CalLite

Central Valley Water Management Screening Model (Version 3.00)

Reference Manual

November 2014

California Department of Water Resources

and

United States Bureau of Reclamation

State of California
Edmund G. Brown Jr., Governor

The Resources Agency
John Laird, Secretary for Natural Resources

Department of Water Resources
Mark W. Cowin, Director

Bay-Delta Office
Paul A. Marshall, Chief

Modeling Support Branch
Francis Chung, Principal Engineer

This Report Was Prepared Under the Direction of:
Erik Reyes..Supervising Engineer, Water Resources, Bay-Delta Office

And the Following Work Team Leads:
Nazrul Islam..Senior Engineer, Water Resources, Bay-Delta Office
Holly Canada……………………………………………………………Engineer, Water Resources, Bay-Delta Office
Raymond Hoang..Engineer, Water Resources, Bay-Delta Office
Ali Abrishamchi…………………………………………………………… Engineer, Water Resources, Bay-Delta Office
Chris Quan………………………………………………………………… Engineer, Water Resources, Bay-Delta Office
Z.Q. Richard Chen...Engineer, Water Resources, Bay-Delta Office
Hao Xie...Engineer, Water Resources, Bay-Delta Office
Kevin Kao...Engineer, Water Resources, Bay-Delta Office

Nancy Parker...Engineer, Water Resources, Bureau of Reclamation
Tom Fitzhugh ....Modeler, Water Resources, Bureau of Reclamation
Travis Yonts………………………………………………………… Engineer, Water Resources, Bureau of Reclamation

WITH ASSISTANCE FROM:

Andy Draper ....Engineer, Principal, MWH
Tad Slawecki...Senior Engineer, LimnoTech
Dan Easton..Senior Engineer, MBK Engineers

Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

8RI = Eight River Index
AD = Accretion/depletion
Ag = Agricultural
ANN = Artificial Neural Network
B2 = §3406(b)(2) of the Central Valley Project Improvement Act
BO = Biological Opinion
BDCP = Bay Delta Conservation Plan
C2VSIM = California Central Valley Groundwater-Surface Water Simulation Model
CALFED = CALFED Bay-Delta Plan
CCF = Clifton Court Forebay
CCWD = Contra Costa Water District
cfs = Cubic feet per second
cm = Centimeter
COA =Coordinated Operations Agreement
CS2CL = WRIMS 2 model for creating CalLite inputs from CalSim inputs and outputs
CVC = Cross Valley Canal
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
DCC = Delta Cross Channel
Delta = Sacramento-San Joaquin Delta
DFG = California Department of Fish and Game
DI = Delivery Index
DLL = Dynamic Link Library
DMC = Delta-Mendota Canal
DSA = Demand Service Area
DSM2 = Delta Simulation Model II
DSS = Database file in Hydrologic Engineering System Data Storage System format
DV = Decision Variable (CalSim/CalLite/WRIMS 2 output variable)
DWR = California Department of Water Resources
D-xxxx = Water Right Decision
EBMUD = East Bay Municipal Utility District
EC = Electrical Conductivity
EI = Export-inflow
EID = El Dorado Irrigation District
EIS = Environmental Impact Statement
EWA = Environmental Water Account
FC&WSD = Flood Control and Water Service District
FERC = Federal Energy Regulatory Commission
FRSA = Feather River Service Area
FRWP = Freeport Regional Water Project
FVB = Fairfield, Vacaville, and Benecia
FWS = Fish and Wildlife Service

GCC = Glen-Colusa Canal
GLC = Grant Line Canal
GUI = Graphical User Interface
HEC-DSS = Hydrologic Engineering System Data Storage System
HORB = Head of Old River Barrier
ID = Irrigation District
IPCC = Intergovernmental Panel on Climate Change
IWFM = Integrated Water Flow Model
JPOD = Joint Point of Diversion
KCWA = Kern County Water Agency
km = Kilometer
LCPSIM = Least-Cost Planning SIMulation model
LOD = Level of Development
LYRA = Lower Yuba River Accord
MAF = Million acre-feet
MAF/yr = Million acre-feet per year
M&I or MI = Municipal and industrial
Mmhos /cm = Milliohms /centimeter
MWD = Metropolitan Water District
MWDSC = Metropolitan Water District of Southern California
NCD = Net consumptive depletions
NDO = Net Delta Outflow
NMFS = National Marine Fisheries Service
NPS = National Park Service
OCAP = Operations Criteria and Plan (for CVP)
OMR = Old and Middle River
QWEST = Minimum flow standard on San Joaquin River near Jersey Point
PCWA = Placer County Water Agency
PP = Pumping Plant
RBDD = Red Bluff Diversion Dam
ROD = Record of Decision
RPA = Reasonable and Prudent Alternatives
SB 1 = Senate Bill 1
SCWA = Sacramento County Water Agency
SBA = South Bay Aqueduct
SJR = San Joaquin River
SJWD = San Juan Water District
SLR = Sea level rise
SMUD = Sacramento Municipal Utility District
SRI = Sacramento River Index
SV = State Variable (CalSim/CalLite/WRIMS 2 input variable)
SWP = State Water Project
SWRCB = State Water Resources Control Board
TAF = Thousand acre-feet
TAF/yr = Thousand acre-feet per year
TCC = Tehama-Colusa Canal

UARM = Upper American River Model
USBR = United States Department of the Interior, Bureau of Reclamation
USFWS = United States Fish and Wildlife Service
USGS = United States Geological Survey
VAMP = Vernalis Adaptive Management Plan
X2 = location of the 2 parts per thousand salinity contour (isohaline), one meter off the bottom of the estuary, as measured in kilometers upstream from the Golden Gate Bridge
YCWA = Yuba County Water Agency
WA = Water Agency
WBA = Water Budget Area
WD = Water District
WPD = Watershed Protection District
WR = water right
WRESL = Water Resources Engineering Simulation Language
WRIMS 2 = Water Resources Integrated Modeling System
WSD = Water Storage District
WSI-DI = Water Supply Index - Delivery Index
yr = Year

Summary

The California Department of Water Resources (DWR) and United States Bureau of Reclamation (Reclamation) have developed and maintained CalLite, a screening-level planning model, for analyzing Central Valley water management alternatives.

This reference manual describes a new version of CalLite (Version 3.00). Major enhancements since the last release (Version 2.01), include:

- Climate Change scenarios for Early Long Term and Late Long Term Q1-Q5 based on the BDCP analysis
- Los Vaqueros Enlargement
- Shasta Enlargement
- D-1485 regulatory options
- Payback wheeling
- "Quick Select" options for running typical regulatory environments (D-1485, D-1641, and BO)
- San Joaquin River Restoration
- Dynamic San Joaquin capability
- B2 Actions
- Generation of WSI-DI curves
- Forecast Allocation Method (FAM)
- Custom Results (MTS/DTS Tree)
- Batch Run Capability
- Mass Balance Schematic

CalLite 3.0 has been developed using the Water Resources Integrated Modeling System (WRIMS 2) software, a modeling framework developed and used by DWR and Reclamation in CalSim modeling. The advantages of using WRIMS 2 over GoldSim based CalLite and WRIMS 1 are as follows:

- Corroboration studies between CalLite and CalSim II will be directly comparable, because both models have the same solution algorithm and similar assumptions and data structures.
- DWR and Reclamation staff expertise in using WRIMS 2 easily transfers between CalSim II and CalLite.
- WRIMS2 affords the capacity to add new features in the future such as daily time step modeling, reservoir routing, Monte Carlo simulation, or a dynamic link library (DLL) for groundwater simulation.

Other important features of the CalLite model are:

- Run time is much shorter than CalSim II (about 6 minutes on an up-to-date modeling computer), because of lumped hydrology and a reduced number of solution cycles.
- An intuitive Java-based Graphical user Interface (GUI) allows both novice and expert modelers to construct scenarios, post process and view results.
- The GUI can be easily modified to accommodate future regulation changes and model capabilities.
- The ability to run independently of the GUI allows the use of pre-processing scripts to automatically parameterize and run of a large number of studies in a short amount of time.
- The results obtained from a typical CalLite run are within 1% of a corresponding CalSim run.

1 Introduction

California is experiencing unprecedented pressures on its water resources and water infrastructure. Recent issues such as the Sacramento-San Joaquin Delta (Delta) ecological crisis, court-mandated cutbacks due to endangered species concerns, and southwest drought have combined with longer-term issues such as population growth and climate change to create a tenuous water supply picture in California. Various state, federal, and regional planning processes are considering significant changes to California water management to improve water supply reliability, protect fisheries and enhance ecosystems, and improve water quality.

In 2007, DWR and Reclamation embarked on the development of a rapid, interactive screening model for Central Valley water management. DWR and Reclamation identified the need for a tool that bridges the gap between more detailed system models managed by these agencies and policy/stakeholder demands for rapid and interactive policy evaluations. This screening model, named CalLite, simulates the hydrology of the Central Valley, reservoir operations, SWP and CVP operations and delivery allocation decisions, existing water sharing agreements, and Delta salinity responses to river flow and export changes. The existing hydrology and operations planning model, CalSim II (Munévar and Chung 1999, Draper et al. 2004), was used to provide aggregated hydrology and guidance on system operating rules, and previously developed Artificial Neural Networks (ANNs) were embedded in CalLite to simulate Delta flow-salinity relationships.

CalLite simulates water conditions in the Central Valley over an 82-year planning period (water years 1922-2003) in about 6 minutes and allows interactive modification of a variety of water management actions including enlargement of existing storage facilities, demand management, and river and Delta channel flow and salinity targets. In addition, CalLite can simulate observed or possible future hydrologic regimes to enable the user to determine climate change impacts. The tool is designed to assist in the screening of a variety of water management options and for use in a variety of stakeholder processes for improved understanding of water system operations and future management.

The first version of CalLite (Version 1.00R) was released in July 2008, followed by Version 1.10R in February 2009. This documentation describes the development, structure, and use of the newest version of the CalLite model (Version 3.00). While Versions 1.00 and 1.10 of were implemented in the GoldSim modeling platform (Islam et al. 2011), Versions 2.00 and 3.00 are implemented using a simulation engine developed using WRIMS 2, and a customized GUI that replicates the functionality contained in previous versions of CalLite.

The first several sections of this document provide the general context and role of screening models in California water planning and outline the objectives in the development of CalLite. The modeling platform and model representation of the physical system are then described, including a discussion of the differences between CalLite and CalSim II. This discussion is followed by a description of the hydrology and system operations (including regulations) included in the CalLite model, which is supported by a detailed hydrology development appendix (Appendix A). Several innovative features of CalLite are then described in detail. Comparisons of CalLite and CalSim II model results are provided in order to illustrate the consistency of the two models. Finally, this document includes a discussion of limitations of the CalLite model and associated data sets and provides future directions that are being considered by DWR and Reclamation. Appendices provide additional detail on such topics as regulatory controls, sea level rise, delivery allocation procedures, and model assumptions as compared to CalSim II.

While CalLite simulates the hydrology and operations over much of the same geographic area as the CalSim II model, there are several features in the CalLite screening model that are unique and are highlighted here. These innovative features or capabilities permit a range of analyses to be conducted that are distinct from those that can be reasonably performed in existing system models. These features are highlighted here and documented further in Section 7 of this report.

Rapid runtime and interactive interface

CalLite simulates monthly water conditions in the Central Valley over an 82-year planning period in approximately 6 minutes and allows interactive access to simulation controls and results. While short runtime is not a benefit in of itself, it does allow many more alternatives or trials to be explored, and is necessary for any reasonable analysis of uncertainty. Interactive controls and output displays allow the CalLite model to be accessible to a broader user-base.

Delta requirements and facility controls

CalLite incorporates a flexible approach for allowing user-selection and specification of Delta requirements to be implemented in simulations. A menu of existing and potential future Delta requirements has been developed. CalLite users may also specify alternative values for various controls. The Delta controls allow for inclusion and specification of user-defined Old and Middle River (OMR) and QWEST flow restrictions.

Demand management options

CalLite currently incorporates both "current" and "future" levels of demand as established in the Common Assumptions Common Model Package (Version 9B) (DWR 2009). However, an option also exists for user-specified SWP and CVP south of Delta demands. This capability allows for exploration of demand management in the export area.

Sea level rise simulation capabilities

In addition to modeling Delta conditions under historical sea levels, CalLite also has two options for sea level rise associated with global climate change (15 centimeter (cm) and 45 cm rise).

2 California Water Planning and Role of Screening Models

Many existing computer models are applied for California water planning and management. The capabilities of these models cover a wide range of analysis categories: hydrology, system operations, hydraulics/hydrodynamics, water quality, lake and river temperature, groundwater, ecosystems, agricultural water use, fish mortality, economic optimization, and others. Due to the complex nature of California's Central Valley water resources system, each of these existing models is necessarily detailed in order to capture specific system responses. These tools are important to the understanding of physical processes and play a critical role in California water planning.

A typical application of these models in a water management setting is as follows: (1) policymakers are faced with water management problems and request technical support, (2) technical teams are formed and develop a list of studies to be performed, (3) modeling teams develop simulations for specific resource areas, and (4) results of these model simulations are processed, analyzed, and summarized for policymakers and stakeholders. This process is generally repeated several times until the questions have been framed properly and sufficient information has been developed to make informed decisions.

Many of the problems (and solutions) facing California water today are ill-defined and require significant exploration of the decision space and causal relationships. Often, existing tools are not well-suited for exploratory analysis due to issues such as long runtimes, lack of multi-disciplinary dynamic linkages, limited accessibility for non-technical stakeholders, and lack of immediate graphical responses to specified management scenarios. This gap in the array of available analytical tools is what motivated the development of CalLite.

CalLite is designed for use in a variety of stakeholder processes for improved understanding of water system operations and management. The tool bridges the gap between more detailed system models, such as CalSim, maintained by DWR and Reclamation, and policy and stakeholder demands for rapid and interactive policy evaluations. The role of the screening model along with key characteristics in terms of complexity and ease of use is illustrated in Figure 1. As shown in Figure 1 (a), the models at the top of the pyramid allow exploration, user interaction, and are accessible to non-expert modelers. In contrast, the models at the bottom of the pyramid are highly complex and require expert modelers to operate.

Figure 1 (b) briefly depicts the relationship between CalLite and the other modeling tools used and managed by DWR and Reclamation. CalSim is the Central Valley-wide water system detailed model, which requires input such as hydrology, demands, regulations, and operational constraints. The outputs (i.e., river flows, reservoir storage etc.) from the CalSim model are used as input boundary conditions to the physically based models (Delta Simulation Model II (DSM2) and Integrated Water Flow Model (IWFM)). The flow and salinity outputs from DSM2 are used to train an Artificial Neural Network (ANN), which is then used by the CalSim and CalLite models to rapidly replicate DSM2 results during simulations. CalLite uses hydrologic and demand timeseries data from a base CalSim run as inputs, which allows it to closely replicate CalSim results under different modeling assumptions. Lastly, final alternatives generated from a CalLite screening analysis are modeled in more detail using CalSim, when producing final results for environmental impact analyses or feasibility studies and reports (Islam et al. 2011).

CalLite includes the most important dynamic system responses, but simplifies or aggregates less important system features. CalLite is not a replacement for existing detailed and complex models, but rather is informed by the data and results of existing models and allows users to explore future water management actions, improve understanding, and support more stakeholder-involved decision-making. CalLite allows screening of a suite of alternatives to identify a smaller subset to be incorporated into more detailed models. In this sense, CalLite becomes part of a portfolio of analytical tools that range in complexity and stakeholder accessibility.

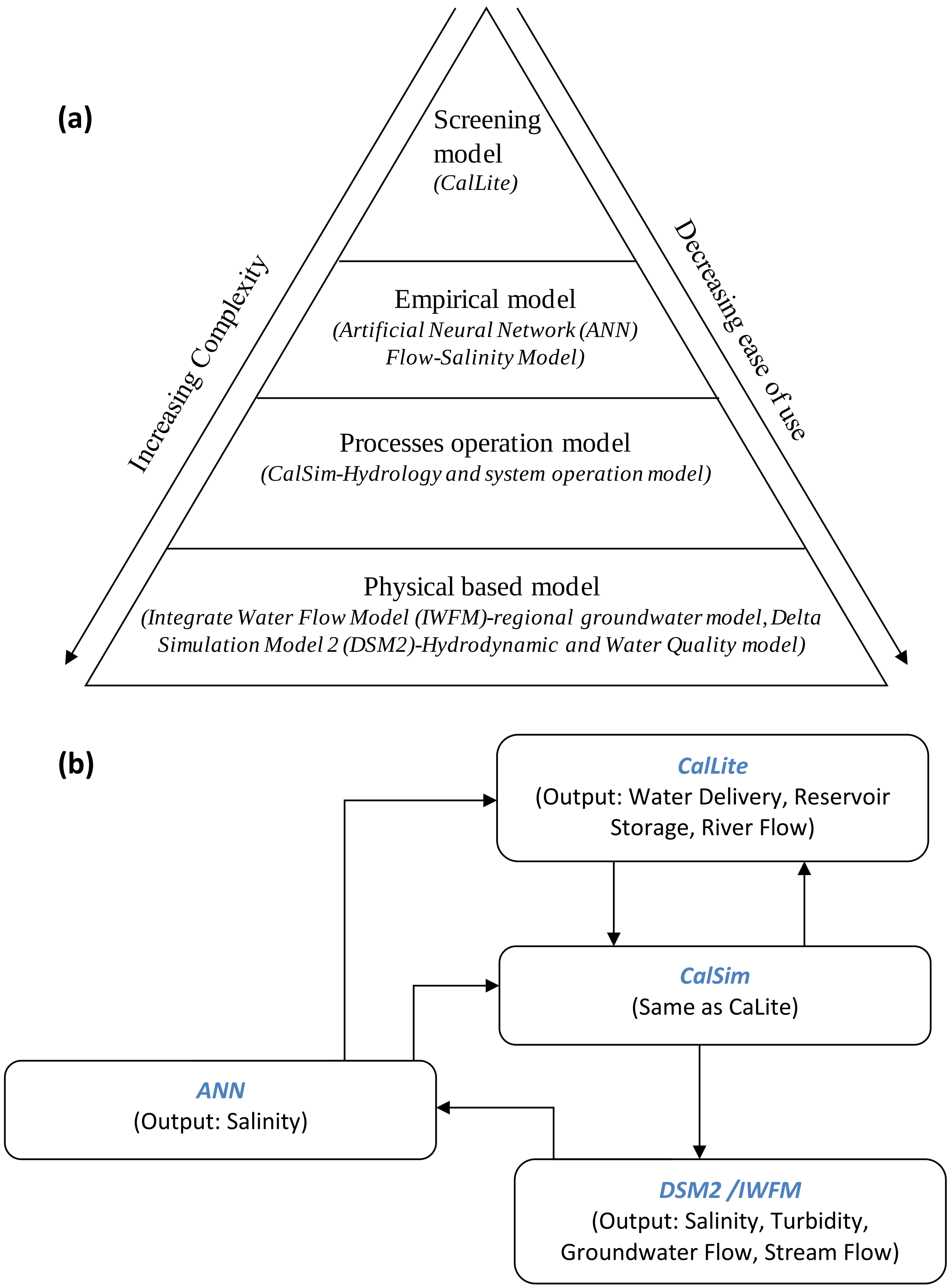


Figure 1. Conceptual diagram of (a) relative complexity and easy of model use and (b) the relationship between the CalLite screening model and other existing tools managed by the Department of Water Resources and U.S. Bureau of Reclamation (Mid-Pacific Region).

3 Modeling Platform

Version 3.00 of the CalLite screening model consists of a simulation engine produced using WRIMS 2 in executable form (.exe) and a standalone GUI that allows the user to design and run scenarios and view model results. WRIMS 2 is the generalized Water Resources Integrated Modeling System software for evaluating operational alternatives of large and complex river basins (DWR 2011). It was originally developed to implement the CalSim II model. WRIMS 2 uses a linear programming (LP)/mixed integer linear programming (MILP) solver to determine an optimal set of decisions for each time period given a set of relative weights and system constraints. The system constraints and weights are specified using the Water Resources Engineering Simulation Language (WRESL) (DWR 2000a, 2000b). For Version 3.00 of CalLite, WRESL code was written to implement a simplified version of the system simulated in CalSim II, thereby reducing run time while still maintaining the key features of the system.

3.1 Structure of WRIMS 2-based CalLite

Figure 2 shows the design of the new WRIMS 2-based version of CalLite. The code for the model is written in WRESL, and WRIMS 2 is used to compile that code into an executable (CalLite.exe) which performs all of the model calculations. The distributed version of the model includes this executable together with the CalLite GUI. The user uses the CalLite GUI to design scenarios and specify any customized settings desired. When the user clicks the button to run a scenario, the GUI first creates a temporary folder and copies the appropriate input files and libraries into that folder. The GUI then calls CalLite.exe and runs the scenario. Outputs from CalLite.exe are stored in the Hydrologic Engineering System Data Storage System (HEC-DSS) - the same format as CalSim II. After the run is completed, the user can use the GUI to view these outputs in graphical and tabular format.

While most of the interactions shown in Figure 2 will be invisible to the user, use of WRIMS 2 and WRESL will allow model developers to make changes as needed to the CalLite.exe simulation engine. For example, changes could be made to add different management or regulatory options or update code to improve calculations or consistency with CalSim II. Likewise, the CalLite GUI can also be customized by developers in parallel with changes in the simulation engine. The GUI.xml file and GUI linking tables (see Figure 2) are used to specify the GUI options that will be available for a given version of CalLite. In addition to facilitating the normal process of updating and improving the software as time goes by, these features will enable developers to create customized versions of CalLite for different users and for different purposes.

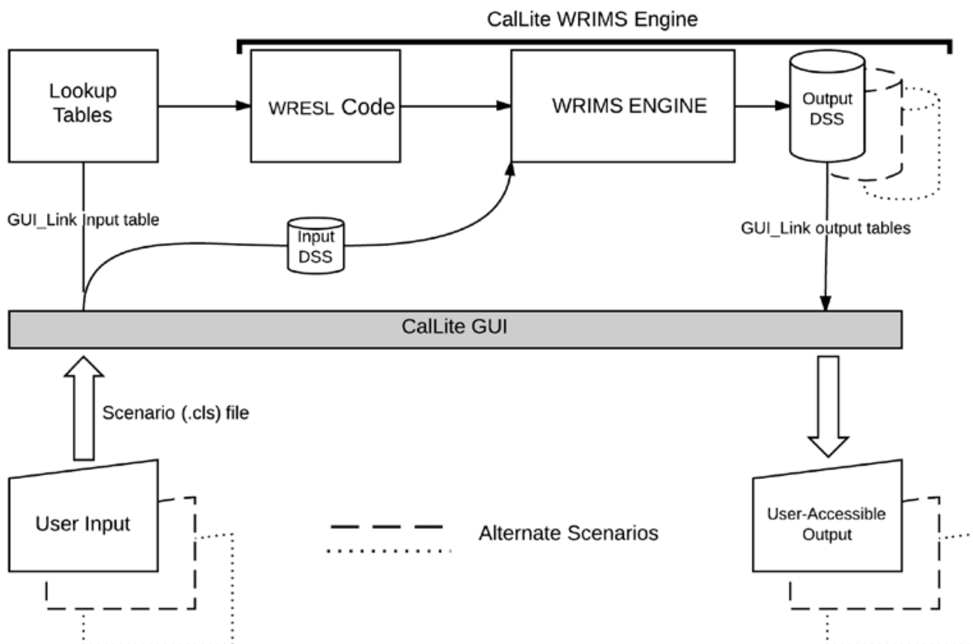


Figure 2. Design of WRIMS 2-based CalLite, illustrating the CalLite GUI as an interface between the user and the technical components.

3.2 CalLite Utilities

A number of utilities complement the CalLite WRIMS 2 model and GUI. These are summarized here and described in more detail in the appendices:

CS2CL ("CalSim to CalLite") tool. This is a WRIMS 2 model that is used to create timeseries inputs to the CalLite model. These inputs include inflows and accretion-depletion terms listed in Appendix A, along with many other timeseries used by CalLite. These timeseries are either directly imported from CalSim II input and output, or they are new timeseries that are calculated from the CalSim II timeseries and additional factors. In versions of CalLite prior to Version 2.00, these timeseries were developed using MS Office Excel spreadsheets, but this method proved tedious and error-prone. Generating these timeseries in a WRIMS 2 model has a number of advantages, including consistency in coding with CalLite itself, generation of a record of exactly how timeseries are generated, easier updating of timeseries and tracking of changes, and automation of the procedure for generating timeseries. More details about the CS2CL model are available in Appendix H.

Running CalLite WRIMS 2 model without the GUI. For greater customization and flexibility, the CalLite model can also be run manually (i.e. without the GUI). Appendix I describes the procedure for doing this, which involves modifying input text files and double-clicking on a Windows batch file to run the model. One potential use of this manual run capability would be to set up and batch run a very large number of CalLite studies, which could be more efficient than having to parameterize and run each individual study through the GUI.

CalLite Report Tool. The report tool is a quick and easy way to compare the results of two CalLite studies, two CalSim studies, or a CalLite study to a CalSim study. The report tool can be run using the External PDF tab in the CalLite GUI. By default the CalLite GUI will display a standard report that compares two CalLite studies, but this report can also be customized by editing a template file that accompanies CalLite. Appendix J describes how to use the report tool and how to edit the template file to create other customized reports.

4 Model Representation of the Physical System

CalLite represents the Central Valley water resource system based on a simplified network. The simplified network was developed in cooperation with SWP and CVP operators and planners in terms of criteria that tend to control project operations. Once these controls were agreed upon and the level of spatial complexity was determined, aggregation of the planning-level hydrology from the existing CalSim II model was developed to produce the CalLite model hydrology. The relationship between the CalSim II and CalLite hydrology is maintained through the pre-processing tool (CS2CL) described in the preceding section. This pre-processing tool can be used to synchronize the hydrology between the two models as changes are made to both models in the future. The physical system is shown in Figure 3 and the resulting CalLite network is shown in Figure 4. Figure 42, Figure 43, and Figure 44, in Appendix A show parts of the schematic at a larger scale that is easier to read.

North of the Delta, the schematic in Figure 43 is almost identical to the schematic used in Version 1.10R of CalLite, except that two nodes on the Yuba River upstream of Daguerre Point Diversion Dam that were in Version 1.10R are not included in the newest version of CalLite. In the Delta and south of the Delta, Version 3.00 has a more detailed schematic than earlier versions of CalLite. This additional detail is needed to properly model and understand the implications of different water management alternatives in those areas.

Figure 3. Geographic extent and general location of SWP and CVP facilities simulated in CalLite.

