvin-Edison connections
  - Cross-Valley Canal
  - Shafter-Wasco connection
  - Trans-Valley Canal
- Integrated Friant – SWP operations
  - Proposed groundwater banks in Tulare basin
  - Proposed storage facilities
  - Changed operation of existing facilities

3.1.8 CalSim-II Common Assumptions Model

The Friant Division is incorporated in the CalSim-II Common Assumptions Model. The depiction of the Friant Division is very consistent with the spreadsheet models described above. (The spreadsheet models were actually used as precursor development tools for CalSim-II logic.) The only substantive difference in logic/system depiction between CalSim-II and the spreadsheet tools is the incorporation of land-use-based hydrology for the Madera Canal geographical area within CalSim-II. This difference results in slightly altered operations of the Madera Canal between the models.

Further documentation is available from DWR/Reclamation.

3.1.9 USJRBSI CalSim Model

USJRBSI has used the CalSim model to evaluate reservoir options considered under the project. In the past, the USJRBSI produced most updated versions of San Joaquin River system description in the CalSim environment. After the Settlement was completed, this model represents a refinement of the Settlement Model, with the option of including Temperance Flat and Fine Gold reservoirs. This model currently exists in spreadsheet form, and is being integrated into the CalSim environment. In particular, the continued development of the USJRBSI requires an integration study of the entire CVP and SWP systems, similar to that considered in the FWUA-MWD exchange discussion. Therefore, the current working version of CalSim-II incorporates the components developed for the previous efforts. USJRBSI modeling work is scheduled for completion by February 2008 to support development of the Plan Formulation Report for the USJRBSI.

3.1.10 CalSim-LITE

CalSim-LITE was constructed for the evaluation of water transfers in the Central Valley on an uncomplicated platform that allowed flexible alternative development and quick analysis. Specifically, the goals for CalSim-LITE were (1) providing rapid screening of transfer alternatives, (2) including hierarchy of facility use priorities, (3) incorporating the most significant components of the full CalSim-II model, (4) evaluating timing and availability of conveyance and storage capacity, (5) evaluating potential water supply/environmental gains of transfers under existing and proposed facilities, and (6) providing integration with more detailed system-wide CalSim-II modeling.

3.1.11 CalSim III Hydrology Development Project Model

DWR and Reclamation jointly developed a program to enhance the capabilities of this model, and improve on its applicability for water resources planning in California. Among the features of this development project are (1) a higher resolution representation of the physical system, (2) enhancement of local water supply estimates, (3) development of a more accurate representation of CVP/SWP and non-project demands, (4) enhancement of procedures for allocating priorities to meet demands from multiple sources of surface water and groundwater, and (5) enhancement of current, and/or development of new, methodologies for simulating groundwater flow and surface water-groundwater interaction. One of the foremost improvements provided by the CalSim III effort was a new, physically based schematic that facilitates intercomparisons with other planning models (e.g. C2VSIM and CVPM).

The current CalSim III model was built for the State Water Resources Control Board (SWRCB) Water Right Decision 1641 (D-1641) step for the Sacramento Valley, and is being incorporated into the latest version of the CALFED Bay-Delta Common Assumptions framework tool. The San Joaquin Valley portion of the model is currently under development for the D-1641 step.

3.2 Simulation Requirements Matrix

Table 3-1 displays the list of models (columns) described above with their attributes (rows).