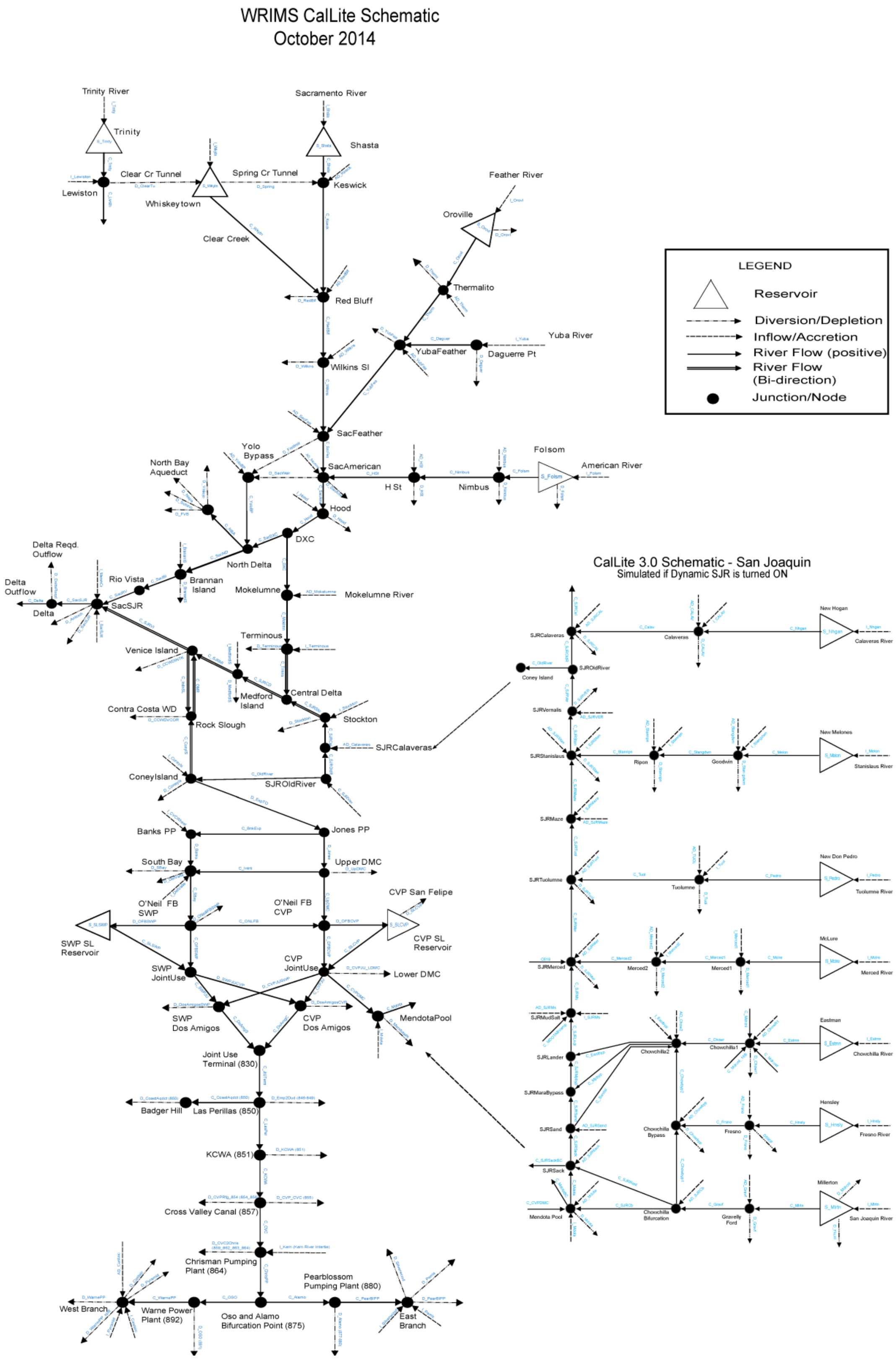


Figure 4. CalLite Schematic.

4.1 River Basins Incorporated

The CalLite screening model incorporates a simplified version of the CalSim II schematic as the basis for the system configuration and identification of operational constraints. CalLite incorporates the hydrology and operation of the upper Trinity River, Sacramento River, lower Feather River, lower Yuba River, lower American River, and the Delta. The hydrology of the Sacramento Valley and the Delta and treatment of SWP and CVP demands are described in detail in Appendix A. With CalLite 3.0, users have the option to run a study with either a fixed or a dynamic SJR system. Under a fixed system, the San Joaquin River and its tributaries will not be simulated in CalLite. Instead, the inflow to the Delta from the San Joaquin is set equal to the flow at Vernalis as computed by CalSim II. Under a dynamic SJR system, the San Joaquin River, its tributaries, and the major storage facilities in that basin are modeled during the simulation. SJR regulations can also be modified by the user when CalLite is run with the dynamic SJR system.

4.2 Major Storage and Conveyance Facilities

Table 1 lists all the major storage and conveyance facilities represented in CalLite. All major facilities included in CalSim II in the Sacramento Basin are represented here, except for New Bullards Bar and Engelbright reservoirs on the Yuba River. The configuration of the Delta and facilities just south of the Delta (i.e. Banks and Jones Pumping Plants) is identical to that in CalSim II. The representation of the Delta Mendota Canal (DMC), California Aqueduct, and San Luis Reservoir remains largely consistent with CalSim II, though the schematic is more aggregated.

4.3 Sacramento Valley Hydrology Aggregation

Hydrologic inputs for the major reservoirs in CalLite are identical to those used in CalSim II. However, the valley floor river accretions and depletions were aggregated to match the reduced CalLite schematic. The hydrology and water management in the Sacramento and San Joaquin valleys is extremely complex as water is diverted from streams and rivers, applied to agricultural and urban areas, and often reused before returning to the surface water system through drainage networks. Since the current focus of CalLite is to explore regional and cross-Delta water management actions, much of the valley floor stream/drainage network and water supply system was simplified. In CalLite, SWP and CVP contractor diversions are simulated dynamically and surface water is delivered to these users based on allocation logic. In contrast, non-project diversions are pre-determined and set equal to non-project diversions in CalSim II. These simplifications led to a significant reduction in the complexity of the network. All hydrology for both the CalLite and CalSim II models is specified on a monthly basis for an 82-year planning period. Appendix A describes the hydrology development for CalLite in detail.

4.4 South of Delta Export Area Demand Aggregation

The representation of the DMC, California Aqueduct, and San Luis Reservoir is largely consistent with CalSim II, but spatial extent and contractor diversity are simplified. Demands and deliveries to the SWP and CVP south of Delta contractors have been aggregated into a smaller number of delivery points. While Version 3.00 of CalLite aggregates CalSim II deliveries and facilities south of the Delta, the system is represented in greater detail than it was in Version 1.10R of CalLite, especially south of

Dos Amigos Pumping Plant, which the earlier version of CalLite did not portray. Joint use operations and the Mendota Pool are also represented in Version 3.00 of CalLite in more detail than in previous versions of CalLite.

4.5 Regulatory Constraints

The regulatory constraints used in CalLite are summarized in Table 1 and discussed in Section 5. Water Right Decision 1485 (D-1485) (SWRCB 1978) and Decision 1641 (D-1641) (SWRCB 1999) requirements can be turned off or modified by the user through the Regulations dashboard in the interface. Options are also available to simulate regulatory standards based on the Reasonable and Prudent Alternatives (RPAs) in the Fish and Wildlife Service (FWS) and National Marine Fisheries Service (NMFS) Biological Opinions (BOs) (FWS 2008, NMFS 2009). Details regarding the Delta regulatory constraints in D-1485, D-1641, and the BO RPAs are described in Appendix C. Appendix D has more information on the Sacramento Basin instream flow standards listed in Table 1. Implementation of these standards and operations to satisfy the requirements are identical to those in CalSim II.

Table 1. Major facilities and constraints included in the CalLite screening model.

Storage Facilities	*Conveyance Facilities*	*Operational/Regulatory Constraints*
Sacramento Basin		
Trinity Lake Whiskeytown Lake Shasta Lake Lake Oroville Folsom Lake	• Clear Creek Tunnel • Spring Creek Tunnel • Trinity River • Clear Creek • Sacramento River • Feather River • American River • Yuba River • Fremont Weir • Sacramento Weir • Yolo Bypass	• Trinity River Minimum Flows • Clear Creek Minimum Flows • Keswick Minimum Flows • Red Bluff Minimum Flows • Navigation Control Point at Wilkins Slough • Feather River Minimum Flows • Nimbus Minimum Flows • American River Min Flows @ H St • Lower Yuba/Daguerre Pt Controls
CVP / SWP South-of-Delta		
CVP San Luis Reservoir SWP San Luis Reservoir	• California Aqueduct • Delta Mendota Canal • O'Neill Forebay • San Luis Pumping Plant • Dos Amigos Pumping Plant • South Bay Aqueduct • Coast Aqueduct • Cross Valley Canal • Chrisman Pumping Plant • Pearblossom Pumping Plant • Warne Power Plant • Mendota Pool	• San Luis Operations • California Aqueduct Capacity Restrictions • DMC Aqueduct Restrictions • Delivery Allocation Procedure
San Joaquin River Basin		
None	• San Joaquin River at Vernalis	• Upstream operations and regulatory constraints are either: 1) Fixed = implicit in the boundary condition flow at Vernalis (timeseries from CalSim); or 2) Dynamic = simulated real time in CalLite. o VAMP Pulse Flows o Vernalis 60-day Pulse Flow RPA (NMFS Action 4.2.1) o Stanislaus Flow RPA (NMFS Action 3.1.3) o SJR Restoration Flows (Interim or Full)

Table 1 (cont'd). Major facilities and constraints included in the CalLite screening model.

Storage Facilities	*Conveyance Facilities*	*Operational/Regulatory Constraints*
Sacramento-San Joaquin Delta		
None	• Delta Cross-Channel • North Bay Aqueduct • Jones Pumping Plant • Banks Pumping Plant	• SWRCB D-1485/D-1641 standards for Delta outflow, Rio Vista minimum flow, and salinity • SWRCB D-1641 standards for X2, EI ratio • FWS BO RPA standards for OMR flows and Fall X2 • D-1641/D-1485, VAMP, and NMFS BO RPA export restrictions • Delta Cross-Channel Gate Operation (D-1641/D-1485 and NMFS BO RPA)

4.6 Incorporation of Future Water Management Actions

CalLite 3.00 includes the capability to simulate several possible future water management actions. Currently, users may simulate an enlargement of Shasta and of Los Vaqueros. CalLite includes only skeletal implementations of these facilities and the results should be considered draft. The future water management actions are discussed further in Appendix B.

5 Regulatory Environment

State Water Board Decision 1485 (D-1485) was issued in August of 1978 to protect vested water rights and the public interest. The underlying principal of D-1485 is that “water quality in the Delta should be at least as good as those levels which would have been available had the state and federal projects not been constructed. The D-1485 standards aim to protect the beneficial uses of the water of the Sacramento-San Joaquin Delta (Delta) and Suisun Marsh. The State Water Resources Control Board (Board) did not intend to resolve the water quality problems in the southern Delta through D-1485 because the Board agreed that the SWP and CVP facilities covered by the permits before the Board in the D-1485 proceedings did not appear to have a direct impact on water quality conditions in the southern Delta.

D-1485 modified the permits held by the Bureau of Reclamation (Bureau) and the Department of Water Resources (DWR) and established water quality standards to follow. All burden of meeting the standards was placed on the SWP and CVP, but no priority was established between the two. The Board declared that: “water quality standards in the Delta must be satisfied prior to any export from the Delta to other areas for any purpose [and that] these standards must be maintained as first priority operating criteria”.

In 1986, the Racanelli Decision overturned D-1485 because its use of “pre-project construction” conditions as a measure of flows needed to protect existing water rights in the Delta focused on water rights instead of beneficial uses. The courts also concluded that the use of “pre-project construction” conditions was invalid because it placed all responsibility on the CVP and SWP and ignored other Delta water rights holders.

Thirteen years later, in 1999, State Water Board Decision 1641 (D-1641) was issued and has continued to be the overlying water quality regulation for the water projects. Its primary purpose was to allocate responsibility for implementing the flow-dependent objectives of the 1995 Bay-Delta Plan. D-1641 sets today’s minimum outflow requirements for the Delta, delta cross channel operations, minimum river flows at Rio Vista, X2 requirements for salinity control, export restrictions through the export-inflow ration and Vernalis criteria, and salinity standards at Emmaton, Jersey Point, Rock Slough, and Collinsville.

The biological opinions (BOs) implemented in CalLite are the Reasonable and Prudent Alternatives of the U.S. Fish and Wildlife Service (USFWS) Operational Criteria and Plan (OCAP) Delta Smelt BO (issued December 2008) and the National Marine Fisheries Service (NMFS) OCAP Salmonids BO (issued June 2009). In CalLite these BOs set: minimum flow requirements below Whiskeytown Dam at Clear Creek (NMFS Action 1.1.1), additional X2 salinity requirements (FWS Action 4), additional closure of the delta cross channel gates during flushing flows in Oct-Dec (NMFS Action 4.1.2), flow restrictions at Old and Middle River (FWS Actions 1-3), limited CVP and SWP exports in April and May (NMFS 4.2.1), and minimum flow requirements below Goodwin Dam on the Stanislaus River (NMFS 3.1.3).

5.1 Base Assumptions

The base model assumptions for the three regulatory environments are shown in Table 2. More thorough descriptions of the regulatory standards as implemented in CalLite are located in Appendix C and Appendix D.

Table 2. Base assumptions of the three types of regulatory environments.

	D-1485	D-1641	D-1641 + BO RPAs
Hydrology	PreBO D-1641 hydrology (either Future or Existing) and VAMP "ON" timeseries		
VAMP	OFF	South Delta export limits Apr 15th – May 15th	South Delta export limits Apr 15th – May 15th
Delta Cross Channel	Closed Jan-Apr 15th and 20 days in Apr 16th-May 31st when DOI>12,000 cfs	*Closed 45 days Nov-Jan. *Closed Feb-May. *Closed 14 days June.	*Closed 45 days Nov-Jan. *Closed Feb-May. *Closed 14 days June. *Conditional closure Oct 1st -Jan 31 (NMFS BO IV 1.2)
EI Ratio	None	35% Feb-Jun, 65% Jul-Jan	35% Feb-Jun, 65% Jul-Jan
Delta Outflow and Rio Vista Requirements	D-1485 standard: varies by month	*D-1641 standard: varies by month *X2 requirement *Roe Trigger standard	*D-1641 standard: varies by month *X2 requirement *Roe Trigger standard *FWS BO Action 4
Salinity Req's	Emmaton, Jersey Point, Rock Slough, Collinsville, Antioch, Chipps Island	Emmaton, Jersey Point, Rock Slough, Collinsville	Emmaton, Jersey Point, Rock Slough, Collinsville
JPOD	OFF	On	On
Intertie + CV Wheeling	On	On	On

6 Simulated Operations of Existing Facilities

While many aspects of the Central Valley's water resources system were simplified for implementation in CalLite, some parts of the model are identical to CalSim II model. These areas include (1) aspects governing operation and control of Delta facilities, water quality, and channel flows; and (2) delivery allocation procedures for the CVP and SWP. A useful reference on CalSim assumptions, many of which are replicated in CalLite, is the report on the Common Assumptions Common Model Package (Version 9B) (DWR 2009).

6.1 Upstream Reservoirs and Operations

A list of the operational criteria used in CalLite, is included below.

6.1.1 CVP Reservoirs and Operations

6.1.1.1 Trinity Reservoir

- Flood Control – Safety of Dams
- Fish and Wildlife Requirements on the Trinity River immediately below Lewiston
- Transbasin Exports through the Clear Creek and Spring Creek Tunnels
- Hydropower Operations

6.1.1.2 Whiskeytown Reservoir

- Maximum permissible/targeted storage levels
- Fish and Wildlife Requirements on Clear Creek

6.1.1.3 Shasta and Keswick Reservoir Operations

- Flood Control
- Fish and Wildlife Requirements on the Sacramento River immediately below Keswick
- Minimum Flow for Navigation – Wilkins Slough
- Hydropower Operations

6.1.1.4 Folsom and Natoma Reservoir Operation

- Flood Control
- Fish and Wildlife Requirements on the American River immediately below Nimbus
- Hydropower Operations

6.1.1.5 Trinity-Shasta-Folsom Balancing

The balancing of storage between Trinity, Shasta, and Folsom reservoirs in CalLite is done using the same criteria as in CalSim II. Storages in these reservoirs are balanced through model weights that encourage equivalent storage zones in the three reservoirs to be filled to the same proportional level, all else being equal. The weights encouraging zone balancing are relatively low, so that reservoir balancing will not take priority over other project operations.

6.1.1.6 NOD-San Luis Storage Balancing

CVP north of Delta storage is balanced with storage in San Luis Reservoir using the same CVP San Luis rule curve criteria established and applied in CalSim II. If CVP San Luis storage is below rule curve, the model weights encourage water to be pulled from CVP north of Delta reservoirs down to CVP San Luis. When storage is above the rule curve, priority is given to leaving water in storage north of Delta. The CVP San Luis rule curve usually peaks in April or May and is at its lowest in September, and is higher in wet years and lower in dry years.

6.1.2 SWP Reservoirs and Operations

6.1.2.1 Oroville/Thermalito Reservoirs and Operations

- Flood Control
- Fish and Wildlife Requirements on the Feather River
- Hydropower Operations

6.1.2.2 Oroville-San Luis Storage Balancing

Oroville storage is balanced with storage in San Luis Reservoir using the same CVP San Luis rule curve criteria established and applied in CalSim II. Oroville-San Luis balancing criteria is similar to that described for CVP above.

6.2 Delivery Allocation Decision-Making

Delivery allocations for the CVP and SWP are calculated by either the Water Supply Index – Delivery Index (WSI-DI) Method or the Forecast Allocation Method (FAM).

The WSI-DI method is the procedure currently used in CalSim II. This logic develops an allocation decision for system-wide CVP and SWP deliveries based on water in storage, forecasts of usable inflow, and storage carryover targets. The allocations for the CVP Water Right, Exchange, and Settlement contractors and SWP Feather River Service Area contractors are dependent on reservoir inflow criteria. South-of-Delta delivery allocations for the CVP are based on water in CVP San Luis storage plus projections of available water for export prior to low point. This is identical to the current procedure used in CalSim II.

FAM is developed based on the California Allocation Module (CAM). The model is developed by utilizing the multi-step optimization functions in WRIMS 2. FAM is coupled with the CalLite model by working as an additional cycle.

Appendix G describes these allocation procedures in more detail.

6.3 Coordinated Operations Agreement

The Coordinated Operations Agreement (COA) (USBR and DWR 1986) assigns responsibility for releases for in-basin uses or apportions available water for export to the CVP and SWP depending on the hydrologic conditions. If stored water must be withdrawn from project reservoirs to meet in-basin uses (including Delta requirements), the responsibility for releases is shared in the ratio 75:25 between the CVP and SWP, respectively. Under conditions in which unstored water is available for export (exports exceed project storage withdrawals), the water is shared in the ratio 55:45 between the CVP and SWP, respectively. If one party cannot use its entire share of water under the COA, the other party is permitted to use the unused share. The COA is implemented in CalLite in exactly the same way as in CalSim II.

6.4 Delta and Export Operations

6.4.1 Delta Requirements and Export Controls

Delta requirements and export controls are implemented in the same manner as in CalSim II. Due to the importance and scrutiny of these requirements and operational control, they are summarized in Section 7.4 and described in detail in Appendix C and Appendix D. In addition to the minimum health and safety pumping rates described for Jones and Banks below, export caps associated with BO RPA actions cannot be reduced below 1500 cubic feet per second (cfs) for both pumping plants combined. This is to avoid rapid drawdown of San Luis Reservoir for dam safety reasons, which could occur under situations where supplies are available and allocated but exports are constrained by the RPAs.

6.4.2 Jones Exports

Exports at Jones Pumping Plant are governed by the need to meet demands on the Delta Mendota Canal and San Luis Unit, desired storage levels for CVP water in San Luis Reservoir, availability of CVP water for export in the Delta, regulatory limits, and physical capacity of the pumping plant and the conveyance facilities. The target pumping level is determined by a CVP south of Delta demand which includes demands from both contractors and for maintaining CVP San Luis target storage levels. Export limits due to regulatory controls then serve as a cap on total project exports. In the current CalLite version, the allowable export curtailments are shared 50/50 between the SWP and the CVP. A minimum pumping rate of 800 cfs is applied for health and safety requirements. The minimum pumping rate is reduced to 600 cfs when storage in Lake Shasta is less than 1500 thousand acre-feet (TAF), to conserve storage in Shasta.

6.4.3 Banks Exports

Exports at Banks Pumping Plant are subject to similar controls as Jones Pumping Plant: demands on the California Aqueduct, desired storage levels for SWP water in San Luis Reservoir, availability of SWP water for export in the Delta, regulatory limits, and physical capacity of the pumping plant and the conveyance facilities. The target pumping level is determined by the SWP south of Delta demand which includes demands from both contractors and for maintaining SWP San Luis and terminal reservoirs at target storage levels. Export limits due to regulatory controls then serve as a maximum on total project exports. In Version 3.00 of CalLite the allowable export curtailments are shared 50:50 between the SWP and the CVP. A minimum pumping of 300 cfs is applied for health and safety requirement.

6.5 South of Delta Operations

6.5.1 CVP Delivery Allocations

6.5.1.1 Delivery Allocations

Overall CVP delivery allocations are made through the water supply index approach. This allocation, or delivery target, is specified as the sum of all CVP contractor categories. A separate process, identical to that in CalSim II, performs the assignment of water to specific contractor types or categories. A tiered reduction scheme is employed so that contractor allocations match the overall delivery allocations (DWR 2009), as shown in Table 3. The model proceeds sequentially through each tier until sufficient cuts have been made. In addition, exchange contractor deliveries are always cut from 100% to 77% when the Shasta water year type is critically dry. Agricultural, municipal and industrial (M&I), refuge, and exchange contractor demands are then satisfied at the appropriate delivery location.

Table 3. CVP cutback tiers for agricultural and M&I deliveries.

	Agricultural contractor cuts	M&I contractor cuts
Tier 1	100% to a minimum of 75%	
Tier 2	75% to a minimum of 50%	100% to a minimum of 75%
Tier 3	50% to a minimum of 25%	
Tier 4	25% to a minimum of 0%	75% to a minimum of 50%

6.5.2 SWP Delivery Allocations

6.5.2.1 Table A Allocations

As with the CVP, overall SWP delivery allocations are made through the water supply index approach. This allocation, or delivery target, is specified as the sum of all SWP Table A contractor categories. Any reductions to Table A allocations that are required to match the overall SWP delivery target are shared in proportion to the Table A entitlement of the contractor category. CalLite aggregates demands from the 29 SWP contractors in three general categories: Agricultural, M&I – MWDSC (Metropolitan Water District), and M&I – Other contractors.

6.5.2.2 Article 56 Deliveries

Article 56 deliveries refer to SWP contractor deliveries that were allocated in the previous year, but were stored in SWP storage before being delivered in the current year. SWP contractors sometimes defer taking the allocated water in wetter years in the hopes that the delivery of water in the subsequent year would prove more beneficial. CalLite incorporates an accounting scheme for the Article 56 water in storage and provides this for delivery in the subsequent year to each eligible contractor (DWR 2009).

6.5.2.3 Article 21 Deliveries

Article 21 deliveries are made by the SWP when excess water is available in the Delta, SWP share of San Luis Reservoir storage is full, SWP Table A and Article 56 deliveries have been satisfied, and Banks Pumping Plant has available capacity for additional pumping. The delivery of Article 21 water in CalLite is simulated by allocating water to a series of contractor-specific interruptible deliveries which are only satisfied if all of the above conditions are met.

6.5.3 San Luis Reservoir Operations

The operational objective of San Luis Reservoir for both projects is to maximize storage in the early spring to help meet the high water demands in the late spring, summer, and early fall. Reservoir filling generally occurs December through April while the drawdown period is generally May through November. The projects generally rely upon winter and spring flows in the Delta to fill San Luis Reservoir, however, they will also make storage withdrawals from upstream reservoirs during this period to ensure that there is sufficient water in San Luis Reservoir to meet future demands and storage targets. The operation of the CVP, due to greater constraints on upstream reservoirs and limited Jones Pumping Plant capacity, generally limits the ability to significantly control San Luis Reservoir storage during the fill period; exports are maximized until the CVP share of San Luis Reservoir is full or upstream storage is limited. During the fill cycle, San Luis Reservoir rule curves for both the SWP and CVP are applied for each project based on available upstream storage and initial project allocations, per CalSim II assumptions. As in CalSim II, rule curves are used to balance north of Delta supplies with San Luis Reservoir storage (DWR 2009).

6.5.4 Wheeling

6.5.4.1 Cross Valley Canal Wheeling

Deliveries to Cross Valley Canal (CVC) contractors are subject to the CVP south of Delta agricultural water service allocations described in Section 6.5.1.1. However, unlike other south of Delta CVP deliveries, CVC contract supplies are not drawn through Jones Pumping Plant or from San Luis Reservoir; it is wheeled through the SWP's Banks Pumping Plant and the California Aqueduct. CVC deliveries are limited by available conveyance capacity after SWP operations. Capacity is typically available in the summer or fall. In CalLite, CVC wheeling occurs in a separate cycle after determining SWP exports at Banks Pumping Plant and SWP south of Delta deliveries.

6.5.4.2 Payback Wheeling

D-1485 regulation restricts the CVP to mean monthly exports of only 3,000 cfs in May and June. Under Condition 3 of D-1485, the CVP is allowed to make up any deficiencies caused by the limitation by direct diversion or by re-diversion of releases of stored water through State Water Project facilities. Exhibit D of COA (see Section 6.3) lays out an exchange procedure to minimize the impact of the limitation on CVP and SWP power operations. In CalLite, payback wheeling is only turned on for a D-1485 run; it does not apply to D-1641 runs. Payback wheeling occurs the separate wheeling cycle of CalLite.

6.5.4.3 Joint Point of Diversion

The Joint Point of Diversion (JPOD) is another mechanism by which the CVP wheels water through Banks Pumping Plant. Water wheeled under JPOD supplements Jones Pumping Plant exports by filling the CVP share of San Luis Reservoir and meeting CVP contractor delivery targets. JPOD has lower priority than SWP exports and CVC wheeling. In CalLite, JPOD wheeling only occurs if Jones Pumping Plant or Upper Delta-Mendota Canal capacity is being fully utilized. When the Delta is in surplus conditions, JPOD occurs when SWP San Luis is full, the SWP is meeting all Table A and Article 21 delivery targets, and there is still remaining capacity at Banks Pumping Plant. When the Delta is in balanced conditions, the SWP first uses Banks Pumping Plant as needed and, if there is remaining export capacity and the CVP would like to transfer water from NOD storage to SOD, JPOD can be used. In CalLite, JPOD occurs the separate wheeling cycle after locking in SWP operations.

6.6 San Joaquin River Controls

The controls on this tab relate to operation of the dynamic San Joaquin module of CalLite. Checking the top checkbox will activate this module. If this checkbox is not checked, the flows on the San Joaquin at Vernalis (where it enters the Delta) will be represented as a fixed timeseries, and the other checkboxes will have no effect. The dynamic San Joaquin module allows for adjustment of certain regulations that apply to the San Joaquin basin, in particular to New Melones Reservoir on the Stanislaus River. Activating the appropriate checkbox will activate each of the regulations.

Note that regulations in the San Joaquin basin are currently under review. The two pulse period regulations listed below (VAMP and the 60-day pulse flow RPA) are not implemented in current operations in the San Joaquin basin, but are options in the model because new pulse period flow requirements have not been clearly defined.

The regulations on this tab are as follows:

6.6.1 Vernalis D-1641 Baseflows

This activates the D-1641 flow requirements at Vernalis during February to June (excluding the April 15 - May 15 pulse period). These requirements vary by water year type and whether X2 is located east or west of Chipps. Any additional water needed to meet these requirements above the flows required for other regulations is released from New Melones Reservoir, with a cap on releases in dry conditions.

6.6.2 Vernalis D-1641 Salinity Criteria

This activates the D-1641 salinity requirements at Vernalis, which are 0.7 Electrical Conductivity (EC) during April-August and 1.0 EC during September-March. Any additional water needed to meet these requirements above the flows required for other regulations is released from New Melones Reservoir, with a cap on releases in extremely dry conditions.

6.6.3 VAMP Pulse Flows (Apr 15-May 15)

This activates flow requirements at Vernalis during the April 15 - May 15 pulse period. These flow requirements vary depending on whether the model is run with Existing or Future Level of Development. For Future Level of Development, the flow requirements are based on the Vernalis Adaptive Management (VAMP) that was implemented from 1999-2011. Water is released to meet these requirements from multiple tributaries on a schedule defined in the San Joaquin River Agreement. For Existing Level of Development the flow requirements are based on the agreement between Reclamation and Merced Irrigation District which was implemented in 2012-2013.

6.6.4 Vernalis 60-day Pulse Flow RPA (NMFS Action 4.2.1)

This activates a 60-day pulse flow requirement at Vernalis during April and May, which varies by water year type. This requirement is in the NMFS Biological Opinion released in June 2009. Any additional water needed to meet this requirement above the flows required for other regulations is released from New Melones Reservoir, with a cap on releases in dry conditions.

6.6.5 Stanislaus Flow RPA (NMFS Action 3.1.3)

This activates a fish flow requirement on the Stanislaus River which varies by water year type. This requirement is from the NMFS Biological Opinion released in June 2009.

6.6.6 San Joaquin River Restoration Flows

This toggles the San Joaquin River Restoration flows between interim flows and full flows. Flow requirements vary by water year type. These flows are released from Friant Dam on the upper San Joaquin River, and are defined under the 2006 Settlement that led to the San Joaquin River Restoration Program. Interim flows are designed to allow for collection of data and research prior to implementation of full Restoration flows.

7 Innovative Features

While CalLite simulates hydrology and operations over much of the same geographic area as CalSim II, there are several features in the CalLite Version 3.00 that are unique. These innovative features or capabilities permit a range of analyses to be conducted that are distinct from those that can be reasonably performed in other system models. These features are (1) rapid runtime and interactive interface, (2) Delta requirements and facility controls, (3) demand management options, and (4) hydroclimate simulation capabilities, as described in the following sections:

7.1 Rapid Runtime and Interactive Interface

7.1.1 Rapid Runtime

Because CalLite has a simplified schematic and a reduced number of solution cycles (see Appendix G) compared to CalSim II, it has a much faster run-time. For the same 82 year planning simulation, CalLite runs in approximately 6 minutes, whereas a CalSim simulation typically takes around 30 minutes.

7.1.2 Interactive Interface

The CalLite model is configured with a graphical user interface (GUI) that serves as the primary entry point for most users. For more detail on the GUI beyond the summary provided here, see the CalLite User's Guide, which is contained in the GUI's help system and is also available as a separate pdf document. The GUI has a series of dashboards which allow the user to control, edit, and run scenarios and view results (Figure 5). The first six dashboards (whose tabs are gray with black text) are Run Settings, Hydroclimate, Demands, Facilities, Regulations, and Operations. These dashboards allow the user to load, run, and save scenarios, and also to select options such as level of development (2005 or 2020), sea level rise, South of Delta demands, storage facility options, regulations to be used, and operations.

The five dashboards to the right (whose tabs are white with blue text) are Quick Results, Custom Results, Map View, External PDF, and Web Map. The Quick Results dashboard allows the user to view a variety of pre-selected model outputs in either graphical or tabular format, for a single or for multiple scenarios. Monthly timeseries plots, exceedance graphs, tables of monthly and annual values, and statistics for different water year types and periods are available on this tab. The Custom Results dashboard allows the user to create more customized output graphs and tables. The External PDF dashboard allows the user to generate a standardized pdf report comparing the results of two scenarios (see Appendix J for more details). The Map View dashboard shows the CalLite schematic and mass balance of the Delta. The Web Map dashboard contains an embedded internet browser that allows the user to view CalLite features overlaid on Google Maps. On both of these dashboards the user can view CalLite results by clicking on the schematic or CalLite feature.

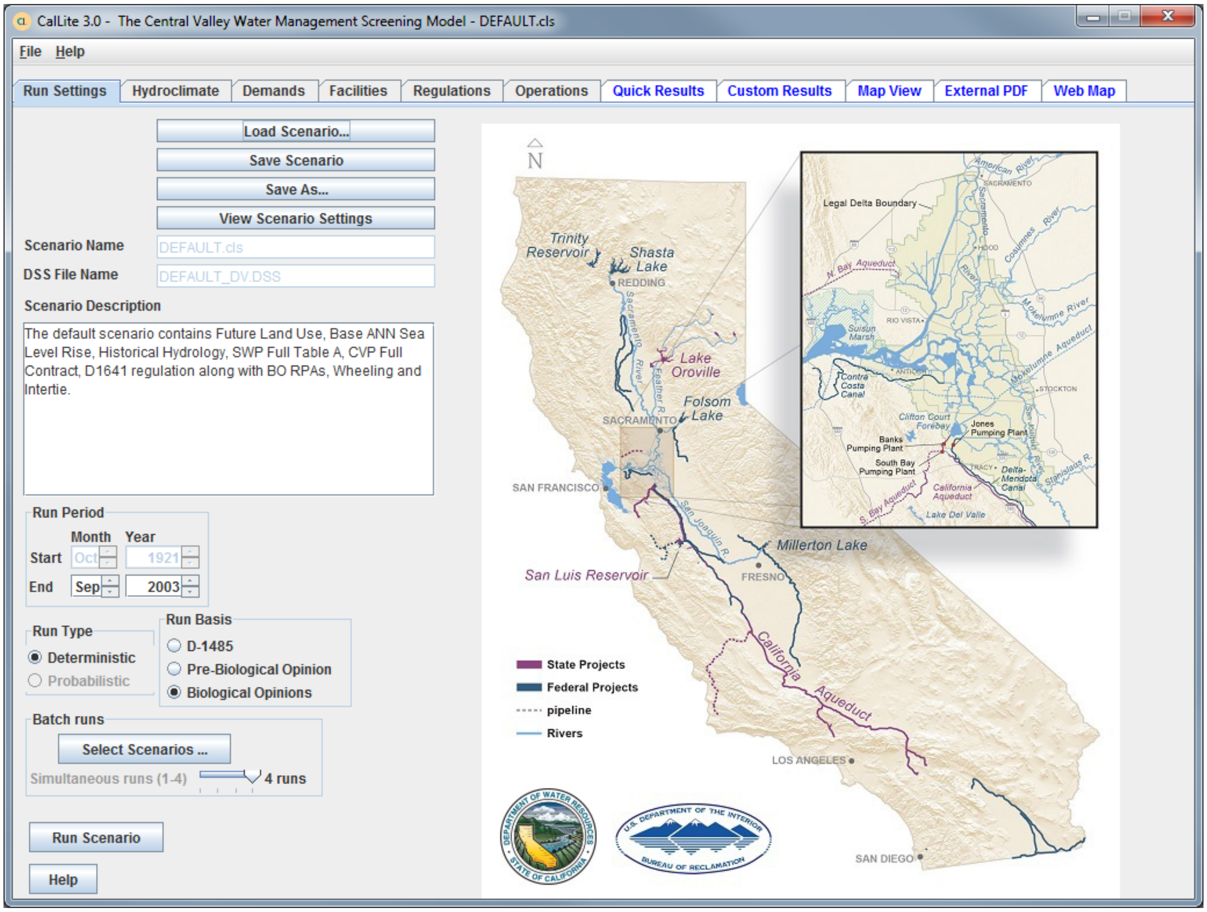


Figure 5. The CalLite GUI.

7.2 Hydroclimate Simulation Capabilities

This section describes CalLite's capabilities to simulate operations using historical hydrology and different climate change futures.

7.2.1 Direct Observed Hydrology

The traditional approach toward assessing future actions is to make the assumption that the historical observed hydrologic conditions and sequence are reasonable for use in projecting future water availability and management. This is the approach that is used in the CalSim II model. CalLite incorporates the same direct observed hydrology as that used in the CalSim II model. This hydrology is based on monthly observed flows from October 1922 through September 2003. Under the direct observed hydrology option, the 82-year simulated hydrologic sequence has hydrologic variability represented by the observed data.

Ten climate change hydrologic scenarios are also available: Early Long Term (ELT) Q1-Q5 and Late Long Term (LLT) Q1-Q5. These scenarios are described in more detail in Appendix F.

7.2.2 Sea Level Rise (SLR)

Increased temperatures cause thermal expansion of the ocean and melt polar ice caps resulting in a higher sea level. Historical data for the later part of last century seem to validate this theory. Observed data along the pacific coast shows a change in the amplitude over the same period. CalLite includes three options for sea level rise (0, 15 cm, and 45 cm) based on the BDCP analysis (BDCP 2012). See Appendix F for more details on the BDCP sea level rise estimates.

7.3 South of Delta Demand Options

To increase the flexibility of CalLite as a screening tool, the user can choose from three different South of Delta demand options for SWP and two different options for CVP. For SWP the options are 2005 level, 2020 level, or user-defined as shown in Figure 6. Pre-defined data sets are included for 2005 and 2020 level demands. The 2005 level includes a variable annual demand between 3.3 MAF to 4.2 MAF. The 2020 level is assumed to be Full Table A entitlement demand per assumptions in the future level studies of Common Assumptions Common Model Package (Version 9B) (DWR 2009).

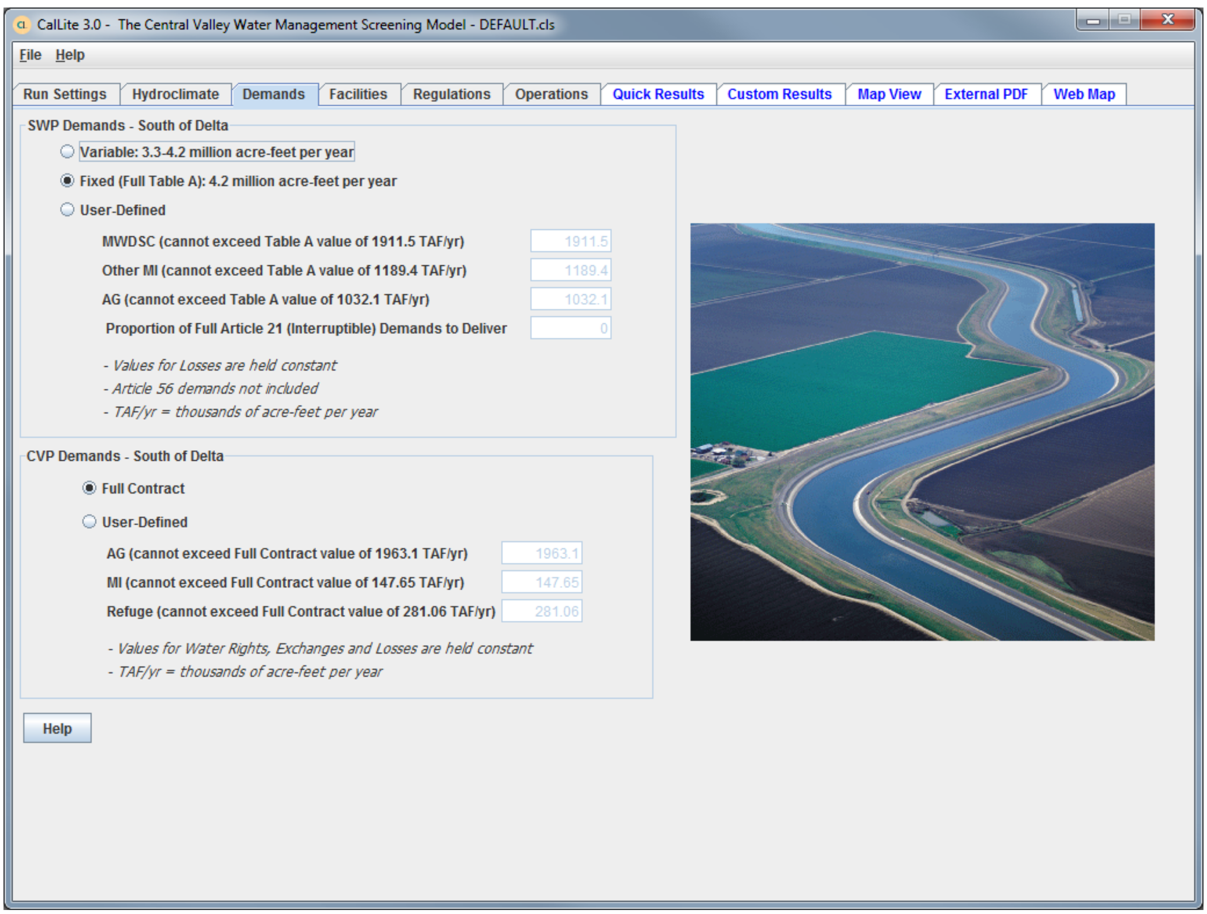


Figure 6. Demands dashboard for specification of annual south of Delta SWP and CVP demand levels.

The third option for SWP is user-defined demand values (in TAF) up to Full Table A amounts. Under this option, the user selects the projected demand levels for SWP Agricultural, M&I-MWDSC (Metropolitan Water District), and M&I-Other contractors. Demand patterns (fractional) are assumed to be the same as the 2020 level patterns. The user can also select a proportion of maximum Article 21 (interruptible) deliveries to implement. Under this option, however, Article 56 (carryover) deliveries are set to zero in order to avoid continued delivery of the these categories when Table A demands are reduced.

For CVP the two options are full contract amount and user-defined. For the user-defined option, the user selects projected demand levels for CVP Agricultural, M&I, and Refuge contractors. However, deliveries to Water Right or Exchange contractors are not permitted to be modified.

7.4 Delta Regulatory Controls

The implementation of Delta regulatory controls and associated operations has been a focal point of CalLite development. The regulatory controls in CalLite allow users to specify requirements for interior Delta flows, minimum river flows, Delta outflows, export restrictions, and salinity objectives. Figure 7 shows a map of the Delta with the locations of Delta regulatory controls. The yellow circles correspond to locations of EC requirements: Chipps Island (CH), Collinsville (CO), Emmaton (EM), Jersey Point (JP), Rock Slough (RS), Vernalis (VI), Contra Costa (CC), and Clifton Court (CI). The blue circles represent locations of flow requirements (Q).

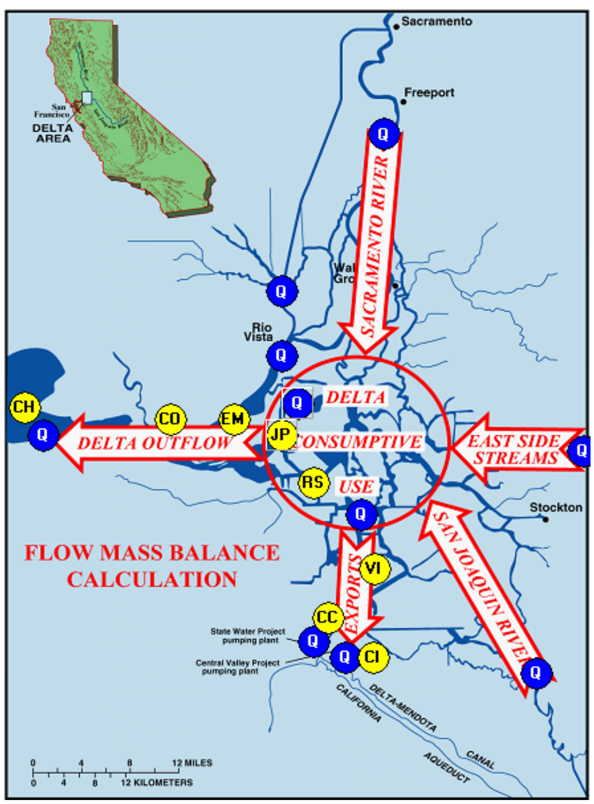


Figure 7. Delta regulatory control locations.

The methodology used in the implementation of Delta regulatory controls is identical to that used in the CalSim II model. However, in the CalLite model, the user can switch requirements on or off, specify Decision 1485, Decision 1641 or BO RPA requirements, or specify new values for the D-1485/D-1641 standards and a few other alternative requirements. These user selections are specified through a Regulations dashboard as shown in Figure 8. If the user chooses to customize the constraints by clicking the radio button for user-defined, then they can enter values in the table in the right side of the GUI. This ability to rapidly switch between Delta requirements is an innovation that does not exist in other models and allows for rapid screening of regulatory benefits and impacts.

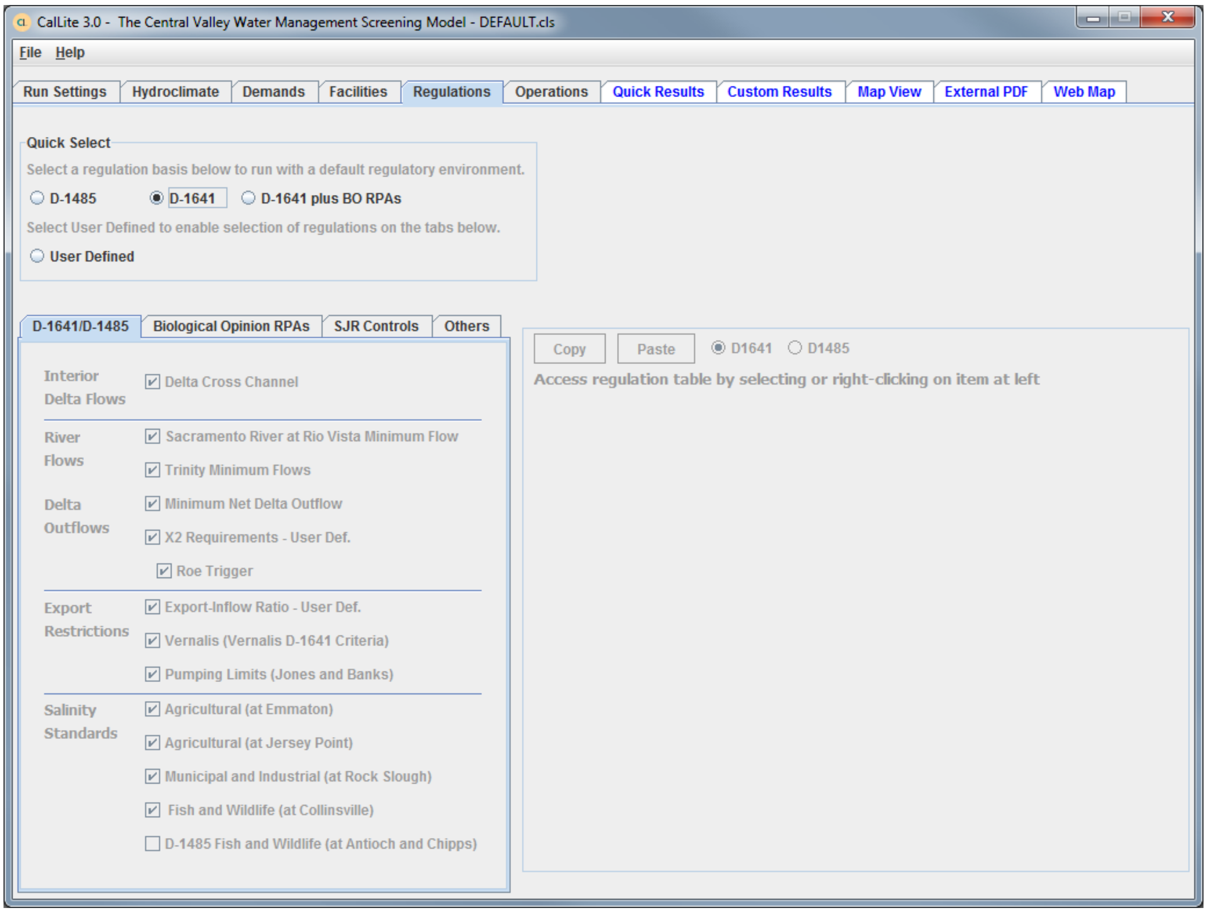


Figure 8. Regulations dashboard in CalLite.

The main Delta regulatory controls included in the CalLite model are shown in Table 4. The Clear Creek RPA standard is listed because it is available for selection in the GUI, even though it is not a Delta standard.

Table 4. Delta and other standards available in CalLite.

Type of Standard	Available Options			
	D-1485 criteria	**D-1641 criteria**	**RPA standard**	**User-defined**
Delta Cross Channel gate position	Yes	Yes	Yes	Yes
Sacramento River at Rio Vista minimum flow	Yes	Yes		Yes
Minimum Delta outflow	Yes	Yes		Yes
X2 requirements		Yes	Yes	Yes
Trigger for implementation of X2 Roe Island standard		Yes		
Export-inflow ratio		Yes		Yes
Vernalis flow-base export restriction during Apr 15-May 15 pulse period		Yes		
VAMP hydrology	Yes	Yes		
Pumping Limits at Jones and Banks	Yes	Yes		
Salinity standards at Emmaton, Jersey Pt, Rock Slough, and Collinsville	Yes	Yes		
Salinity standards at Antioch and Chipps Island	Yes			
Old and Middle River maximum negative flows			Yes	Yes
San Joaquin River Inflow to Export Ratio			Yes	Yes
San Joaquin River near Jersey Point (QWEST) minimum flow				Yes
Payback Wheeling	Yes			
Clear Creek minimum flow			Yes	

Appendix C includes detailed documentation of the main Delta regulatory controls, assumptions, and method of implementation. Note that when all of the regulations shown in Table 4 are turned off, CalLite still implements minimum instream flow standards in the Sacramento basin (these are described in Appendix D).

7.5 Custom Results

The Custom Results Dashboard allows the user to filter and retrieve variables directly from the DV or SV file, including variables that cannot be selected through Quick Results or Map View. The filtered variables can be displayed in the same format as those brought up from Quick Results (i.e. the various kinds of plots and tables). This feature combines the broad range of post-processing features from Quick Results with the ability to bring up and analyze any variable in the DSS files.

The user can view the data for these variables directly, or they may elect to create derived time series (DTS) from them. DTS are created by combining two or more time series with basic mathematical operators and may be custom-tailored to fit the needs of a specific project or investigation. These DTS can be saved and accessed at a later session.

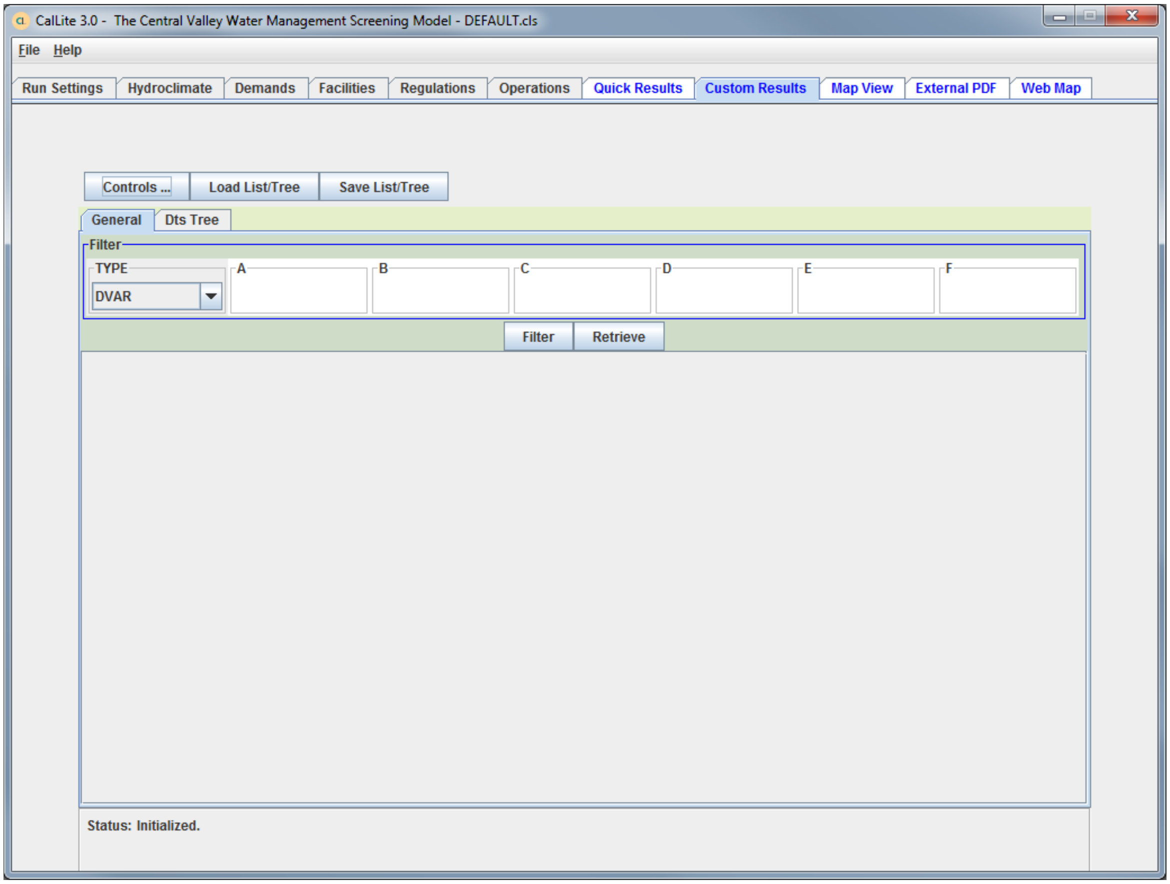


Figure 9. Custom Results dashboard in CalLite.

7.6 Map View

The Map View Dashboard allows users to view the CalLite study results by clicking on the arcs, nodes, and reservoirs in the CalLite schematic. Users can choose to view results from the standard schematic or from the mass balance schematic.

The mass balance schematic aggregates schematic arcs into larger categories. These categories, represented by the red arrows, account for the major inflows, outflows, exports and net consumption within the Delta. Alongside the major flows are selectable elements for salinity stations (represented by yellow circles) and flow objectives (represented by blue circles). Clicking on the Salinity Station will display the salinity at that station along with its respective salinity standard. Similarly, selecting the blue circles will display the flow at that location with its respective flow objective.

Controls

To zoom in, hold the ctrl key and draw a box over the area to be enlarged. An alternative way to zoom in and out is to hold down shift key and right click simultaneously and then move the mouse forward and back. To pan across the schematic, hold down the shift key and click/drag anywhere in the window. Click on 'Controls' at any time to load a CalLite study, or change the format of the data output.

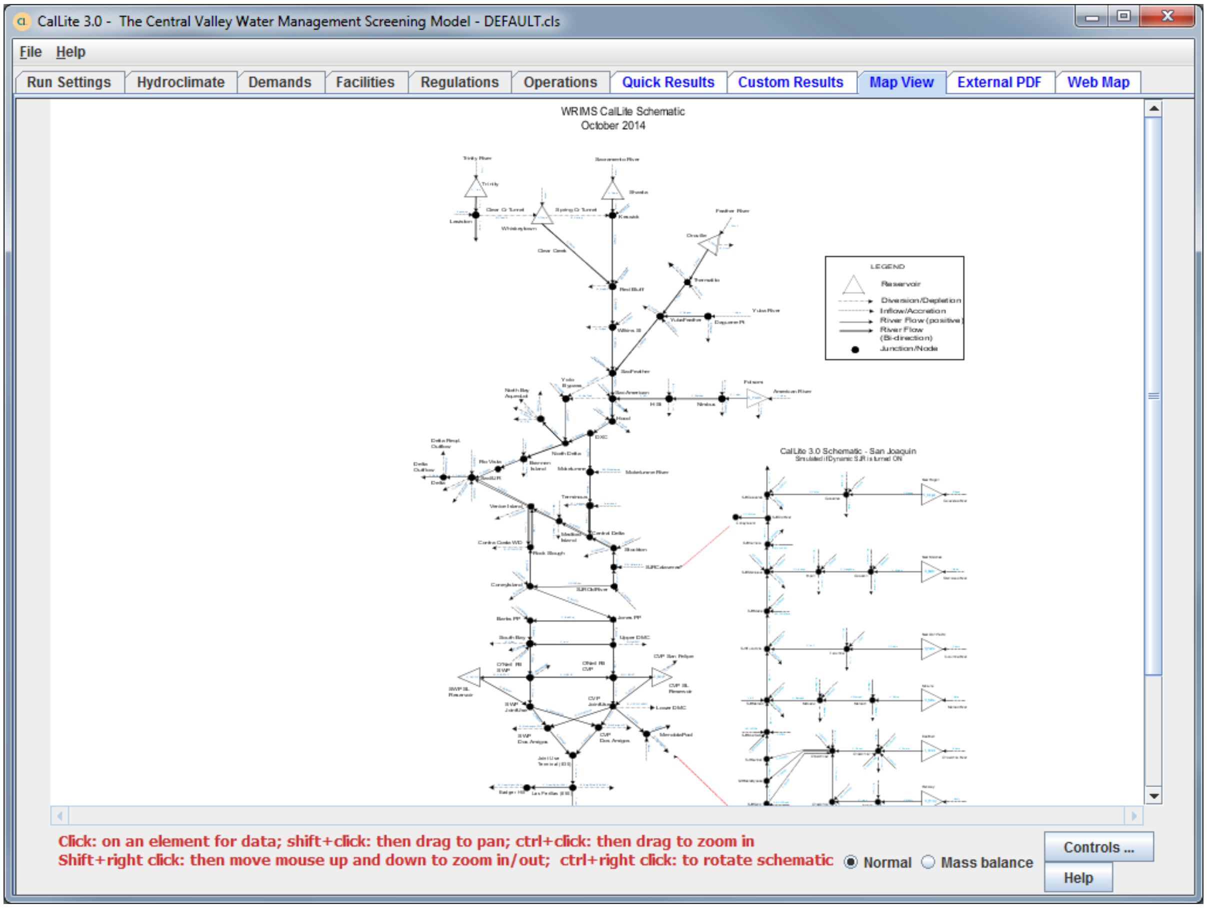


Figure 10. Map View dashboard in CalLite.