Table 3-1
Program Operations Modeling Requirements

Functionality	Water Operations Models										
	FWUA-NRDC Settlement Spreadsheet	Resource Management Coalition Spreadsheet	FWUA-NRDC Water Supply Settlement Spreadsheet	FWUA-MWD Exchange Spreadsheet	Friant-Met Exchange Spreadsheet Model	FWUA-MWD Exchange Spreadsheet Model with Integration	FWUA-MWD Exchange CalSim Model	CalSim Common Assumptions Model	Upper San Joaquin River Basin Storage Investigation CalSim Model (with integration)	CalSim LITE	CalSim III Hydrology Development Project Model
Options Described in Friant Report (FWUA, 2007)											
Delta Recirculation[1] with Cross-Valley Canal Intertie and Friant-Kern Canal Reverse Flow		X	X		X	X	X	X	X	X	X
Delta Recirculation[1] with State Water Project / Kings River Pump-In Facility and Exchange			X	X					X		
Delta Recirculation[1] with Trans-Valley Canal Development						X	X				
Delta Recirculation[1] with Multi-District Conveyance Project					X	X	X		X		
Delta Recirculation[1] with Arvin-Edison-California Aqueduct Intertie					X	X	X				
San Joaquin River Recirculation[1] with Smaller San Joaquin River Interceptor Pumps and Pipeline Intertie to the Delta-Mendota Canal			X								
San Joaquin River Recirculation[1] with Larger San Joaquin River Interceptor Pumps and Intertie to the Delta-Mendota Canal in Exchange for California Aqueduct water			X								
San Joaquin River Recirculation[1] with Larger San Joaquin River Interceptor Pumps and Intertie to California Aqueduct for Kings River Exchange			X								
Transfers and Friant Purchases			X								

Table 3-1
Program Operations Modeling Requirements (continued)

Functionality	Water Operations Models										
	FWUA-NRDC Settlement Spreadsheet	Resource Management Coalition Spreadsheet	FWUA-NRDC Water Supply Settlement Spreadsheet	FWUA-MWD Exchange Spreadsheet	Friant-Met Exchange Spreadsheet Model	FWUA-MWD Exchange Spreadsheet Model with Integration	FWUA-MWD Exchange CalSim-Model	CalSim Common Assumptions Model	Upper San Joaquin Storage Investigation Model (with integration)	CalSim LITE	CalSim-III Hydrology Development Project Model
Options Described in URS Report (URS, 2002)											
Conveyance in the California Aqueduct and Delta-Mendota Canal and Storage in San Luis Reservoir		X	X		X	X	X	X	X	X	X
East and West Conveyance in Southern San Joaquin Valley		X	X		X	X	X		X		
Friant-Kern Canal Reverse Pumping		X	X		X	X	X		X		
Patterson Recirculation[1]			X						X		
Delta Recirculation[1]		X	X		X	X	X		X		
Groundwater Storage and Extraction Programs			X				X		X		
Tulare Lakebed Storage and Conveyance			X						X		
Additional Potential Options											
Simulates Operations of Millerton Reservoir and FWUA	X		X[4]		X[4]	X[4]	X	X[3]	X		
Simulates Allocation Logic for Class 1, 2, and 215 Water	X		X				X	X	X		
Simulates Flood Control			X								
Simulates Water Use on Reaches 1-5		X[5]	X[5]		X	X	X[2]	X[2]			X
Simulates Merced River Operations			X[5]				X	X[2]	X		X
Simulates Lower San Joaquin River			X[5]				X	X			X
Simulates Delta Operations[7]			X[6]	X[6]	X[6]	X[6]	X	X	X	X	X
Incorporates FWUA with Sacramento River SWP							X	X			
Incorporates FWUA with Sacramento River CVP							X	X			

Notes:

[1] Recirculation refers to movement of water made available from increased Friant release and "surplus" from various sources

[2] Additional refinement to break out Sack Dam diversion, and possibly others

[3] Simulates Friant-Kern Canal as diversion point at Friant

[4] Simulates Millerton Lake operations based on "fixed" Friant allocations

[5] Used SANJASM as base and simulated incremental change

[6] Used CalSim as base and simulated incremental change

[7] Does not include hydrodynamic modeling

Key:

CVP = Central Valley Project
FWUA = Friant Water Users Authority
MWD = Metropolitan Water District of Southern California
NRDC = Natural Resources Defense Council
SWP = State Water Project

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4.0 References

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