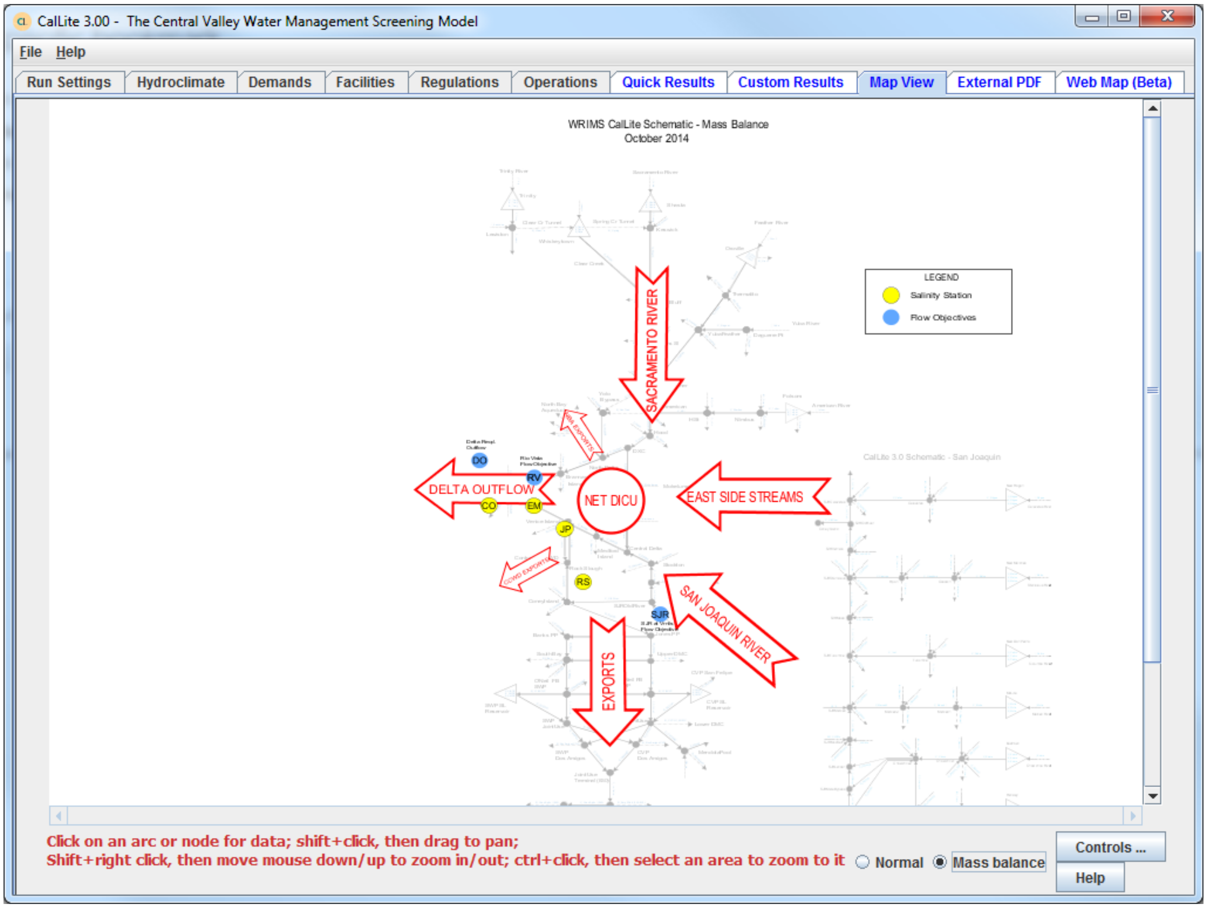


Figure 11. Mass balance in Map View dashboard.

8 Comparison to CalSim II Model Simulations

This section is provided from the CalLite Reference manual v2.00, released October 2011. While the summary numbers have not been updated to match the model being released under version 3.00, the relative comparison of results remains similar.

In order to identify any differences between CalLite and CalSim II and understand the degree to which the approximations included in CalLite affect the key system results, the two models were compared for the 2020 level of development under D-1641 and BO RPA regulatory standards. For a description of D-1641 and BO RPA regulatory standards, see Appendix C. The comparisons that follow show system-wide flows for both models for the long-term 82-year period and the critical drought periods of 1929-1934 and 1987-1992. Storage timeseries and end-of-September exceedance plots are also provided for all major reservoirs simulated in the system. Delta mass balances, X2 position, and Rock Slough electrical conductivity (EC) are also compared. Finally, SWP and CVP contractor allocations are compared between CalLite and CalSim II. Assumptions of the studies used here are presented in Appendix E.

8.1 Comparisons to 2020 Base CalSim II Simulations under D-1641 Regulatory Requirements (as of Oct. 2011)

Table 5. System-wide flow summary between CalLite v.201 and CalSim II D-1641 simulations (taf/yr).

	1922-2003			1929-1934			1987-1992		
River Flow	CalLite	CalSim II	Difference	CalLite	CalSim II	Difference	CalLite	CalSim II	Difference
Trinity R blw Lewiston	707	708	-1	411	411	0	472	472	0
Trinity Export	523	522	1	398	398	1	442	439	4
Clear Cr blw Whiskeytown	122	120	2	85	85	0	102	102	0
Sacramento R @ Keswick	6242	6243	-1	4093	4097	-4	4497	4504	-7
Sacramento R @ Wilkins Slough	6534	6534	0	4063	4068	-5	4730	4733	-4
Feather R blw Thermalito	3165	3169	-4	1646	1649	-3	1599	1617	-18
American R blw Nimbus	2395	2395	0	1261	1265	-4	1094	1095	-1
Delta Inflow	21706	21710	-4	10099	10111	-13	10565	10595	-30
Sacramento R @ Hood	15973	15994	-21	8294	8306	-13	9044	9073	-30
Yolo Bypass	1870	1853	17	101	101	0	135	135	0
Mokelumne R	666	666	0	202	202	0	155	155	0
San Joaquin R d/s Calaveras	3197	3197	0	1499	1499	0	1231	1231	0
Delta Outflow	14675	14679	-4	5181	5193	-12	5442	5446	-3
Required Delta Outflow	4379	4393	-14	4127	4128	-2	3877	3877	0
Delta Diversions	6050	6050	-1	3738	3738	0	3867	3891	-25
Banks SWP	3558	3558	-1	2175	2181	-6	2113	2123	-10
Banks CVP	0	0	0	0	0	0	0	0	0
Jones	2492	2492	0	1563	1557	6	1753	1768	-15
SWP SOD Deliveries	3543	3544	-1	2158	2165	-7	2119	2130	-11
Table A	3156	3165	-9	1777	1780	-3	1918	1937	-19
Article 21	258	263	-5	343	346	-4	133	125	8
Article 56	129	116	13	39	39	0	67	68	0
CVP SOD Deliveries	2756	2576	0	1524	1518	6	1828	1844	-16

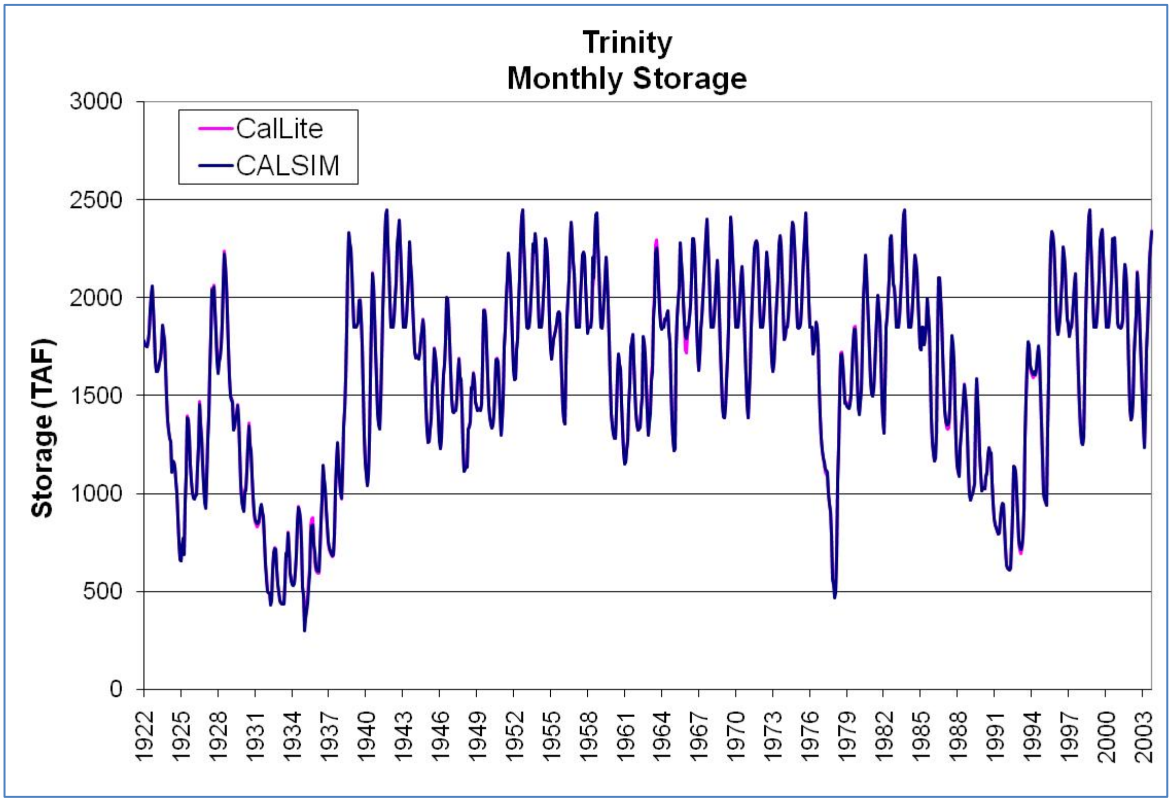


Figure 12. Trinity Reservoir storage for CalLite and CalSim II D-1641 simulations.

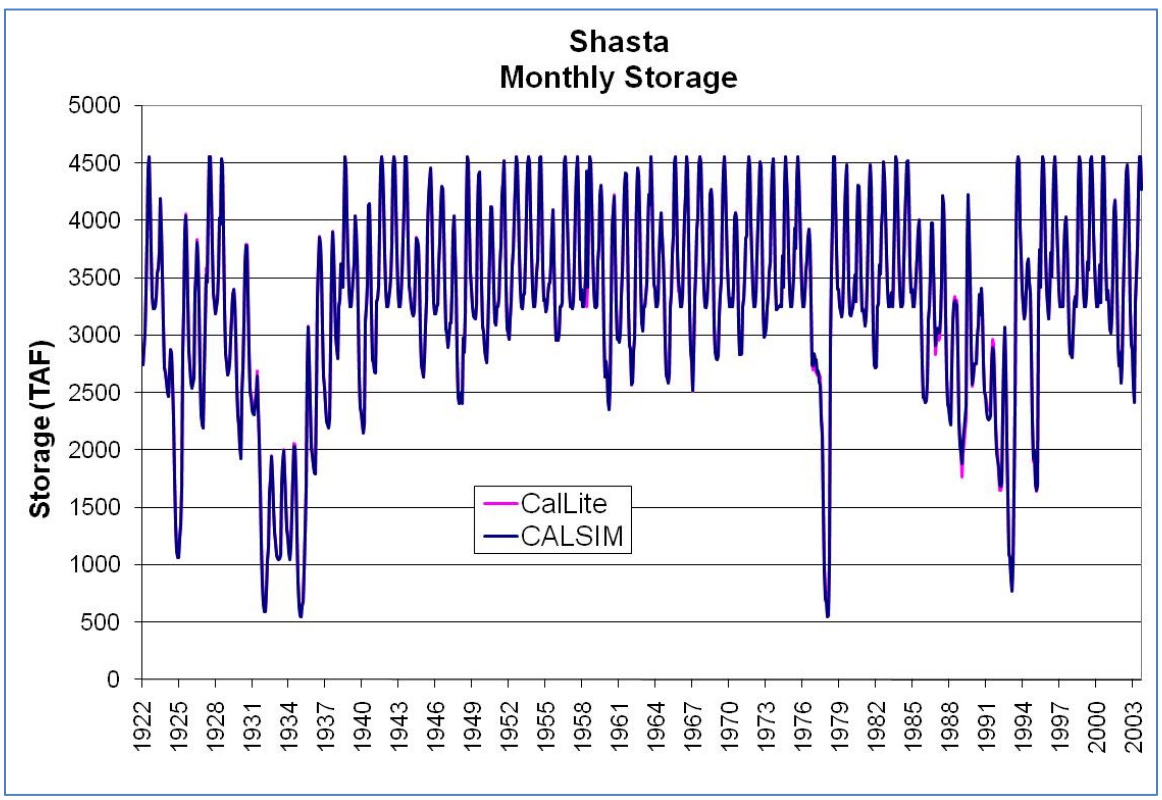


Figure 13. Shasta Reservoir storage for CalLite and CalSim II D-1641 simulations.

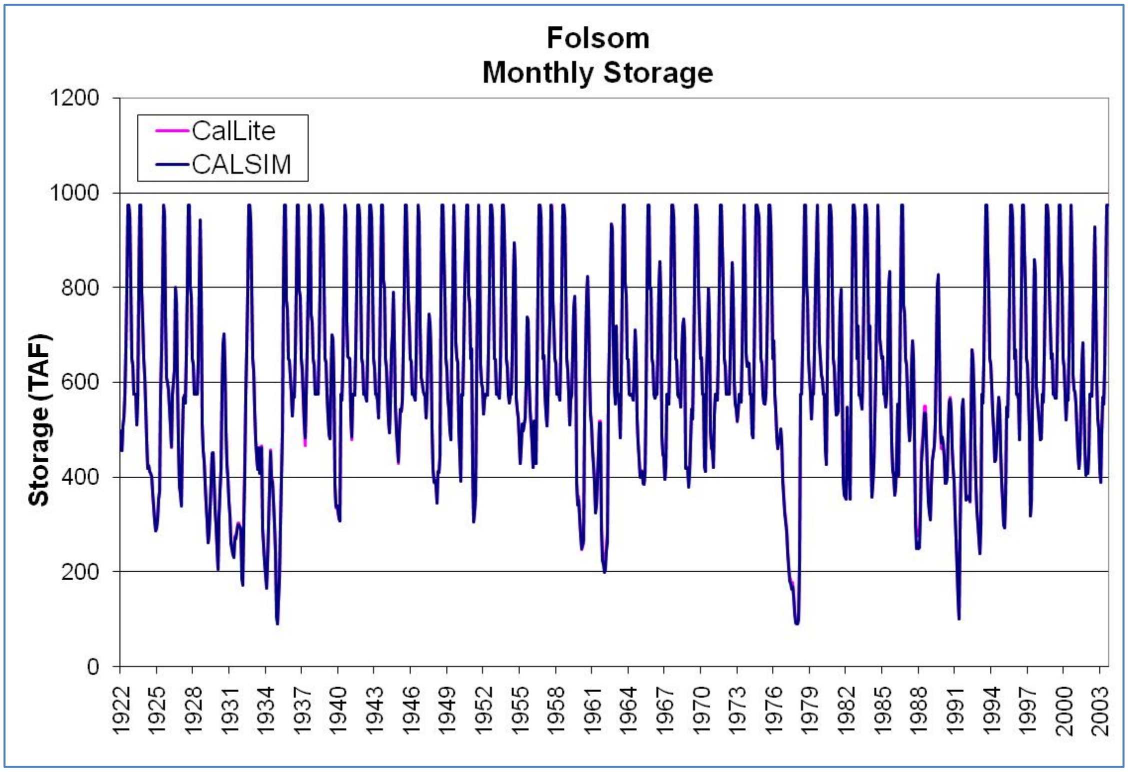


Figure 14. Folsom Reservoir storage for CalLite and CalSim II D-1641 simulations.

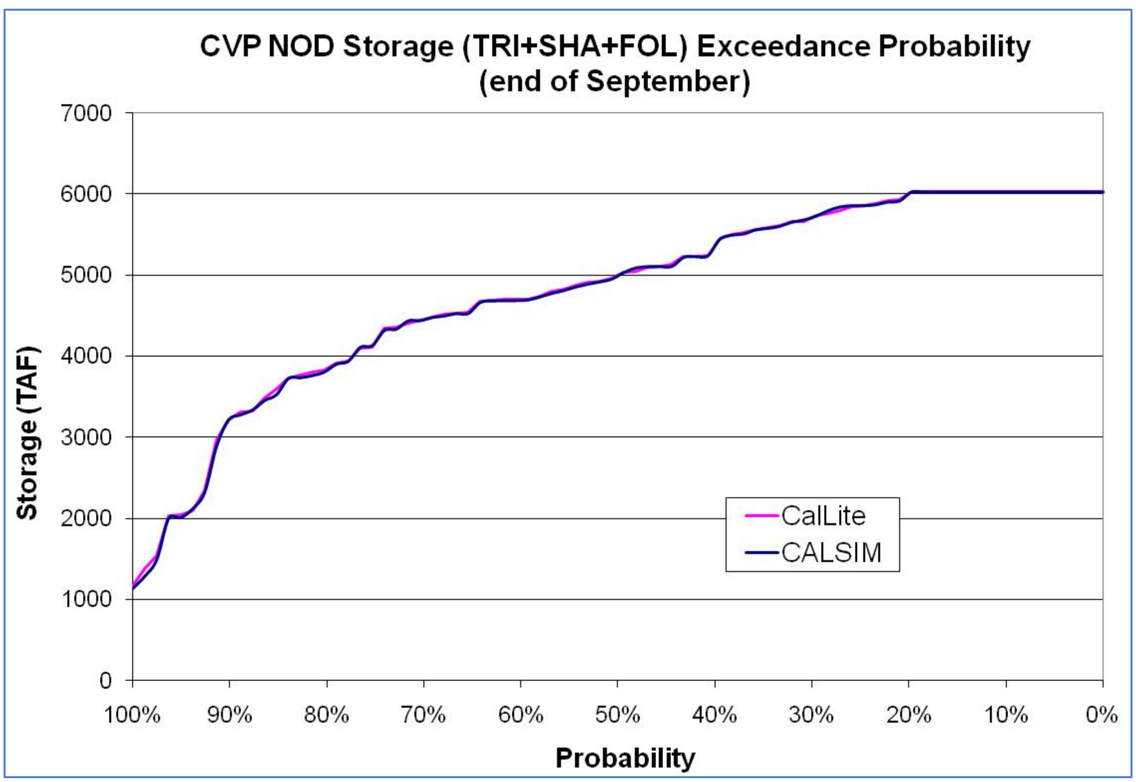


Figure 15. CVP north of Delta end of September storage exceedance probability for CalLite and CalSim II D-1641 simulations.

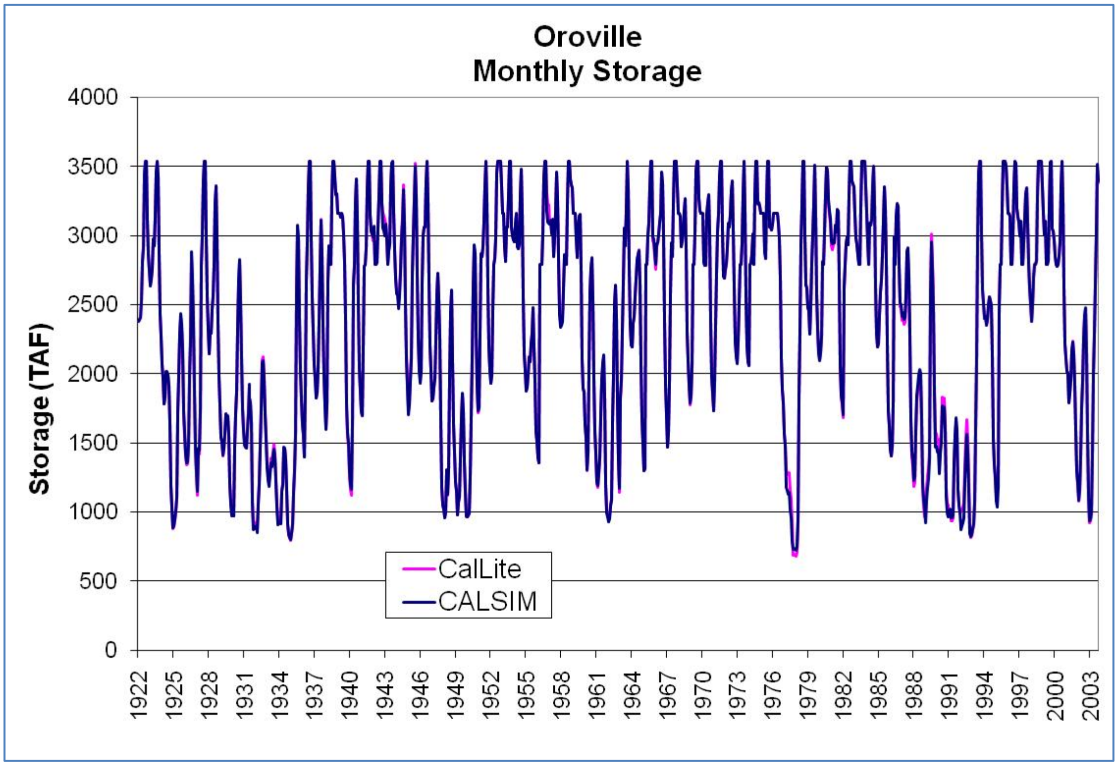


Figure 16. Oroville Reservoir storage for CalLite and CalSim II D-1641 simulations.

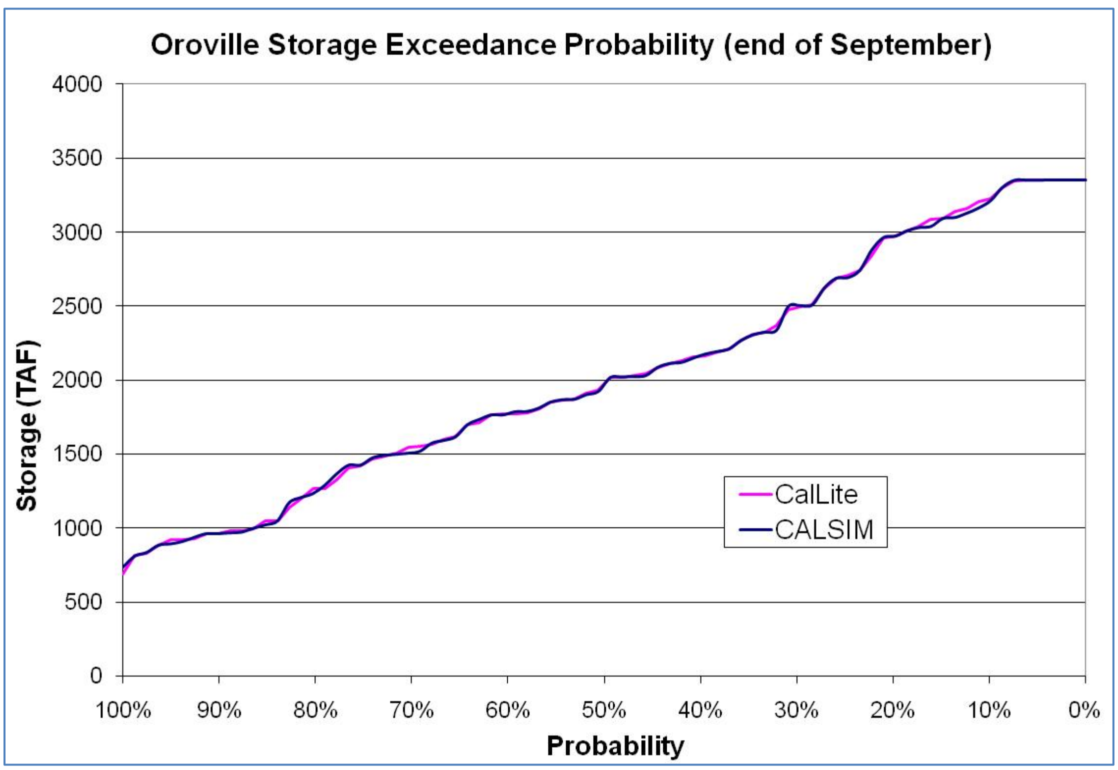


Figure 17. Oroville end of September storage exceedance probability for CalLite and CalSim II D-1641 simulations.

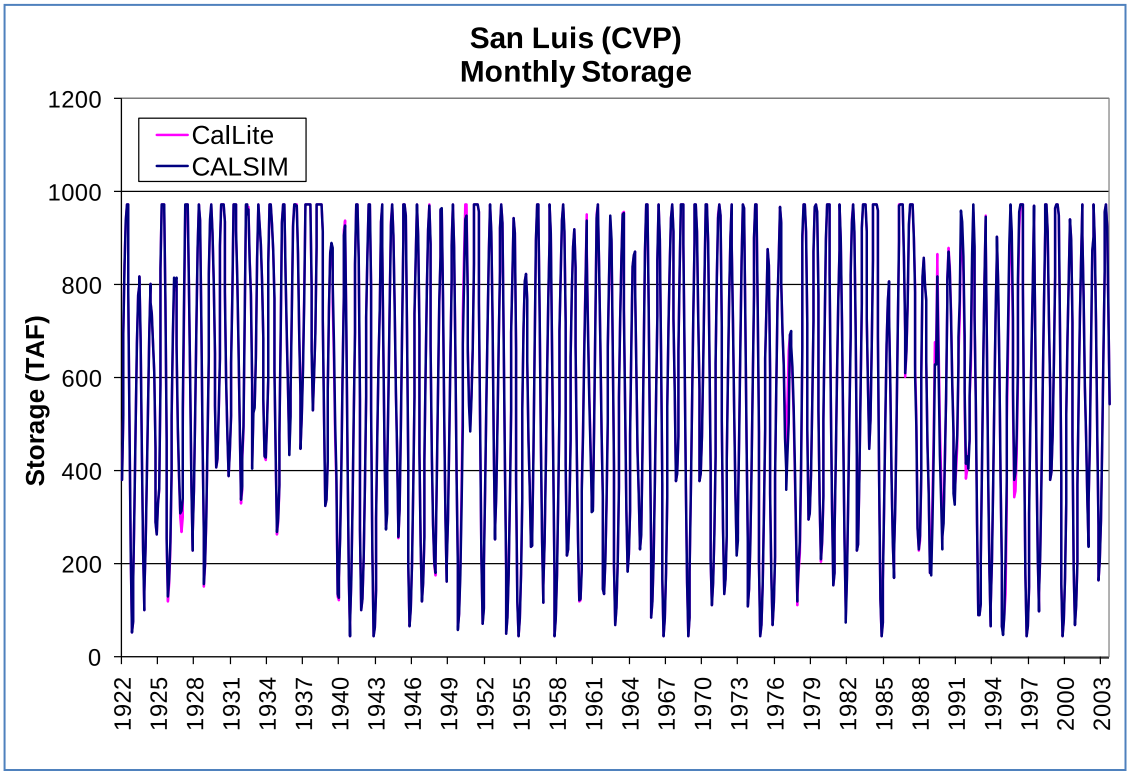


Figure 18. CVP San Luis storage for CalLite and CalSim II D-1641 simulations.

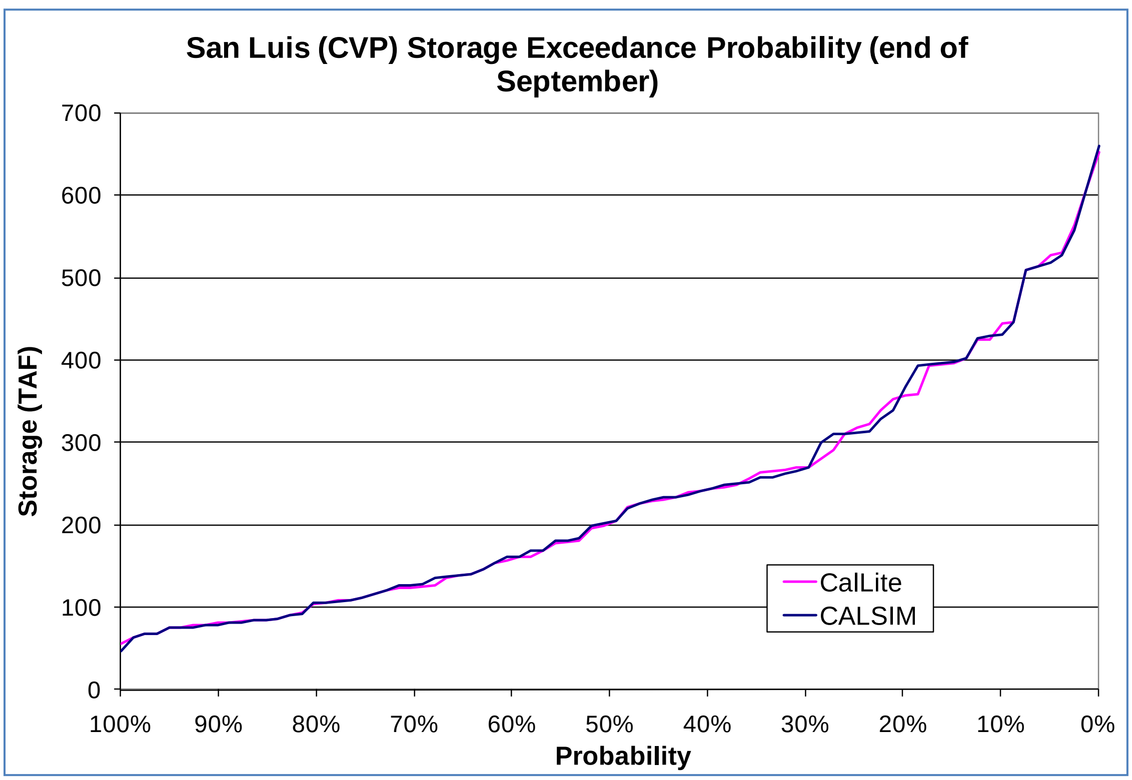


Figure 19. CVP San Luis end of September storage exceedance probability for CalLite and CalSim II D-1641 simulations.

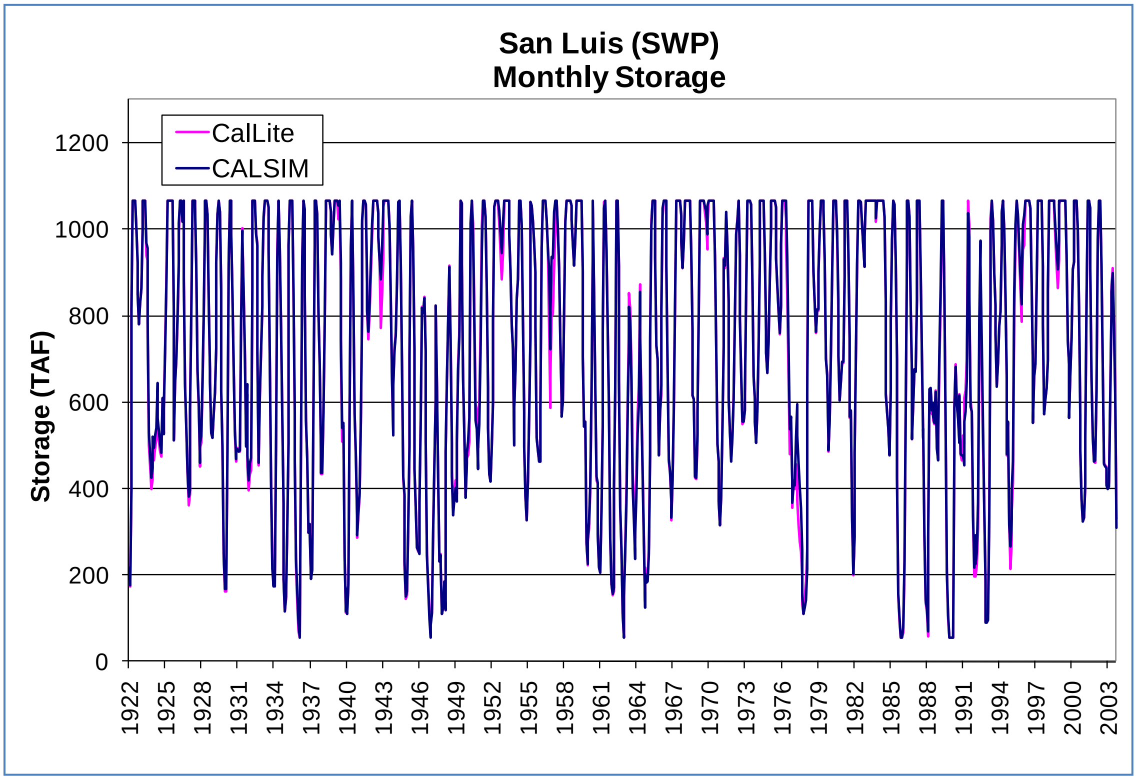


Figure 20. SWP San Luis storage for CalLite and CalSim II D-1641 simulations.

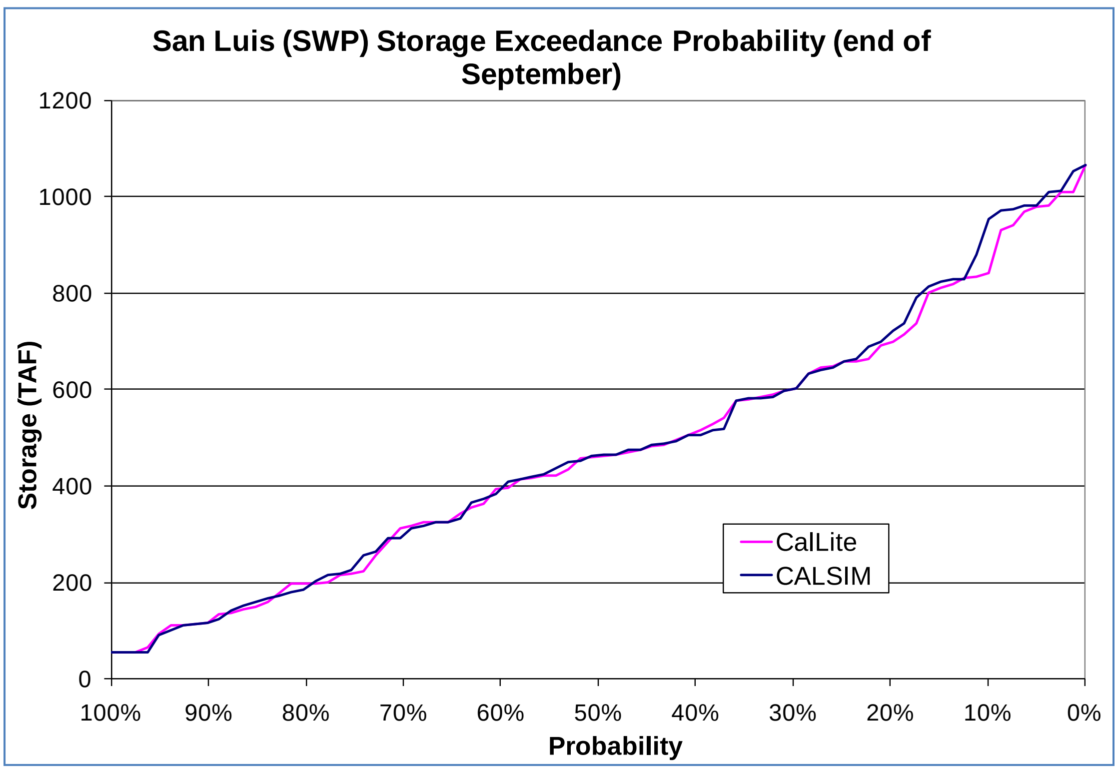


Figure 21. SWP San Luis end of September storage exceedance probability for CalLite and CalSim II D-1641 simulations.

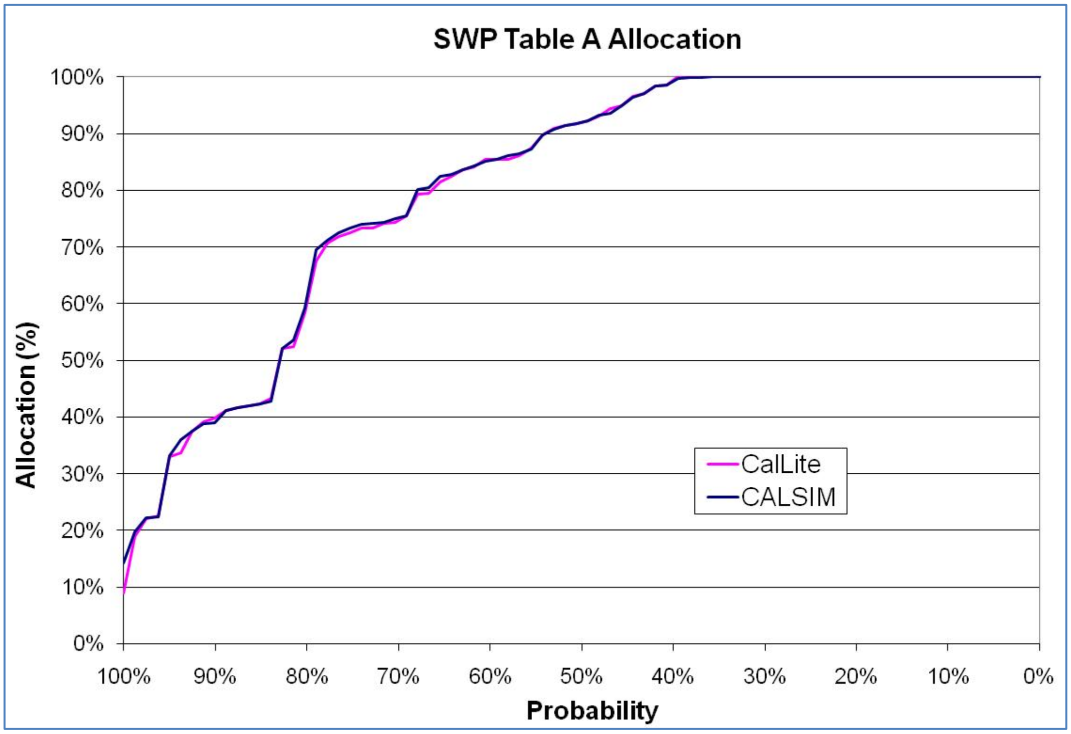


Figure 22. SWP Table A allocation exceedance probability for CalLite and CalSim II D-1641 simulations.

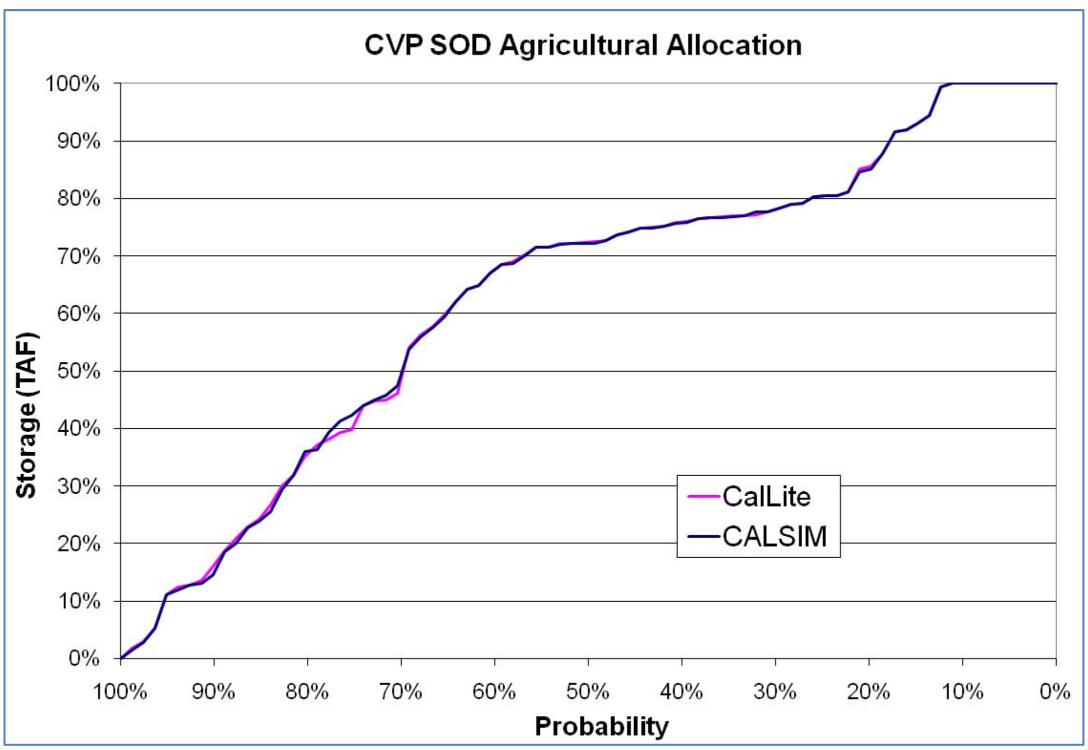


Figure 23. CVP south-of-Delta agricultural water contractor allocation exceedance probability for CalLite and CalSim II D-1641 simulations.

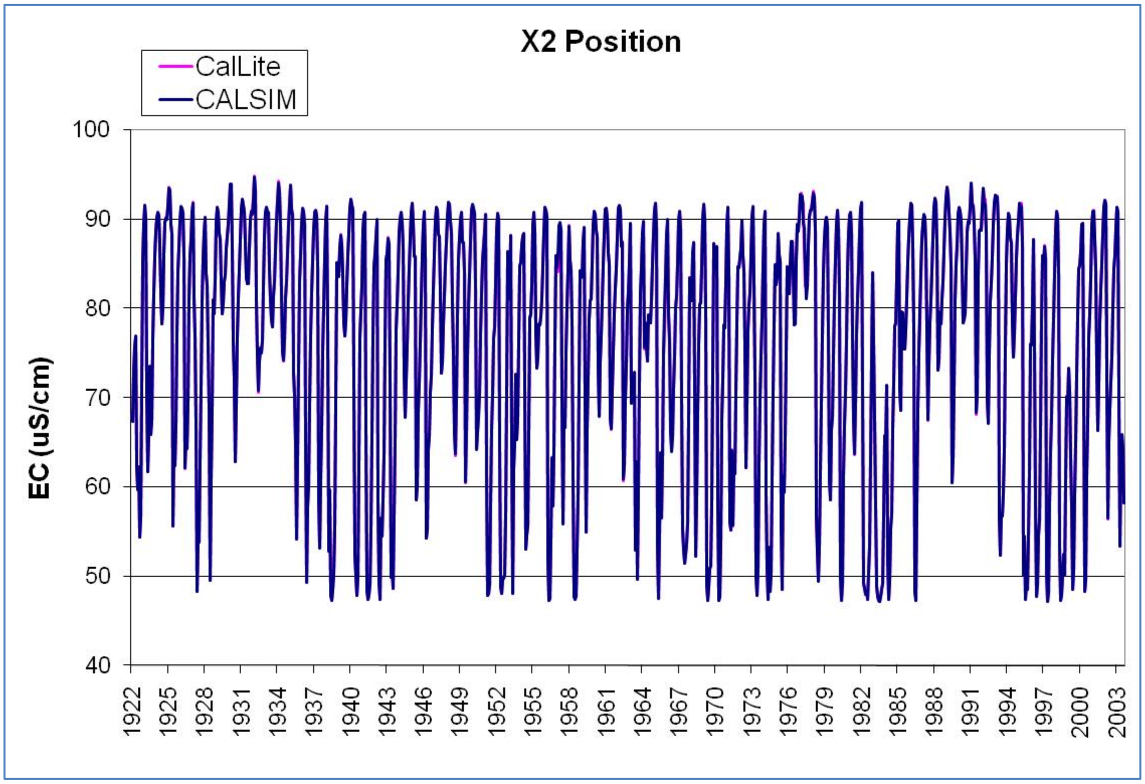


Figure 24. X2 position for CalLite and CalSim II D-1641 simulation.

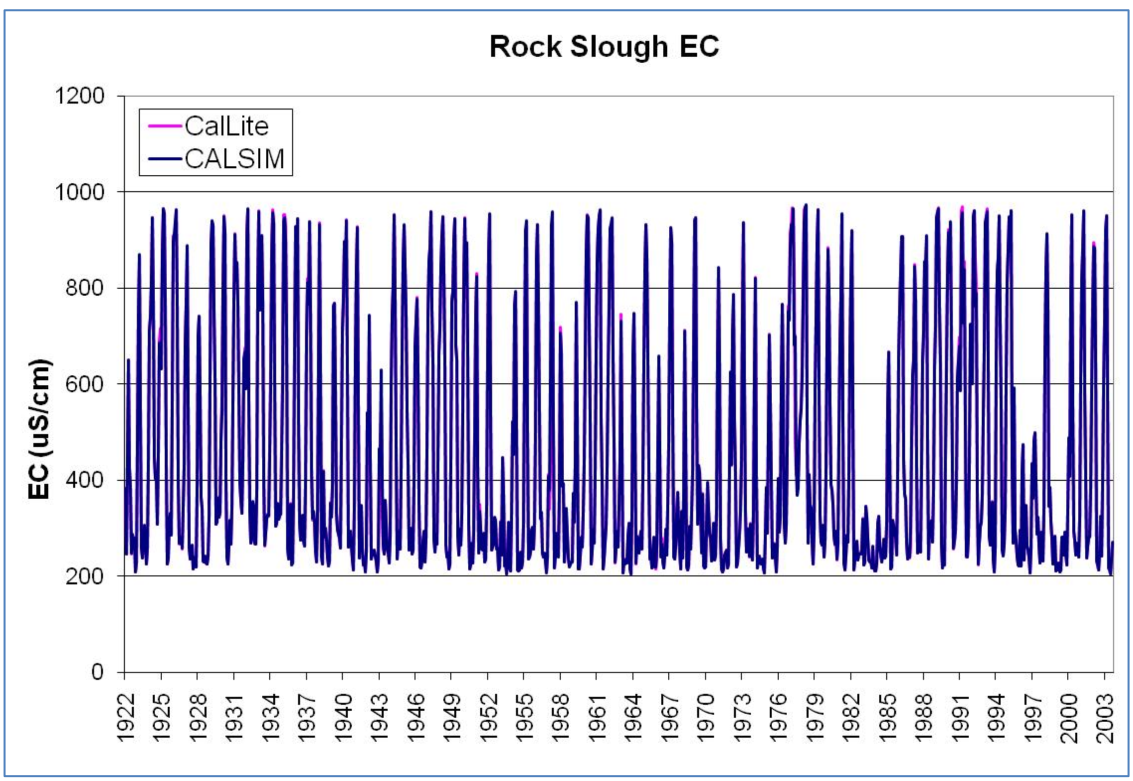


Figure 25. Old River at Rock Slough salinity for CalLite and CalSim II D-1641 simulations.

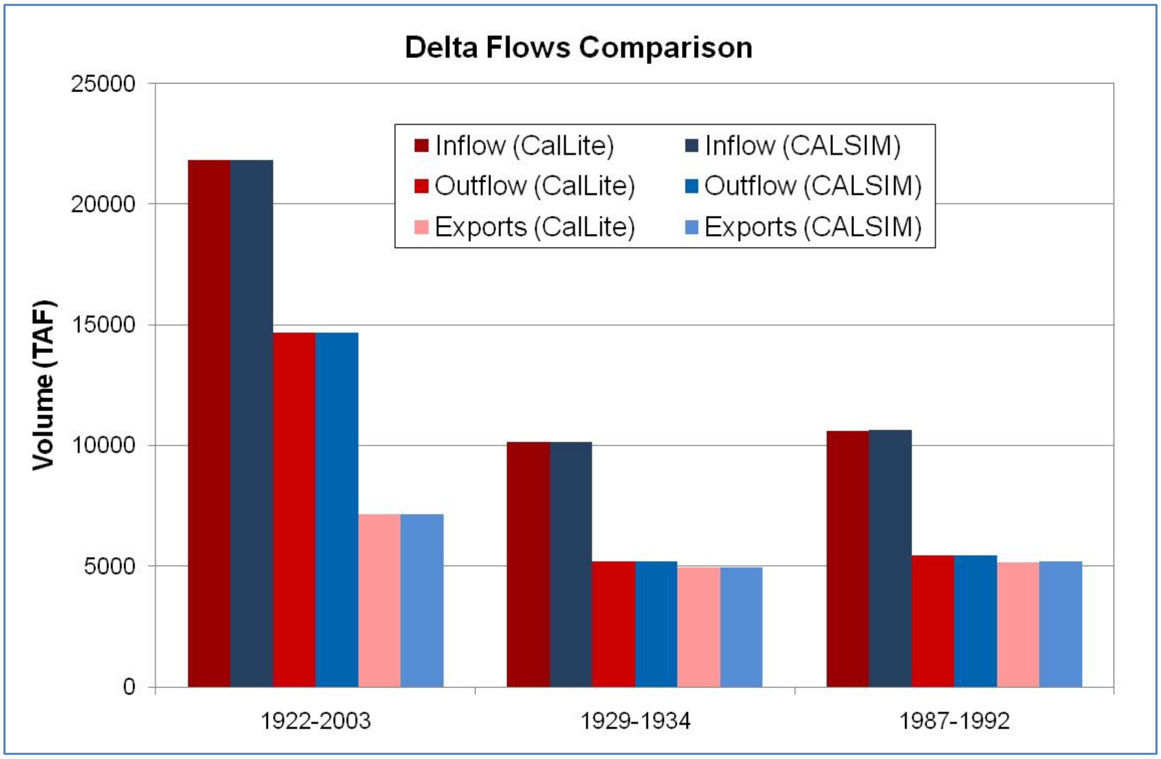


Figure 26. Period average Delta flows for CalLite and CalSim II D-1641 simulations.

8.2 Comparisons to 2020 Base CalSim II Simulations under BO RPA regulatory requirements (as of Oct. 2011)

Table 6. System-wide flow summary between CalLite v2.01 and CalSim II BO RPA simulations (TAF/yr).

	1922-2003			1929-1934			1987-1992		
River Flow	CalLite	CalSim II	Difference	CalLite	CalSim II	Difference	CalLite	CalSim II	Difference
Trinity R blw Lewiston	698	694	3	411	408	3	472	472	0
Trinity Export	534	537	-3	430	435	-5	489	499	-10
Clear Cr blw Whiskeytown	129	127	2	101	101	0	116	116	0
Sacramento R @ Keswick	6251	6256	-5	4099	4107	-9	4633	4647	-14
Sacramento R @ Wilkins Slough	6634	6637	-3	4104	4118	-14	4917	4932	-15
Feather R blw Thermalito	3180	3179	0	1608	1627	-19	1485	1487	-2
American R blw Nimbus	2388	2388	0	1267	1270	-3	1121	1122	-1
Delta Inflow	21607	21613	-6	9989	10028	-39	10524	10549	-25
Sacramento R @ Hood	15669	15684	-15	8336	8375	-39	9157	9183	-25
Yolo Bypass	2248	2238	9	101	101	0	141	141	0
Mokelumne R	666	666	0	206	206	0	155	155	0
San Joaquin R d/s Calaveras	3024	3024	0	1346	1346	0	1071	1071	0
Delta Outflow	15767	15778	-11	5612	5650	-38	6172	6193	-21
Required Delta Outflow	5011	5011	0	4108	4111	-3	4032	4039	-6
Delta Diversions	4877	4872	5	3202	3203	-1	3095	3099	-3
Banks SWP	2628	2626	2	1760	1764	-4	1544	1544	0
Banks CVP	65	63	2	8	8	0	28	28	0
Jones	2184	2183	1	1443	1440	3	1552	1555	-3
SWP SOD Deliveries	2605	2602	3	1645	1650	-5	1456	1458	-2
Table A	2470	2474	-4	1553	1565	-12	1416	1414	1
Article 21	49	44	5	79	66	13	10	9	1
Article 56	86	84	2	14	19	-5	30	35	-4
CVP SOD Deliveries	2361	2358	3	1399	1395	4	1620	1615	5

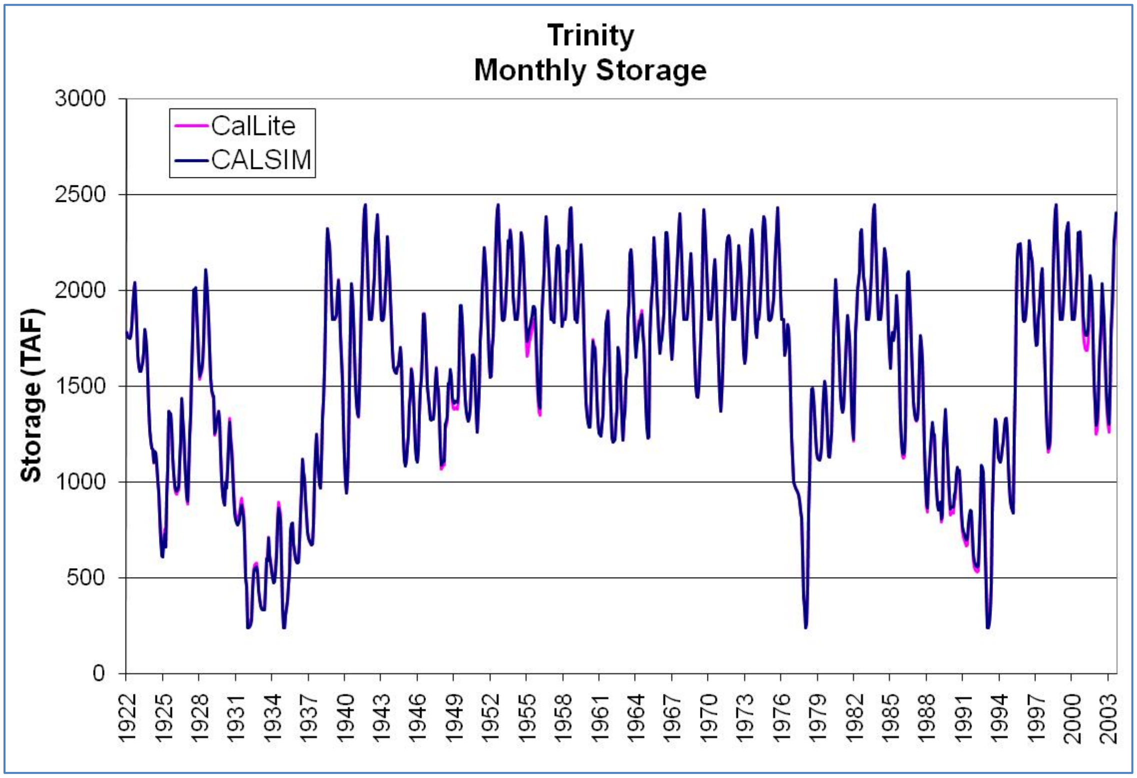


Figure 27. Trinity Reservoir storage for CalLite and CalSim II BO RPA simulations.

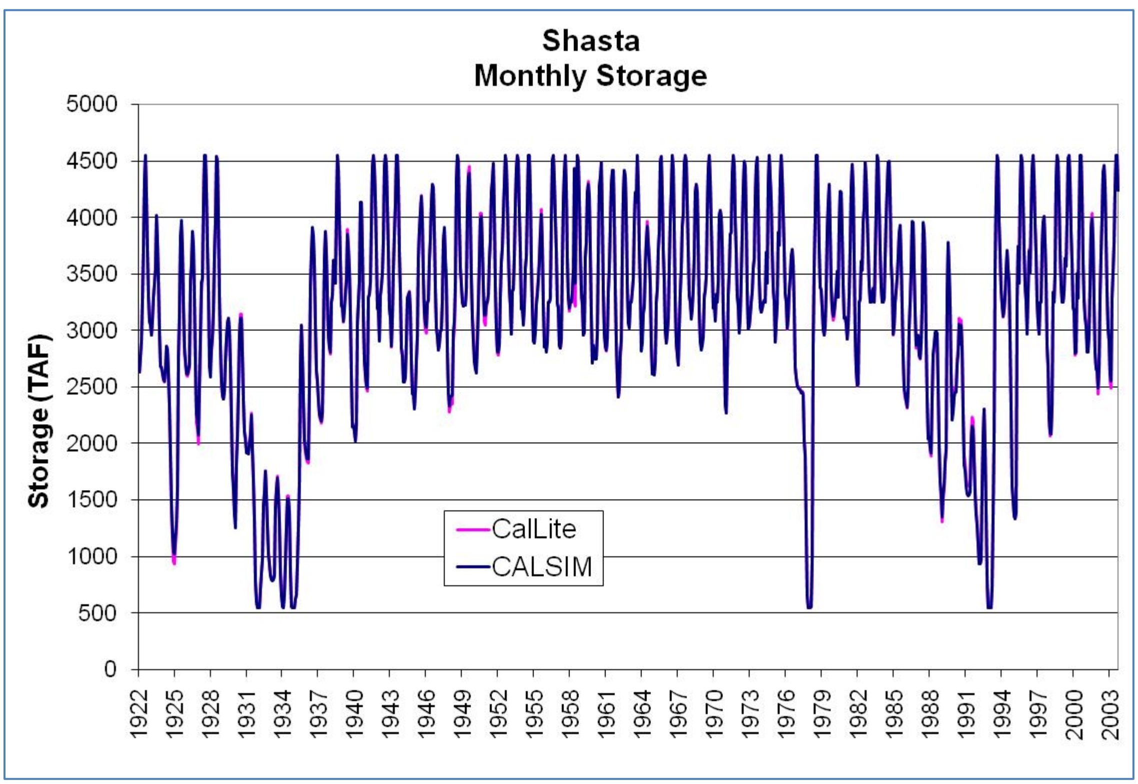


Figure 28. Shasta Reservoir storage for CalLite and CalSim II BO RPA simulations.

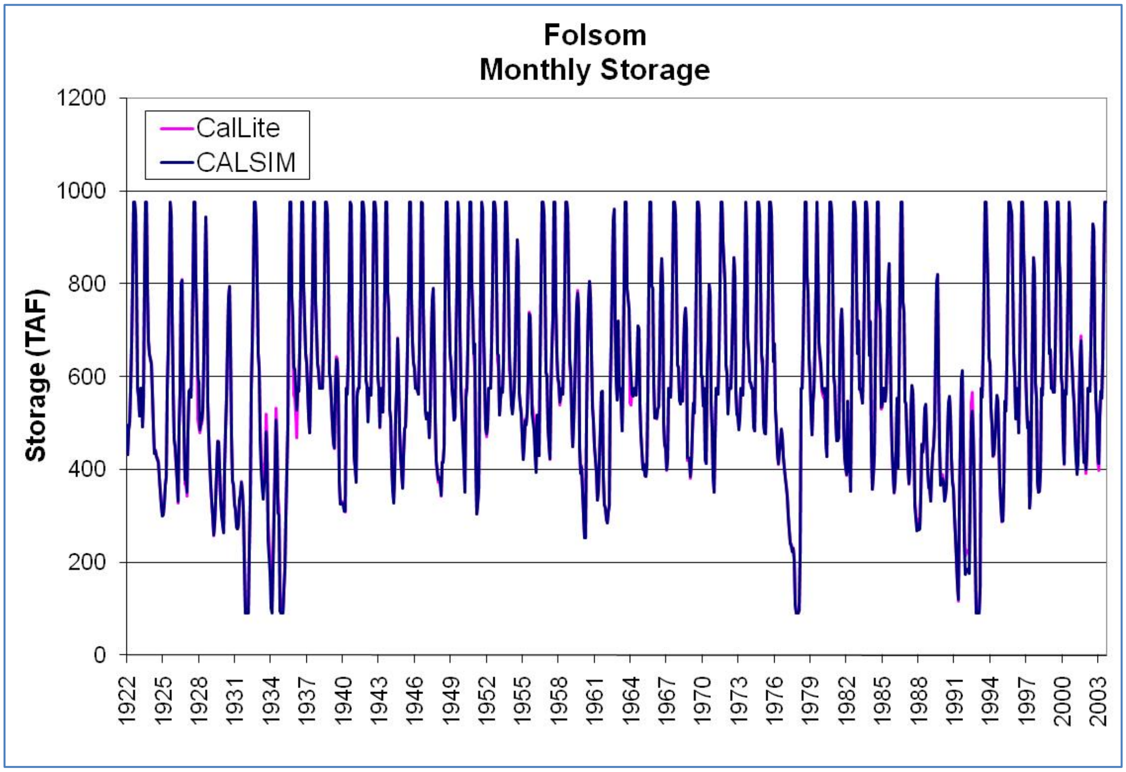


Figure 29. Folsom Reservoir storage for CalLite and CalSim II BO RPA simulations.

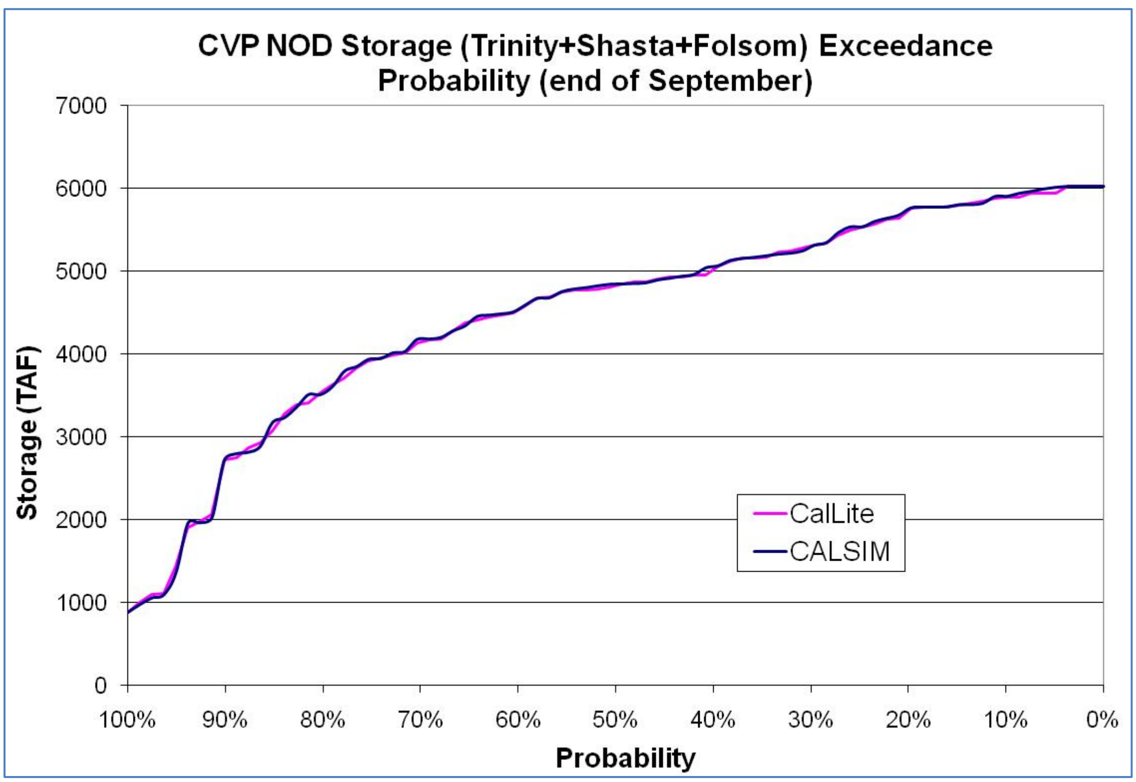


Figure 30. CVP north of Delta end of September storage exceedance probability for CalLite and CalSim II BO RPA simulations.

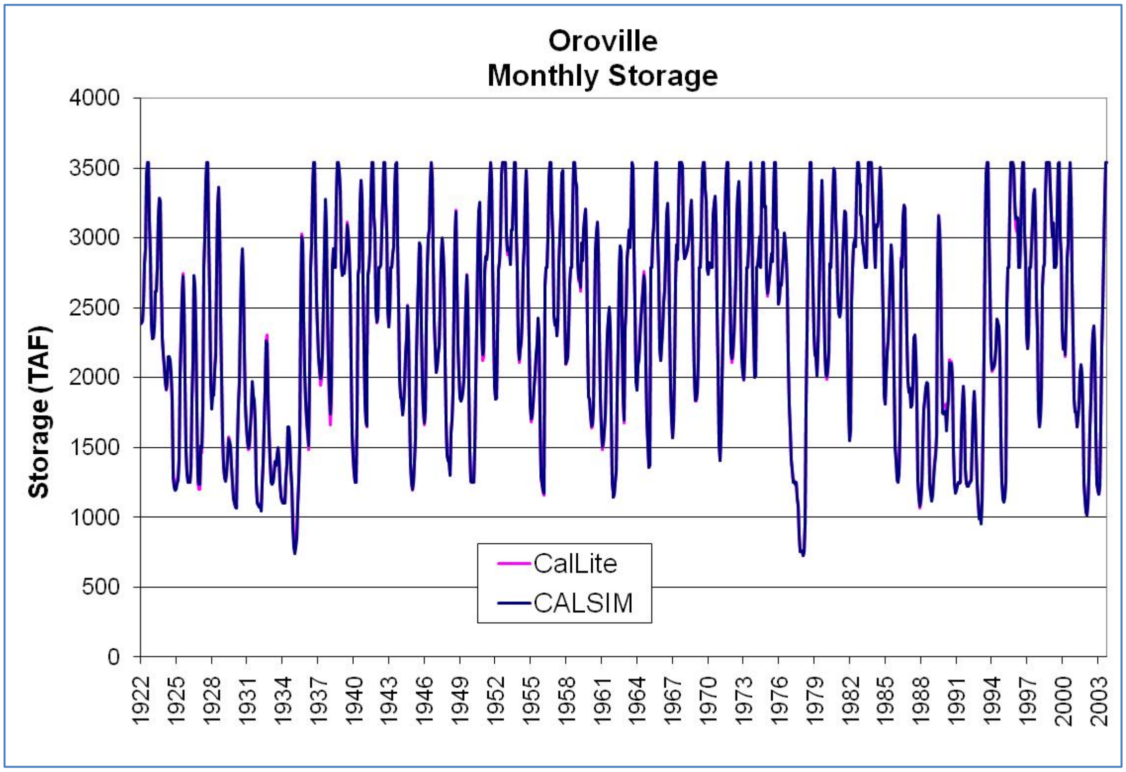


Figure 31. Oroville Reservoir storage for CalLite and CalSim II BO RPA simulations.

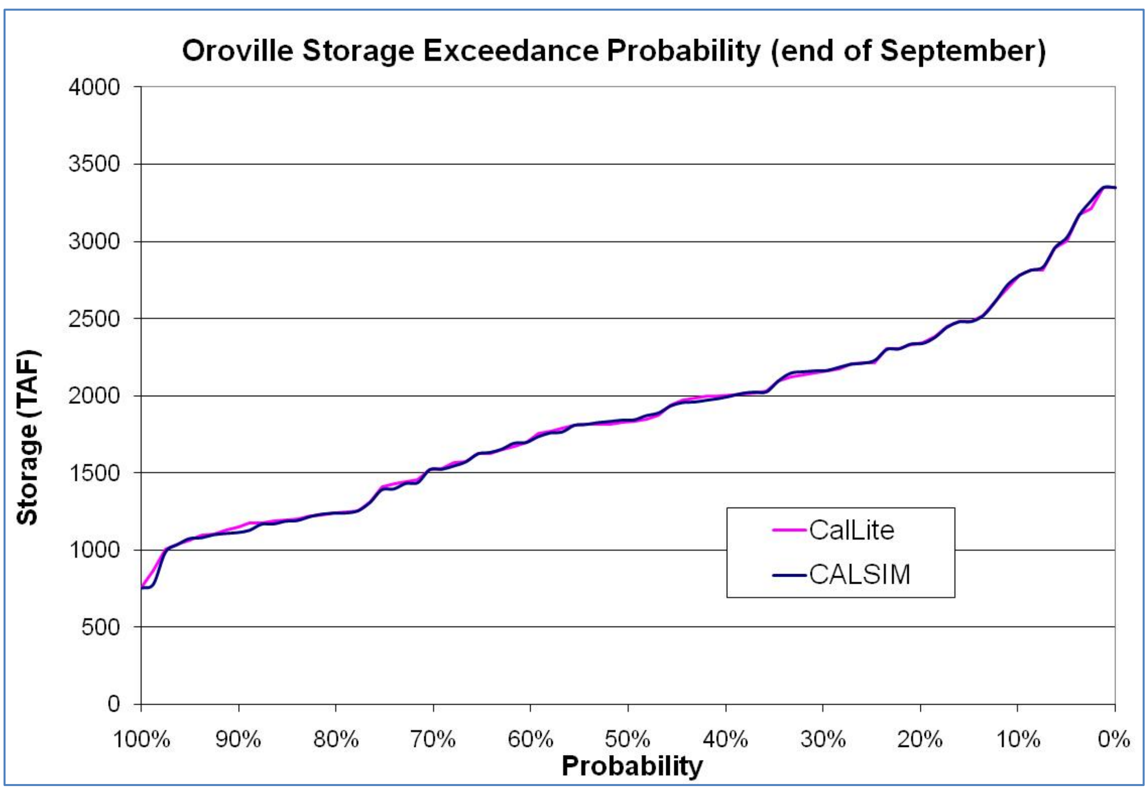


Figure 32. Oroville end of September storage exceedance probability for CalLite and CalSim II BO RPA simulations.

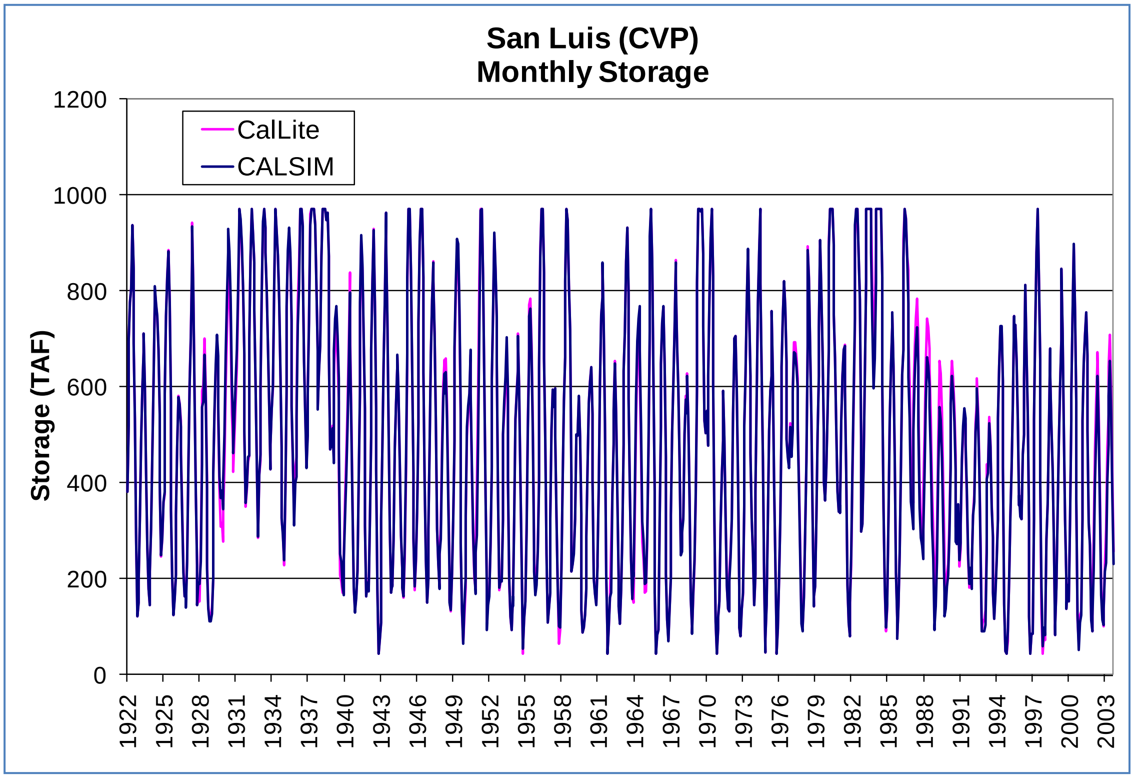


Figure 33. CVP San Luis storage for CalLite and CalSim II BO RPA simulations.

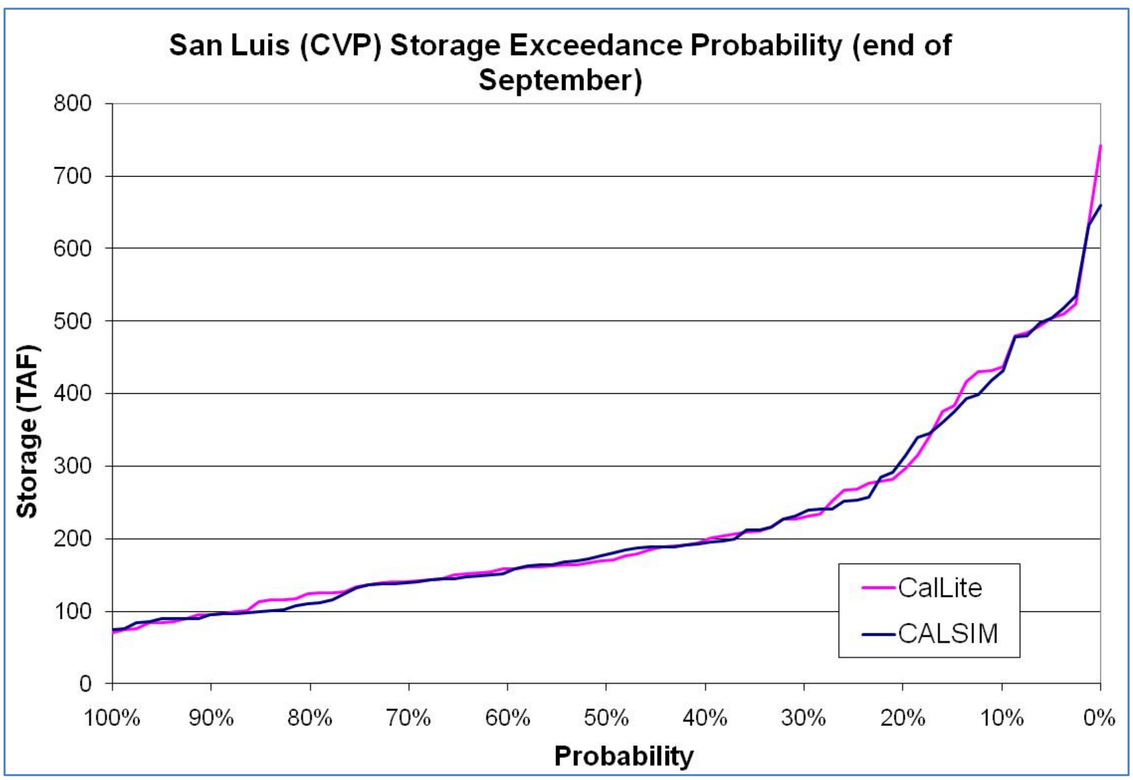


Figure 34. CVP San Luis end of September storage exceedance probability for CalLite and CalSim II BO RPA simulations.

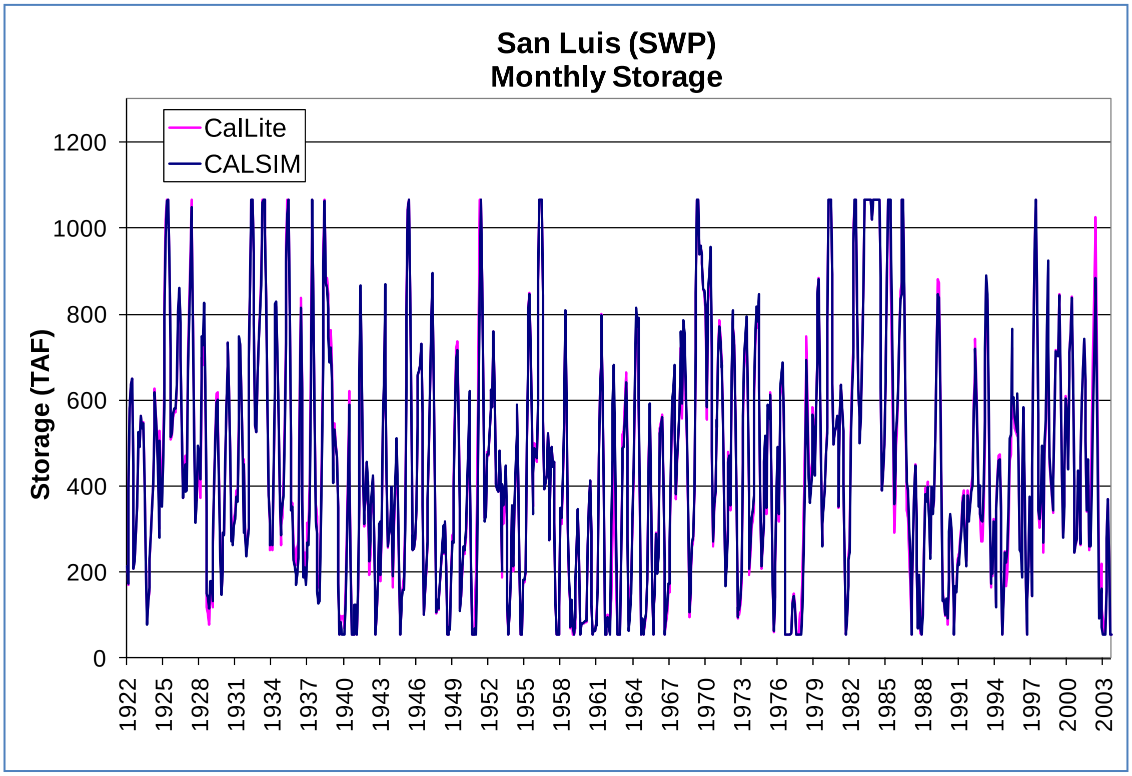


Figure 35. SWP San Luis storage for CalLite and CalSim II BO RPA simulations.

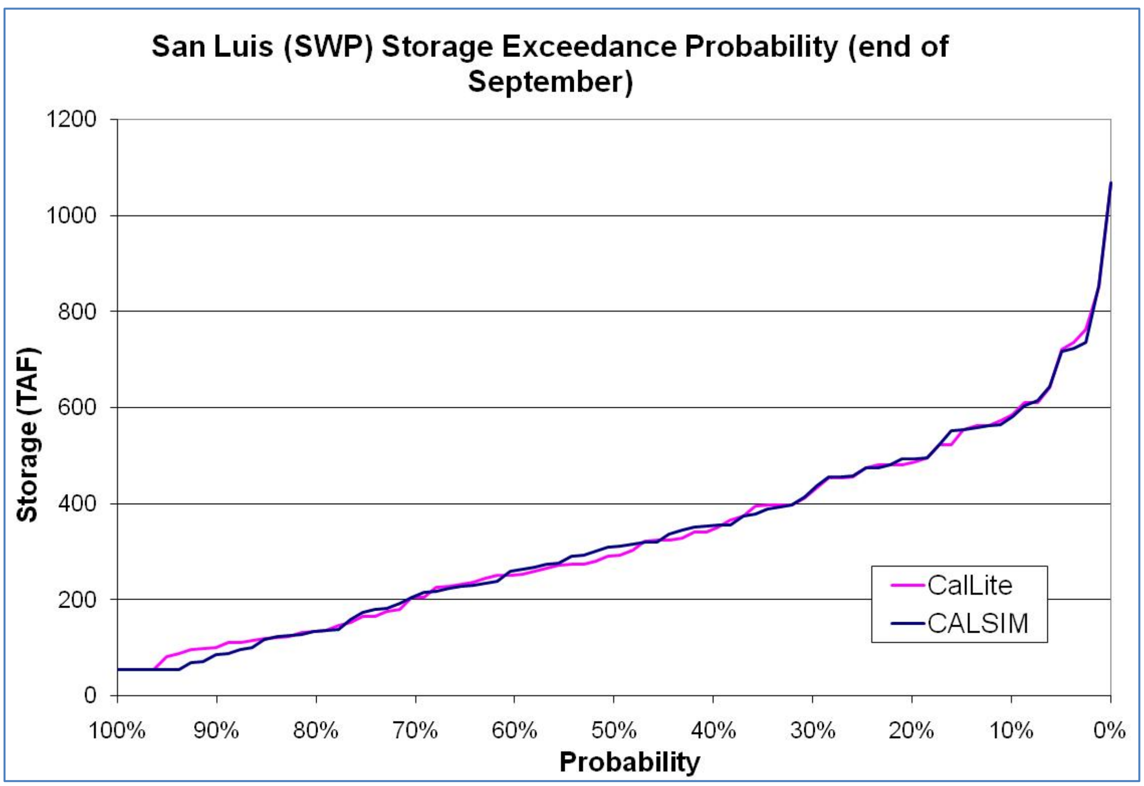


Figure 36. SWP San Luis end of September storage exceedance probability for CalLite and CalSim II BO RPA simulations.

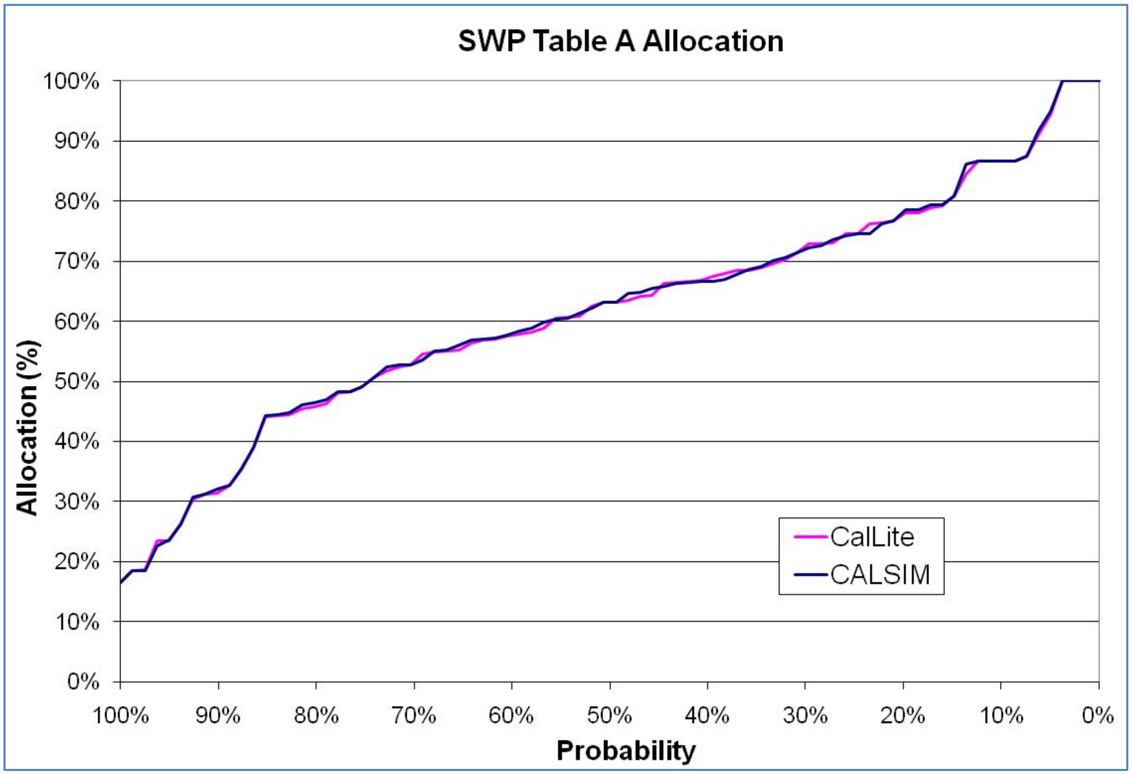


Figure 37. SWP Table A allocation exceedance probability for CalLite and CalSim II BO RPA simulations.

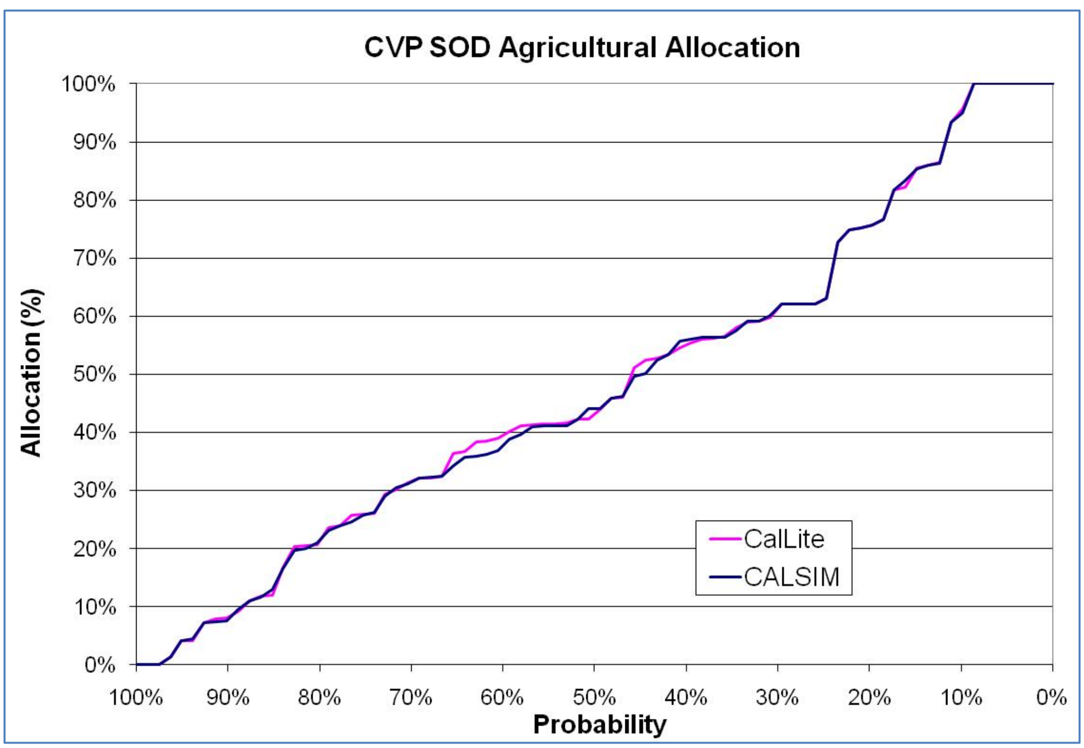


Figure 38. CVP south-of-Delta agricultural water contractor allocation exceedance probability for CalLite and CalSim II BO RPA simulations.

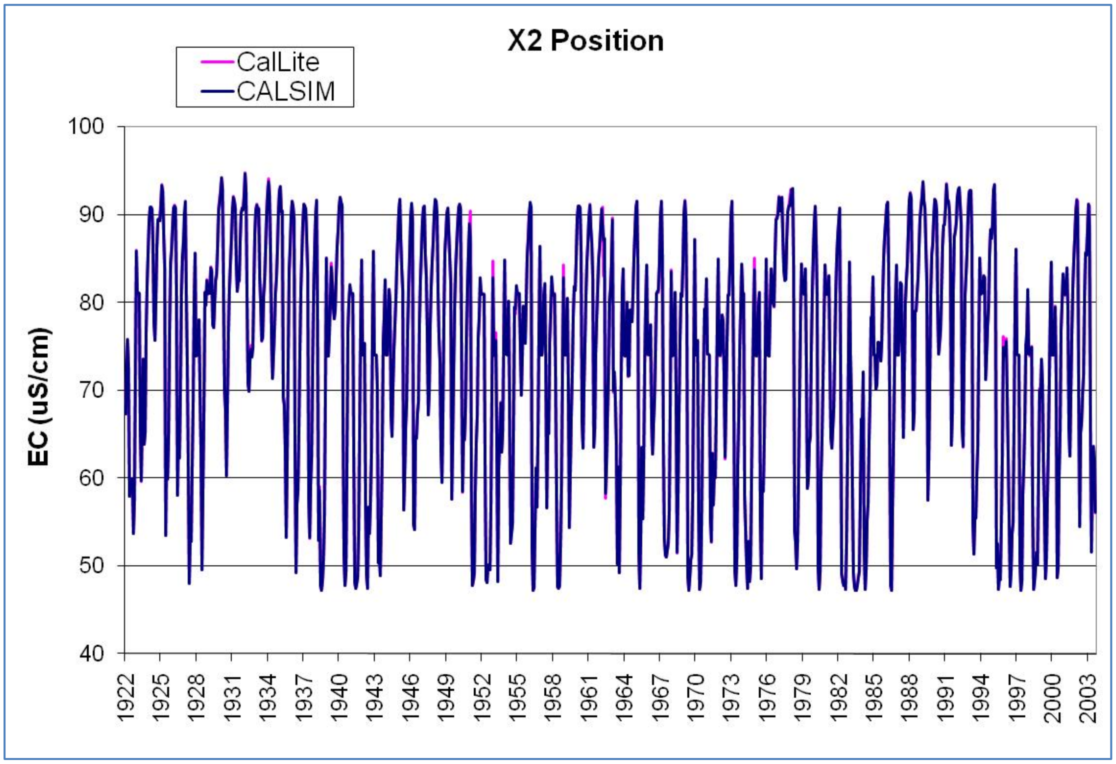


Figure 39. X2 position for CalLite and CalSim II BO RPA simulations.

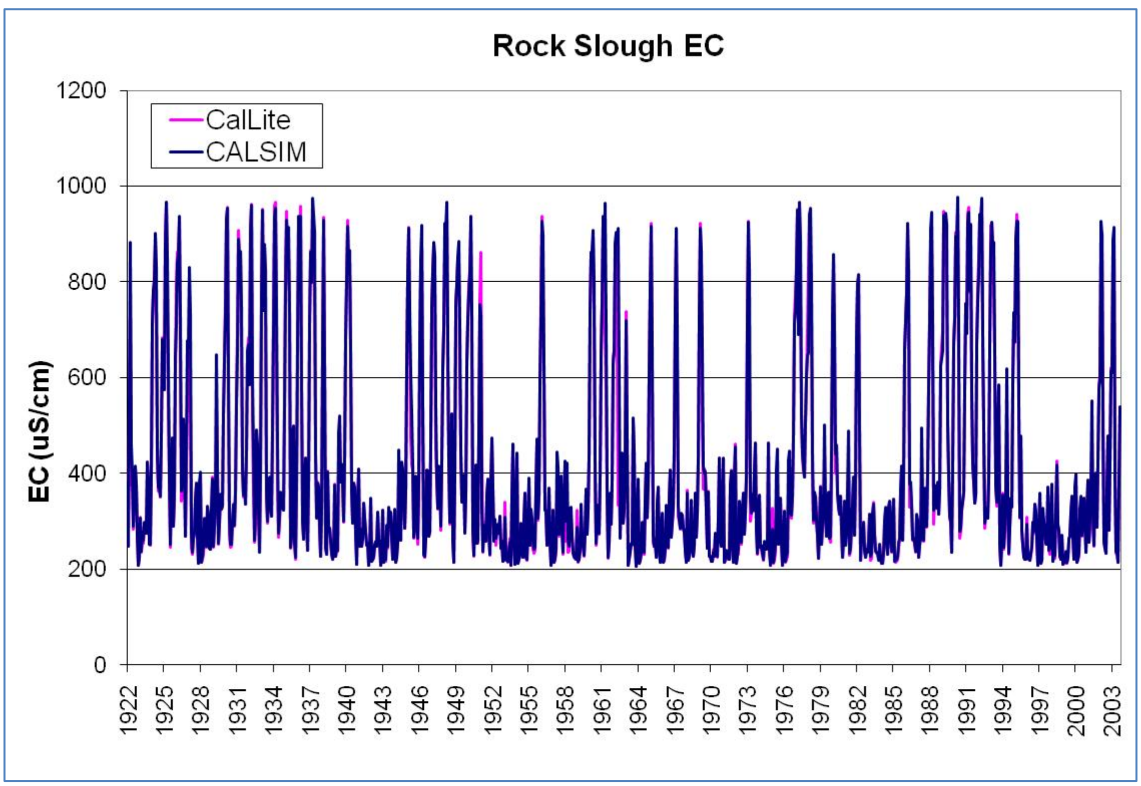


Figure 40. Old River at Rock Slough salinity for CalLite and CalSim II BO RPA simulations.

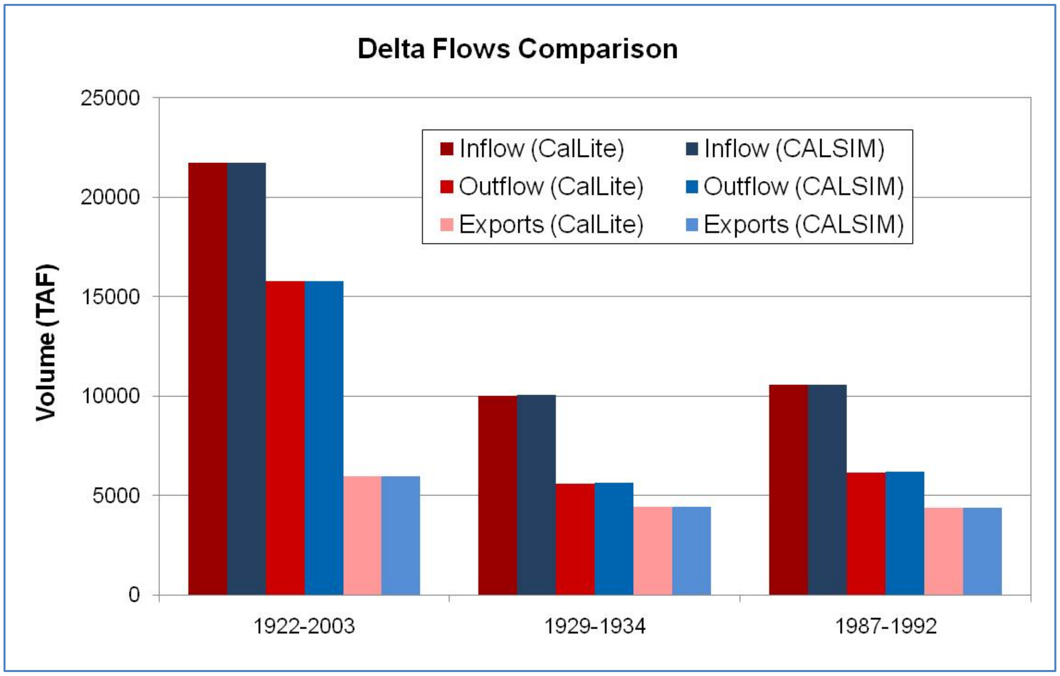


Figure 41. Delta period average flows for CalLite and CalSim II BO RPA simulations.

8.3 Discussion of CalSim II vs CalLite Comparisons

To reiterate, this section is provided from the CalLite Reference manual v2.00, released October 2011. While the summary numbers have not been updated to match the model being released under version 3.00, the relative comparison of results remains similar.

The comparisons above show a very close correspondence between CalLite v2.01 and CalSim II model results. Long-term average Delta inflows and outflows, CVP and SWP exports, and flows in the Trinity, Sacramento, Feather, and American Rivers are almost identical between the two models, all differing by far less than 1 percent (see Table 5 and Table 6). Differences for these same parameters are also very small during the 1929-1934 and 1987-1992 dry periods, almost always less than 1 percent and never more than 2 percent. The only outputs that differ by more than 2 percent are outputs involving relatively small volumes of water, such as CVP pumping at Banks and SWP Article 21 and 56 deliveries.

CalLite simulated storage for CVP reservoirs (Trinity, Shasta, and Folsom) and the SWP's Oroville reservoir show a very good match with that simulated by CalSim II (see Figure 12 to Figure 17 and Figure 27 to Figure 32). The model results are very similar both in terms of monthly storage patterns and also end-of-September storage exceedance graphs. Simulated San Luis storage in CalLite for both the SWP and CVP also matches the results of CalSim II (see Figure 18 to Figure 21 and Figure 33 to Figure 36), though there is a little more difference here than for the other reservoirs.

Allocation percentages for SWP and CVP contractors are very close, showing that both models are equally aggressive or conservative regarding delivery allocations (see Figure 22, Figure 23, Figure 37, and Figure 38).

Delta flows and exports drive the results for X2 and salinity conditions. The X2 position results from CalLite also compare well to those in CalSim II (see Figure 24 and Figure 39). Salinity comparisons at various stations in the Delta indicate that the ANNs respond identically to the external boundary conditions (Figure 25 and Figure 40). Figure 26 and Figure 41 compare Delta inflows, outflows, and exports for the two models, which are also very close.

9 Model and Data Limitations

CalLite is intended as a screening model for Central Valley water management. Compared to CalSim II, CalLite is a simplified model and much of the complexity of the system has been aggregated. CalLite captures the most prominent aspects of the Central Valley hydrology and system operations, but simulated hydrology and water management within specific sub-basins has limited detail. As such, it is important to understand the limitations of the model when applying CalLite for Central Valley water management screening. The following are some limitations or sources of uncertainty when using CalLite.

- Like CalSim II, CalLite runs on a monthly time step, so it cannot simulate phenomena that occur at finer time scales.

- Return flows and surface water–groundwater interactions are not simulated dynamically. The effects of these processes are implicitly contained in the accretion/depletion terms derived from CalSim II results (see Appendix A). Because these terms are fixed, CalLite scenarios whose assumptions vary from the CalSim II study used to develop the accretion/depletion terms may have a greater level of error in these terms.

- The simplified schematic omits much of the hydrologic detail present in the larger CalSim II model.

- The model is designed to simulate CVP and SWP operations under conditions that are reasonably close to current conditions in terms of system facilities, operational rules, and regulations. But CalLite allows the user to significantly change some aspects of the system, particularly regulations, South-of-Delta demands, and allocation methods. While such flexibility is desirable for a screening model, the user should be aware that model error may increase as CalLite settings move further away from current system conditions and that simulations with assumptions that are drastically different from current conditions may produce counterintuitive results.

10 On-Going and Future Developments

This document has described the features of CalLite Version 3.00, including options for Delta standards, simulating sea level rise, Biological Opinion actions and innovative GUI features. The next development phase of CalLite will add storage and conveyance alternatives, habitat restoration, and conjunctive use. A final addition will be improved allocation procedures. Reclamation and DWR are currently refining the methodology for delivery allocation to include forecast information that is consistent with that used by the Reclamation Central Valley Operations Office (CVO) and the DWR Operation and Maintenance Division (O&M).

In addition to these near-term CalLite refinements, DWR and Reclamation expect to utilize and develop the CalLite and CalSim II models in tandem. Features and operations initially explored using CalLite in interactive sessions with operators and stakeholders may eventually be transferred to the more detailed CalSim II model. Similarly, the development and refinement of the CalSim II model will continue to support many planning efforts, and periodically the hydrology and operating criteria in CalLite may need to be re-synchronized with CalSim II, if applicable. It is recommended that a review of the two models be performed annually, or at significant release points, to determine whether revisions to either model are warranted.

The CalLite modeling platform could also permit loose integration with a number of more detailed models of specific resource areas. The current integration with the flow-salinity ANNs is a good example. In this example, the hydrodynamics and water quality response of the DSM2 model is loosely coupled to CalLite through the use of the ANN. Other models, or response functions based on these models, could be coupled to allow simulation of groundwater conditions (C2VSIM model); power generation, consumption, and greenhouse gas emissions (LTGEN model); salmon life-cycle and mortality analysis, and regional economics (LCPSIM model).

Currently, CalLite simulations are deterministic in nature. In the future, the model will be adapted to run in probabilistic and position analysis mode to perform stochastic and Monte Carlo type simulations. Stochastic analysis would be particularly useful in CalLite because results obtained from several hundred stochastic runs could be compiled in a relatively short period of time. Stochastic analysis is common practice in simulating climate change scenarios. Finally, CalLite will be adapted to use an alternative daily time step. The objectives of this implementation are: (1) to simulate daily reservoir releases (optimized for minimum flow required for fish and water quality, and for flood control downstream); (2) to simulate weir flows at a daily time step; and (3) to simulate SWP/CVP Delta operations (export and delta cross channel) at a daily time-step.

11 References

Bay Delta Conservation Plan (BDCP). 2012. *BDCP EIR/EIS Modeling Technical Appendix*. 5th Revision. Website: http://baydeltaconservationplan.com/Home.aspx

California Department of Water Resources (DWR). 2000a. *CalSim Water Resources Simulation Model Manual*. Sacramento, Calif.

California Department of Water Resources (DWR). 2000b. *CalSim Water Resources Simulation Model WRESL Language Reference*. Sacramento, Calif.

California Department of Water Resources (DWR). 2009. *Common Assumptions Common Model Package.* Sacramento, Calif.

California Department of Water Resources (DWR). 2011 (web access date). *WRIMS 1 Model Engine and CalSim 2 Model.* Website: http://baydeltaoffice.water.ca.gov/modeling/hydrology/CalSim/index.cfm

Draper, A., Munévar, A., Arora, S., Reyes, E., Parker, N., Chung, F. and Peterson, L. 2004. CalSim II: Generalized Model for Reservoir System Analysis. *ASCE Journal of Water Resources Planning and Management* 130(6): 480-489.

Fish and Wildlife Service (FWS). 2008. Biological Opinion on the Long-Term Operational Criteria and Plan for Coordination of the Central Valley Project and State Water Project.

Islam, N., Arora, S., Chung, F., Reyes, E., Field, R., Munévar, A., Sumer, D., Parker, N., Chen, Z. 2011. CalLite: California Central Valley Water Management Screening Model. *ASCE Journal of Water Resources Planning and Management* 137(1): 123-133.

Munévar, A. and Chung, F. 1999. Modeling California's Water Resource Systems with CalSim II. *American Society of Civil Engineers Water Resources Planning and Management Conference Proceedings*, Tempe, AZ.

National Marine Fisheries Service (NMFS). 2009. *Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project.*

State Water Resources Control Board (SWRCB). 1995. Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Sacramento, Calif.

State Water Resources Control Board (SWRCB). 1999. *Water Right Decision 1641.* Sacramento, Calif.

State Water Resources Control Board (SWRCB). 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. Sacramento, Calif.

Appendix A Hydrology Development Documentation

The purpose of this appendix is to provide information regarding the assumptions and development of the hydrology inputs to CalLite. A useful reference on CalSim assumptions, many of which are replicated in CalLite, is the report on the Common Assumptions Common Model Package (Version 9B) (DWR 2009).

A.1 General Approach

A.1.1 Introduction

Because the CalLite schematic is greatly simplified compared to CalSim II, CalLite input hydrology is also aggregated and simplified. Figure 42, Figure 43, and Figure 44 (at the end of this appendix) show the CalLite schematic. Sub-sections of the CalSim II schematic and the corresponding section in CalLite are shown in Figure 45 through Figure 53 (at the end of this appendix). CalLite's hydrologic inputs were prepared by mapping CalSim II hydrology to the CalLite schematic as shown in these figures and described in the rest of this appendix.

The major CVP/SWP reservoirs of the Central Valley (Shasta, Trinity, Whiskeytown, Oroville, Folsom, and San Luis) are simulated in CalLite exactly as they are in CalSim II. Nodes on the CalLite schematic generally correspond to important controlling locations on the CalSim II schematic (e.g. locations where minimum flow requirements are enforced). CalSim II hydrology between those identified points was aggregated to match the CalLite nodes. Diversions pertinent to a segment in CalSim II are simulated as diversions from the relevant CalLite node. CVP/SWP project demands are simulated dynamically in CalLite, whereas non-project demands are included as "pre-operated" timeseries that are derived from a companion CalSim II study. For project deliveries, CalLite simulates the same detailed deliveries as CalSim II (listed in Table 16, Table 25, Table 26 and Table 27), but then aggregates them together to get the CalLite deliveries shown in the schematic.

CalSim II inflows, system losses/gains such as groundwater-surface water interaction, and return flows are combined to create the “local inflow” at each CalLite node. Figure 45 through Figure 53 show exactly which area of the CalSim II schematic corresponds to each CalLite node. CalSim II inputs and outputs are used to generate the net accretion/depletion within each of these areas, which is identified as the “local inflow” to the corresponding CalLite node. If the net flows contributing to a node result in a net depletion rather than accretion, then the “local inflow” may have a negative value. In the CalLite schematic and in the tables below, these accretion/depletion (AD) terms derived from CalSim II model outputs begin with the prefix "AD_". These terms make CalLite results as consistent as possible with CalSim II results by adjusting for differences in schematic detail between the two models.

A.1.2 Shortages in North of Delta Accretion/Depletion Terms

Under certain scenario assumptions, when reservoir releases are very low, CalLite is not able to generate a feasible solution which fully meets both the AD terms and the fixed non-project deliveries north of the Delta. In order to avoid this problem, CalLite will allow the AD terms to be "shorted", essentially adding more water to the system if that is the only way to generate a feasible solution. This is done by employing soft constraints which use very high penalties (negative weights) to strongly encourage AD terms to be fully met, but which will allow those terms to be shorted in the circumstances described above. Table 7 shows the 10 nodes where the AD terms can be shorted. If any of these terms have been shorted, CalLite will give a warning message at the end of the simulation and users can examine detailed shortage data (i.e. water volumes) on the Quick Results dashboard in the CalLite GUI.

Table 7. Shortage variables and locations.

Variable Name	Location
SHORT_AD_HST	Sacramento River at H Street
SHORT_AD_KSWCK	Sacramento River at Keswick
SHORT_AD_NIMBUS	Sacramento River at Nimbus
SHORT_AD_REDBLF	Sacramento River at Red Bluff
SHORT_AD_SACAME	Sacramento and American River confluence
SHORT_AD_SACFEA	Sacramento and Feather River confluence
SHORT_AD_THERM	Feather River at Thermalito
SHORT_AD_WILKNS	Sacramento and Wilkins Slough confluence
SHORT_AD_YOLOBP	Yolo Bypass
SHORT_AD_YUBFEA	Yuba and Feather River confluence

A.2 Modeled Level of Development

The hydrology input datasets used by CalLite Version 3.00 have been developed using the CalSim II 2005 and 2020 LOD hydrology from the Common Assumptions Common Model Package (Version 9B) (DWR 2009). CalSim II model outputs are also used for generating AD terms. The CalSim II study used for these outputs varies depending not only on LOD but also on whether the user selects a Biological Opinion (BO) or pre-BO or D-1485 run basis (available on the Run Settings dashboard). For a BO run basis the CalSim II study used is the one developed for analysis of the Bay Delta Conservation Plan, as of April 2010. The pre-BO run basis study has identical assumptions except that the BO Reasonable and Prudent Alternatives (RPAs) have been removed from the model. Appendix E lists all of the assumptions in these Calsim II studies. Input data for CalLite is prepared using the CS2CL tool, which uses the WRIMS 2 engine and WRESL code to convert CalSim II inputs and outputs (DV and SV DSS files) into CalLite inputs. See Section 3.2 and Appendix H for description of the CS2CL tool. If the user wishes to create CalLite inputs using CalSim II studies with different assumptions than those described here, the CS2CL tool can be used to do this.

A.3 Rim Basin Inflows

Rim basin inflows to CalLite are shown in Table 8, along with the CalSim II flow record used for each inflow. Inflows to north of Delta reservoirs are set equal to the equivalent CalSim II inflows as stored in the SV DSS file. Inflows to the Delta from Eastside streams, the San Joaquin River, and the Calaveras River are set equal to equivalent CalSim II output flows. Inflow to the Mendota Pool from James Bypass, Millerton Flood control releases, and agricultural return flows are set equal to CalSim II output. Inflow to the California Aqueduct from the Kern River is the same as CalSim II input flow.

Table 8. Model inflow locations and corresponding CalSim II flows.

Location	CalSim II Flow Arc(s)	CalLite Flow Arc(s)
Trinity Reservoir Inflow	I1	I_Trnty
Whiskeytown Reservoir Inflow	I3	I_Wyktn
Shasta Reservoir Inflow	I4	I_Shsta
Oroville Reservoir Inflow	I6	I_Orovl
Folsom Reservoir Inflow	I8+C300	I_Folsm
Yuba River Inflow	I230	I_Yuba
Inflow to Delta from Eastside Streams	C504	AD_Mokelumne
Inflow to Delta from San Joaquin River	C644	AD_SJR
Inflow to Delta from Calaveras	C508+R514A+R514B	AD_Calaveras
Inflow to Mendota Pool from James Bypass	I607+R607West+C605A+C605C	AD_JamesBP
Inflow to California Aqueduct from Kern River	I860	I_Kern

A.4 Local Inflows

Local inflows are also generated from the appropriate CalSim II study. As described earlier, each CalLite node corresponds to a section in the CalSim II schematic, and the local inflow at each CalLite node is equal to the sum of CalSim II inflows and outflows to that section. Any diversions that are dynamically determined (as opposed to pre-operated) in CalLite (e.g., CVP and SWP deliveries and Fremont and Sacramento weir spills) are removed from the local inflows. The following figures and tables illustrate CalLite hydrology development reach by reach.

A.4.1 Upper Sacramento River

The Upper Sacramento River representation in CalLite is illustrated in Figure 45 and the local inflow calculations are provided in Table 9. The Upper Sacramento River representation includes Trinity, Shasta, and Whiskeytown reservoirs and Lewiston Lake, Keswick Dam, and Red Bluff Diversion Dam

(RBDD) as nodes. Lewiston Lake is simulated as a node on the Trinity River. The node is connected to Whiskeytown Lake via Clear Creek Tunnel. Whiskeytown Lake is connected to the downstream node (Red Bluff) through Clear Creek and to the Keswick Reservoir through Spring Creek Tunnel. Trinity River exports are transferred to Keswick Reservoir through these two tunnels. The next node downstream is the Red Bluff node, since it is the diversion point of the Tehama-Colusa Canal (TCC) and the Corning Canal.

This CalLite node corresponds to a section in the CalSim schematic that extends from downstream of Whiskeytown Lake and Keswick Dam (C3 and C5 arcs in CalSim II) to the RBDD (node 112). The corresponding CalSim schematic area also includes the TCC and Corning Canal so that all demands are lumped at the Red Bluff node in CalLite.

Table 9. Upper Sacramento River local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Inflow	Project Diversion*	Local Inflow
Reservoirs			
Shasta	I4 (I_Shsta)		
Trinity	I1 (I_Trnty)		
Whiskeytown	I3 (I_Wkytn)		
Nodes (labeled)			
Red Bluff		Diversion to WBA 4--Corning Canal, WBA 4--Kirkwood, WBA7N, WBA7S (D_RedBlfP)	C112-C5-C3+D104+D112 (AD_RedBlf)
Keswick			C5-D3-C4 (AD_Kswck)
Lewiston			I100 (I_Lewiston)
*All diversions constrained by contract allocation and consumptive use requirements			

A.4.1.1 Keswick

AD_Kswck = C5-D3-C4. This AD term is calculated from a mass balance of inflows (release from Shasta Dam, inflow from Spring Creek Tunnel) and outflows (release from Keswick Dam). CalLite does not dynamically simulate storage and evaporation at Keswick Reservoir. CalSim II typically maintains storage at a constant level of 23.80 TAF. CalSim II storage may drop to 16.30 TAF (Level 3) or 0.01 TAF (Level 1) during critical periods.

A.4.1.2 Red Bluff

AD_RedBlf = C112-C5-C3+D104+D112. This AD term is calculated from a mass balance along the Sacramento River from Keswick Dam (node 5) to Red Bluff Diversion Dam (node 112). CalLite dynamically simulates CVP diversions to both settlement contractors and water service contractors and explicitly represents non-project diversions from tributaries to the Sacramento River (D104_NP); all other flow components are pre-processed based on CalSim II input or output and folded into the CalLite AD term. These pre-processed flows include: (i) stream losses to groundwater (GS60); (ii) tributary inflows including Cow Creek, Battle Creek, Cottonwood Creek and Paynes Creek; (iii) return flows from agricultural and urban return flows. D_RedBlf consists of both project and non-project components. The non-project component (D_RedBlfNP) is pre-processed using CalSim II arc D104_NP.

A.4.2 Colusa Basin

Wilkins Slough was selected as the controlling node since it has the Navigation Control Point minimum instream flow requirement and it is a suitable location to lump Colusa Basin demands. As seen in Figure 46, the corresponding CalSim II schematic area includes all of the Glenn-Colusa Canal (GCC) Irrigation District demands. Moulton, Colusa, and Tisdale are within that area but are not modeled explicitly in CalLite, instead they are part of the AD term. Table 10 represents the local inflow calculations within the Colusa Basin representation in CalLite.

Table 10. Colusa Basin local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Diversion*	Local Inflow
Nodes (labeled)		
Red Bluff	Diversion to WBA 4--Corning Canal, WBA 4--Kirkwood, WBA7N, WBA7S (D_RedBlfP)	C112-C5-C3+D104+D112 (AD_RedBlf)
Wilkins Slough / Navigation Control Pt	Diversions to WBA 8NN, WBA 8NS, WBA 8S, and DSA 15 Eastside, Sacramento Wildlife Refuge, and Colusa/Delevan Refuges, WBAs 9, 18, 19 (D_WilknsP)	C129 - C112 + D113A + D113B + D114 + D122A + D122B + D128 + D129A (AD_Wilkns)
*All diversions constrained by allocation and consumptive use requirements		

A.4.2.1 Wilkins Slough

AD_Wilkns = C129-C112+D113A+D113B+D114+D122A+D122B+D128+D129A. This AD term is calculated from a mass balance along the Sacramento River from the Red Bluff Diversion Dam (node 112) to Wilkins Slough (which is used to represent the Navigation Control Point). CalLite dynamically simulates CVP diversions to settlement contractors along this reach; all other flow components are pre-processed based on CalSim II input or output. These pre-processed flows include: (i) stream losses to groundwater (GS63); (ii) tributary inflows including Mill Creek, Deer Creek, Big Chico Creek, Elder Creek, Thomes Creek and Stony Creek; and (iii) return flows from agricultural and urban return flows; (iv) weir spills to the Butte basin (D117) and Sutter basin (D124, D125, D126).

D_Wilkns includes both project and non-project components. The non-project component (D_WilkinsNP) is pre-processed using CalSim II arcs D113A and D113B. These represent Sacramento River diversions; non-project diversions from tributaries to the Sacramento River are included in the AD term (AD_Wilkns).

CalLite does not simulate storage regulation and diversions from Stony Creek. The net inflow to the Sacramento River is part of the AD term (AD_Wilkns). Diversions from Stony Creek into the Tehama-Colusa Canal are also lumped into the AD term, and these diversions are considered when calculating demand for Sacramento River diversions.

Pre-processing of Colusa Basin Drain inflows make it unnecessary for CalLite to dynamically simulate drain diversions through Knights Landing Ridge Cut during high flow conditions in the Sacramento River.

A.4.3 Lower Sacramento River

The lower Sacramento River representation includes the Sacramento River- Feather River and Sacramento River – American River confluences as well as the Yolo Bypass. The Fremont and Sacramento Weirs are simulated dynamically and spill water to the Yolo Bypass depending on river flows and rating curves as in CalSim II. Figure 47 illustrates the Lower Sacramento River representation and Table 11 represents related local inflow calculations.

Table 11. Lower Sacramento River local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Diversion*	Local Inflow
Nodes (labeled)		
SacFeather	Diversion to Yolo Bypass via Fremont Weir (D_FreWeir)	C160-C129-C223+D160 (AD_SacFea)
SacAmerican	Diversions to Yolo Bypass, DSA 65 Settlement Contractors, City of Sacramento, DSA 70 Settlement Contractors, and SCWA (D_SacAmeP)	C169-C160-C303+D166A+D162 +D163_PRJ+D165+D167 (AD_SacAme)
Yolo Bypass		C156 (AD_YoloBP)
*All diversions (except bypass diversions) constrained by allocation and consumptive use requirements		

A.4.3.1 Confluence of the Sacramento and Feather Rivers

AD_SacFea = C160-C129-C223+D160. This AD term is calculated from a mass balance along the Sacramento River from Wilkins Slough to the confluence with the Feather River. This AD term includes inflow from the Colusa Basin Drain (C184A), irrigation return flows from RD108 and River Garden Farms (R134), flood flows returning to the river via the Sutter Bypass, irrigation return flows from the Sutter Basin returning to the river via RD 1500, inflow from Butte Creek via the Sutter Bypass; and flows from managed wetlands in the Butte and Sutter sinks.

A.4.3.2 Confluence of the Sacramento and American Rivers

AD_SacAme = C169-C160-C303+D166A+D162+D163_PRJ+D165+D167. This AD term is calculated from a mass balance along the Sacramento River from Fremont Weir/Feather River confluence (node 160) and Freeport (node 169). This AD term includes: (i) depletions in Yolo and Solano counties (D163_gain); (ii) agricultural and urban return flows (R169); (iii) water diverted from the Bear River that is not depleted through irrigation. The formula does not include D168 (diversions at Freeport) since those are not modeled dynamically.

A.4.3.3 Yolo Bypass
AD_YoloBP = C156. This AD term represents the inflow to the Delta from the Yolo Bypass, excluding the Fremont and Sacramento weir spills that are represented explicitly in CalLite. The AD term includes net inflows from Cache Creek and Putah Creek, and agricultural and urban return flows. It also includes flows diverted from the Colusa Basin through the Knights Landing Ridge Cut that are not subsequently depleted for irrigation.

A.4.4 Feather River

The Feather River representation in CalSim II is scaled down to four nodes in CaLite: Lake Oroville, Thermalito Complex, Feather River – Yuba River confluence and Feather River – Sacramento River confluence. The minimum instream flow requirement below Thermalito is applied at both Thermalito and Feather River - Yuba River confluence. Figure 48 and Table 12 summarize the Feather River representation and hydrology calculations for CalLite input.

Table 12. Feather River local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Inflow	Diversion*	Local Inflow
Reservoirs			
Oroville	I6 (I_Orovl)	Diversion to Palermo Canal (D_OrovlP)	
Nodes (labeled)			
Thermalito		Diversions to Western Canal, Joint Board, Butte County, Thermalito ID, Gray Lodge, and Butte Sink Duck Clubs (D_ThermP)	C203 -C6 +D201 +D202 +D7A +D7B (AD_Thermalito)
YubaFeather		Diversions to DSA69 (Yuba City, Feather WD, and misc. FRSA) (D_YubFeaP)	C223 -C203 -C230 +D204 +D206A +D206B +D206C (Ad_YubFea)
*All diversions constrained by allocation and consumptive use requirements			

A.4.4.1 Thermalito
AD_Therm = C203-C6+D201+D202+D7A+D7B. This AD term is calculated from a mass balance on the Power Canal, Thermalito Forebay and Afterbay and the Feather River low flow channel. This AD term includes: (i) return flow from the Kelly Ridge powerhouse; (ii) effects of storage regulation and evaporation in the Thermalito Afterbay. CalLite does not dynamically simulate storage and evaporation at in the Afterbay. CalSim II typically maintains storage at a constant level of 55.00 TAF. CalSim II storage may drop to 30.00 TAF (Level 2), or 15.10 (Level 1) during critical periods.

A.4.4.2 Confluence of the Yuba and Feather Rivers
AD_YubFea = C223-C203-C230+D204+D206A+D206B+D206C+D207A. This AD term is calculated from a mass balance along the Feather River from Thermalito Afterbay release to the river's mouth near Verona. It includes inflow from the Bear River (C282), but not those from the Yuba River. The AD term also includes stream losses to groundwater (GS65). All diversions from the Feather River are treated as project diversions in CalLite and are modeled dynamically.

A.4.5 Yuba River

Daguerre Point Diversion Dam on the lower Yuba River was selected as a CalLite node. Simulated minimum instream flow requirements downstream of this node correspond to flow requirements specified at the USGS Marysville gage. The lower Yuba River inflow at Daguerre Point is the same timeseries inflow as is used in CalSim (I230). Figure 49 and Table 13 summarize the Yuba River representation in CalLite.

Table 13. Yuba River local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Inflow	Diversion	Local Inflow
Nodes (labeled)			
DaguerrePt	I230 (I_Yuba)	Diversion to YCWA (D_DaguerP)	

A.4.6 American River

Folsom Lake, Lake Natoma, and H Street comprise the three nodes on the American River. Folsom is included as a reservoir since its operation is simulated dynamically in CalLite, while Lake Natoma (Nimbus Dam) is represented as a simple river node since it primarily serves as a re-regulating reservoir. The H Street node in CalLite represents nodes 301, 302, and 303 of CalSim II model. City of Sacramento diversions are included within this node. While the project demands are modeled dynamically, non-project (water rights) demands are included as time series from CalSim II. Both demand types are excluded from local inflow calculations. Figure 50 illustrates the American River representation and Table 14 represents related local inflow calculations.

Table 14. American River local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Inflow	Diversion*	Local Inflow
Reservoirs			
Folsom	I8+C300 (I_Folsm)	Diversions to DSA 70 (City of Folsom, SJWD, EID, and City of Roseville) (D_FolsmP)	
Nodes (labeled)			
Nimbus		Diversions to SMUD export and CA Parks and Rec (D_NimbusP)	C9-C8+D9 (AD_Nimbus)
H St			C303-C9+D302 (AD_HSt)
*All diversions constrained by allocation and consumptive use requirements			

A.4.6.1 Folsom

I_Folsm = I8 + I300. Similar to CalSim II, but CalLite contains no representation of the North Fork of the American River upstream of Folsom Lake. Non-project diversions (D_FolsmNP) include water rights holders whose diversions are not affected by CVP allocation logic. This includes all or part of the diversions to the cities of Folsom and Roseville, San Juan Water District and El Dorado Irrigation District. In CalSim II these diversions are represented by arc D8_NP.

A.4.6.2 Nimbus
AD_Nimbus = C9-C8+D9. This AD term is calculated from a mass balance of inflows (release from Folsom Dam) and outflows (release from Nimbus Dam, diversion to Folsom South Canal). CalLite does not dynamically simulate storage and evaporation at Lake Natoma. CalSim II typically maintains storage at a constant level of 8.80 TAF. CalSim II storage may drop to 6.50 TAF (Level 3) or 1.75 TAF (Level 1) during critical periods. Diversions at Nimbus represent deliveries via the Folsom South Canal. These include deliveries to the Golden State Water Company, California Parks and Recreation, SMUD (Rancho Seco Power Plant), and several agricultural districts in southern Sacramento County (Omuchumne-Hartnell Water District, Galt Irrigation District, and Clay Water District).

A.4.6.3 H Street
AD_HSt = C303-C9+D302. This AD term represents stream losses to groundwater (GS66) and storm runoff to the lower American River downstream of Nimbus Dam (I302). The diversion at HSt (D_HStNP) represents diversions by the City of Sacramento at its Fairburn plant and by Carmichael Water District for its Bajamont water treatment plant. These diversions are pre-processed in CalLite. Diversions by the City of Sacramento are limited according to the Water Forum Agreement.

A.4.7 The Sacramento - San Joaquin River Delta

CalLite's representation of the Delta retains the same level of detail present in CalSim II. Some nodes represent specific places in the Delta while others represent general areas into which the Delta's consumptive use was subdivided. Nodes are included for Hood, Delta Cross Channel, Sacramento River at North Delta, Brannan Island, and Rio Vista, Mokelumne, Terminous, San Joaquin River at Vernalis, Calaveras, Stockton, Central Delta, Medford Island, and Venice Island, Sacramento and SJR confluence, West Delta, Rock Slough, Coney Island, Jones Pumping Plant, and Banks Pumping Plant (see Figure 51). D-1641 specifies minimum instream flow requirements at Rio Vista and for Delta outflow, and the FWS and NMFS Biological Opinions specify minimum instream flow requirements for Old and Middle Rivers. Table 15 shows the local inflow calculations within the Delta.

Table 15. Delta local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Inflow	Diversion	Local Inflow
Nodes (labeled)			
Hood	I_400 (I_Hood)	dem_D400B (D_Hood_NP)	
North Bay Aqueduct		Diversions to Vallejo, Napa, Solano, and FVB (D_Vallejo, D_Napa, D_Solano, D_FVB)	
Brannan Island	I404 (I_BrananIS)	dem_D404 (D_BrananIs_NP)	
Sac SJR confluence	I406 (I_MarshCr) I406B (I_SacSJR)	dem_D406 (D_SacSJR_NP), dem_D406B (D_Antioch_NP)	
Medford Island	I410 (I_MedfordIS)	dem_D410 (D_MedfordIS_NP)	
Mokelumne			C504 (AD_Mokelumne)
Terminous	I413 (I_Terminous)	dem_D413 (D_TerminousP)	
Vernalis			C644 (AD_SJR)
Calaveras			C508+R514A+R514B – D514A – D514B (AD_Calaveras)
Stockton	I412 (I_Stockton)	dem_D412 (D_Stockton_NP)	
Coney Island	I409 (I_ConeyIS)	dem_D409B (D_ConeyIS_NP)	
Banks PP	I419 (I_CVCWheel)		

A.4.8 South of Delta Export Area

Figure 52 and Figure 53 contain the CalLite schematic for the CVP and SWP south of Delta export area. The Delta Mendota Canal starts at Jones Pumping Plant in the Delta and flows south to O'Neill Forebay and San Luis Reservoir. From there, it continues to the Mendota Pool. The California Aqueduct begins at Banks Pumping Plant and flows south to O'Neill Forebay and San Luis Reservoir and continues to the southern San Joaquin Valley and Southern California. The canals in the CalLite schematic are divided into sections based on canal capacity constraints relative to specific points of diversion. San Luis Reservoir is dynamically operated within CalLite. Storage diversions and releases at the SWP terminal reservoirs (Del Valle, Silverwood, Perris, Pyramid, and Castaic) are pre-processed by CalSim II and input into CalLite as diversion and inflow arcs. The diversions and local inflows in the south of Delta export area are listed in Table 16.

Table 16. South of Delta local inflow calculation and diversions (CalLite Arc name in parentheses).

Feature	Inflow	Diversion*	Local Inflow
Nodes (labeled)			
South Bay		dem_D810,dem_D813, dem_D814, dem_D815, and dem_D816 (D_SbayP)	I_DelValle – D_DelValle (Del Valle Reservoir storage release and diversion)
O'Neill FB (SWP)		dem_D803, dem_D802 (D_ONeillFBSWP)	
Upper DMC		dem_D700, dem_D701, and dem_D702 (D_UpDMCP)	
CVP SL Reservoir		dem_D710 and dem_D711 (D_SLCVPP)	
CVPJointUse		dem_D706,dem_D707, and dem_D708 (D_CVPJU_LDMCP)	
Lower DMC		dem_D607A, dem_D607B, dem_D607C, dem_D607D, dem_608B, and dem_608C (D_MendotaPl)	I607+R607West+C605A (AD_JamesBP)
Dos Amigos (CVP)		dem_D833,dem_D834,dem_ D835,dem_D836,dem_ D837,dem_ D838,dem_ D839, dem_D840, dem_D841,dem_ D842, dem_D843, dem_D844, and dem_ D845 (D_DosAmigosCVPP)	
Dos Amigos (SWP)		dem_D821, dem_D824, dem_D826, dem_D827, dem_D828, and dem_D829 (D_DosAmigosSWPP)	
Las Perillas		dem_D846, dem_D847, dem_D848, dem_D849 , and C848_TVC (D_Emp2DudP)	
Badger Hill		dem_D850: dem_D867, dem_D868, dem_D869, and dem_D870 (D_CoastAqdctP)	
KCWA		dem_D851 and C851_SW (D_KCWAP)	
Cross Valley Canal		dem_D855 (D_CVP_CVCP); dem_D854 and dem_D856 (D_CVPRfg_854P)	
Chrisman Pumping Plant	I860 (I_Kern)	dem_D859,dem_D862,dem_D863,dem_D864 , and C861_AEI (D_CVC2ChrisP)	
Warne Power Plant		dem_D891 (D_OSOP)	
West Branch		dem_D28,dem_ D893, dem_D894, dem_D29, dem_D895, and dem_D896 (D_WarnePPP)	I_Pyramid – D_Pyramid + I_Castaic – D_Castaic (Pyramid and Castaic Lake storage release and diversion)
Pearblossom Pumping Plant		dem_D877, dem_D878, dem_D879, and dem_D880 (D_AlamoP)	
East Branch		dem_D881,dem_D882,dem_D25,dem_D883, dem_D884,dem_D885,dem_D886,dem_D887, dem_D888,dem_D889, dem_D899, and dem_D27 (D_PearBlPPP)	I_Silverwood – D_Silverwood + I_Perris – D_Perris (Silverwood and Perris Lake storage release and diversion)
*All diversions constrained by allocation and consumptive use requirements.			

A.4.9 Upper San Joaquin River

The CalLite Upper San Joaquin River representation includes Millerton Reservoir (Friant Dam), Gravelly Ford, the Chowchilla Bifurcation, Mendota Pool, Sack Dam, and the San Joaquin River down to the junction with the Merced River. Table 17 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 17. Upper San Joaquin River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions / Depletions	Diversions
Reservoirs			
Millerton (S18)	I_Mlrtn (I18_FG+C17+C16_TFB)		D_Fkcnl (D18A) D_Mdrcnl (D18B)
Nodes			
GravellyFord (Node 603)		AD_Gravf (-L603)	D_Gravf (D603)
ChowchillaBifurcation (Node 605)		AD_SJRCb (-L605)	
Mendota Pool (Node 607)	I_Mdota (I607)	AD_Mdota (R607West)	D_Mdota (D607A + D607D) C_MdotaBC (C607BC)
SJRSack (Node 608)		AD_SJRSack (-L608)	C_SJRSackBC (C608BC)
SJRSand (Node 609)		AD_SJRSand (-L609)	
SJRMaraBypass (Node 610)			
SJRLander (Node 611)			
SJRMudSalt (Node 614)	I_SJRMs (I614)	AD_SJRMs (R614West+R614J+R619H)	C_MDOTABVamp (C607BVAMP)
SJRMerced (Node 620)		AD_SJRMer (C619+R620)	D_SJRMer (D620A+D620B+D620C)

A.4.10 Fresno River

The CalLite Fresno River representation includes Hensley Lake, Fresno, and the Chowchilla Bypass. Table 18 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 18. Fresno River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions / Depletions	Diversions
Reservoirs			
Hensley Lake (S52)	I_Hnsly (I52)		
Nodes			
Fresno (Node 588)		AD_Frsno (D590F-L588)	D_Frsno (D588)
Chowchilla Bypass (Node 595)		AD_Chowbyp (R595-L595)	D_Chowbyp (D595)

A.4.11 Chowchilla River

The CalLite Chowchilla River representation includes Eastman Lake, Chowchilla1, and Chowchilla2. Table 19 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 19. Chowchilla River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions / Depletions	Diversions
Reservoirs			
Eastman Lake	I_Estmn (I53)		
Nodes			
Chowchilla1 Nodes (580/582)		AD_ChowR1 (-L582)	C_Mdrcnlf (C590F) D_Chowr1 (D582) C_Mdrcnl_16B (C590_16B) C_Mdrcnl (C590)
Chowchilla2 (Node 587)	I_Eastbyp	AD_Chow2 (R587A+R587B-L587)	

A.4.12 Merced River

The CalLite Merced River representation includes Lake McClure, Merced1, and Merced2. Table 20 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 20. Merced River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions / Depletions	Diversions
Reservoirs			
McClure	I_Mclre (I20)		
Nodes			
Merced1 (Nodes 561/562)	I_Merced1 (I561+I562)		D_Merced1 (D561+D562)
Merced2 (Nodes 564/566)	I_Merced2 (I566)	AD_Merced2 (R564A+R564B +R566)	D_Merced2 (D566)

A.4.13 Tuolumne River

The CalLite Tuolumne River representation includes New Don Pedro Reservoir and Tuolumne. Table 21 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 21. Tuolumne River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions / Depletions	Diversions
Reservoirs			
New Don Pedro	I_Pedro (I81)		
Nodes			
Tuolumne	I_Tuol (I545)	AD_TUOL (R545A+R545B +R545C)	D_Tuol (D540A+D540B+D545)

A.4.14 Stanislaus River

The CalLite Stanislaus River representation includes New Melones, Goodwin, and Ripon. Table 22 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 22. Stanislaus River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions / Depletions	Diversions
Reservoirs			
New Melones	I_Melon (I10)		
Nodes			
Goodwin (Node 520)	I_Stangdwn (I520)	AD_Stangdwn (I76-E76)	D_Stangdwn (D520A+D520A1+D520B +D520C)
Ripon (Node 528)	I_Stanripn (I528)	AD_Stanripn (R528A+R528B+R 528C)	D_Stanripn (D528)

A.4.15 Calaveras River

The CalLite Calaveras River representation includes New Hogan, Calaveras, and SJRCalaveras. Table 23 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 23. Calaveras River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions / Depletions	Diversions
Reservoirs			
New Hogan	I_Nhgan (I92)		
Nodes			
Calaveras (Nodes 506/507/508)	I_CALAV (I506)	AD_CALAV (R508-L507-L506)	D_CALAV (D506A+D506B+D506C+ D507)
SJRCalaveras (Node 514)		AD_SJRCAL (R514A+R514B)	D_SJRCAL (D514A+D514B)

A.4.16 Lower San Joaquin River

The CalLite Lower San Joaquin River representation includes SJRMaze, SJRVernalis, and SJROldRiver. Table 24 shows the correspondence between CalLite and CalSim inflows, accretions, and diversions.

Table 24. Lower San Joaquin River CalLite inflows, accretions, and diversions. Corresponding CalSim variables are shown in parentheses.

Feature	Inflows	Accretions/ Depletions	Diversions
Nodes			
SJRMaze (Node 636)	I_SJRMaze (I636)	AD_SJRMaze (R636A+R636B+R636C)	
SJRVernalis (Node 639)		AD_SJRVER (R639+R639West)	D_SJRVER (D639)
SJROldRiver			

A.5 Demands - North of Delta

North of Delta project demands are also based on 2005 and 2020 LOD CalSim II hydrology from the Common Assumptions Common Model Package (Version 9B) (DWR 2009). Consistent with the CalSim II approach, deliveries are constrained by CVP and SWP allocations and by land use-based diversion requirements for the hydrologic planning area. Table 25 shows CalLite north of Delta model nodes, corresponding Calsim II demand arcs, and CalSim II contract demand timeseries used to represent project demands at each node. Table 25 also shows the DSA land use-based diversion requirement associated with each demand timeseries.

Table 25. NOD CVP and SWP Project Demands as Simulated in CalLite.

CalLite Demand Node (Arc name in parentheses)	Calsim II Demand Arc	Contract Demand Variable	DSA Land Use-Based Diversion Requirement
Red Bluff (D_RedBlf)			
	D104	DEM_D104_PMI, DEM_D104_PAG, DEM_D104_PSC	DSA 58
	D171	CON_D171_PAG	DSA 10
	D172	CON_D172_PAG	DSA 10
	D174	CON_D174_PAG	DSA 12
	D178	CON_D178_PAG	DSA 12
Wilkins Slough (D_Wilkns)			
	D122A	CON_14301SC	DSA 12
	D122B	CON_14501SC	DSA 12
	D143A	CON_114GCID	DSA 12
	D143B	CON_D14302_PRF, CON_114GCID	DSA 12
	D145A	CON_114GCID	DSA 12
	D145B	CON_18201A_PRF, CON_18201B_PRF, CON_114GCID	DSA 12
	D128	CON_131SC	DSA 15
	D129A	CON_18301SC	DSA 12
Oroville (D_Orovl)			
	D6	DEM_D6_PWR	DSA 69
Thermalito (D_Therm)			
	D7	DEM_D7A_PAG, DEM_D7A_PWR, DEM_D7A_PRF, DEM_D7B_PAG, DEM_D7B_PWR, DEM_D7B_PRF	DSA 69
	D201	DEM_D201_PIMI, DEM_D201_POMI	DSA 69
	D202	DEM_D202_PWR	DSA 69
Yuba-Feather Confluence (D_Yub Fea)			
	D204	DEM_D204_PIMI, DEM_D204_POMI	DSA 69
	D206	DEM_D206A_PAG, DEM_D206B_PAG, DEM_D206B_PWR, DEM_D206C_PAG, DEM_D206C_PWR	DSA 69

Table 25 (cont'd). NOD CVP and SWP Project Demands as Simulated in CalLite.

CalLite Demand Node (Arc name in parentheses)	Calsim II Demand Arc	Contract Demand Variable	DSA Land Use-Based Diversion Requirement
Folsom (D_Folsm)			
	D8	DEM_8B_PMI_ANN DEM_8E_PMI_ANN DEM_8F_PMI_ANN, DEM_8G_PMI_ANN, DEM_8H_PMI_ANN, DEM_8I_PMI_ANN	DSA 70
Nimbus (D_Nimbus)			
	D9	DEM_9AB_PMI_ANN, DEM_9A_PMI_ANN	DSA 70
Sacramento-American Confluence (D_SacAme)			
	D162	DEM_D162A_PSC, DEM_D162B_PSC, DEM_D162C_PSC, DEM_D162E_PMI	DSA 70
	D163	DEM_D163_PRJ	DSA 65
	D165	DEM_D165_PRJ	DSA 65
	D167	DEM_D167B_PMI_A	DSA 70

A.6 Demands - South of Delta

A.6.1 State Water Project Demands

Twenty-nine agencies have contracts for a long-term water supply from the SWP totaling approximately 4.2 million acre-feet (MAF) annually, of which about 4.1 MAF are for contracting agencies with service areas south of the Delta. About 70 percent of this amount is the contract entitlement for urban users and the remaining 30 percent for agricultural users. Implementation of these demands in CalLite is similar to CalSim II, however, the contractors are grouped into three types: agricultural (Ag), Metropolitan Water District's municipal and industrial demands (MWD), and other municipal and industrial demands (MI) (see Table 26); similar to older versions of the CalSim II model.

Table 26. SWP Contractors as simulated in CalLite.

IDD[1]	DemArc[2]	IDC[3]	Type	Contractor	CalLite Demand Node
1	D810	1	MI	ALAMEDA COUNTY FC&WCD-ZONE 7	SouthBay
2	D813	1	MI	ALAMEDA COUNTY FC&WCD-ZONE 7	SouthBay
3	D814	2	MI	ALAMEDA COUNTY WD	SouthBay
4	D877	3	MI	ANTELOPE VALLEY-EAST KERN WA	Pearblossom Pumping Plant
5	D868	4	AG	CASTAIC LAKE WA	Badger Hill
6	D896	30	MI	CASTAIC LAKE WA	West Branch
7	D204	5	MI	CITY OF YUBA CITY	Yuba-Feather Confluence
8	D883	6	MI	COACHELLA VALLEY WD	East Branch
9	D201	7	MI	COUNTY OF BUTTE	Thermalito
10	D847	8	AG	COUNTY OF KINGS	Las Perillas
11	D25	9	MI	CRESTLINE-LAKE ARROWHEAD WA	East Branch
12	D884	10	MI	DESERT WA	East Branch
13	D849	11	AG	DUDLEY RIDGE WD	Las Perillas
14	D846	12	AG	EMPIRE WEST SIDE ID	Las Perillas
15	D851A	29	MI	KERN COUNTY WA	KCWA
16	D851	13	AG	KERN COUNTY WA	KCWA
17	D859	13	AG	KERN COUNTY WA	Chrisman Pumping Plant
18	D863	13	AG	KERN COUNTY WA	Chrisman Pumping Plant
19	D867	13	AG	KERN COUNTY WA	Badger Hill
20	D879	14	MI	LITTLEROCK CREEK ID	Pearblossom Pumping Plant
21	D27	15	MWD	METROPOLITAN WDSC	East Branch
22	D851B	15	MWD	METROPOLITAN WDSC	KCWA
23	D885	15	MWD	METROPOLITAN WDSC	East Branch
24	D895	15	MWD	METROPOLITAN WDSC	West Branch
25	D899	15	MWD	METROPOLITAN WDSC	East Branch
26	D881	16	MI	MOJAVE WA	East Branch
27	D403B	17	MI	NAPA COUNTY FC&WCD	North Bay Aqueduct
28	D802A	18	AG	OAK FLAT WD	O'Neill FB (SWP)
29	D878	19	MI	PALMDALE WD	Pearblossom Pumping Plant
30	D886	20	MI	SAN BERNARDINO VALLEY MWD	East Branch
31	D887	21	MI	SAN GABRIEL VALLEY MWD	East Branch

[1] Demand ID
[2] Demand Arc in CalSim II
[3] Contractor ID

Table 26 (cont'd). SWP Contractors as simulated in CalLite.

IDD[4]	DemArc[5]	IDC[6]	Type	Contractor	CalLite Demand Node
32	D888	22	MI	SAN GORGONIO PASS WA	East Branch
33	D869	23	MI	SAN LUIS OBISPO COUNTY FC&WCD	Badger Hill
34	D870	24	MI	SANTA BARBARA COUNTY FC&WCD	Badger Hill
35	D815	25	MI	SANTA CLARA VALLEY WD	South Bay
36	D403C	26	MI	SOLANO COUNTY WA	North Bay Aqueduct
37	D848	27	AG	TULARE LAKE BASIN WSD	Las Perillas
38	D28	28	MI	VENTURA COUNTY WPD	West Branch
39	D29	28	MI	VENTURA COUNTY WPD	West Branch

A.6.2 Central Valley Project Demands

CVP demands in CalLite are currently based on 2005 and 2020 LOD CalSim II hydrology and are consistent with the CalSim II approach. Table 27 summarizes the contractors and their types (agricultural (Ag), Exchange (Ex), municipal and industrial (Mi), Refuge (Ref) water rights (Wr)), Calsim II demand arc and location, and the CalLite node at which they are applied.

Table 27. CVP south of Delta contractors as simulated in CalLite.

Contractor	Calsim II Demand Arc	Calsim II Location	Type	CalLite Demand Node
Plainview WD	D700	Upper DMC	Ag	Upper DMC
Tracy, City of	D700	Upper DMC	Mi	Upper DMC
Banta Carbona ID	D700	Upper DMC	Ag	Upper DMC
West Side ID	D700	Upper DMC	Ag	Upper DMC
Davis WD	D701	Upper DMC	Ag	Upper DMC
Del Puerto WD	D701	Upper DMC	Ag	Upper DMC
Hospital WD	D701	Upper DMC	Ag	Upper DMC
Kern Canon WD	D701	Upper DMC	Ag	Upper DMC
Salado WD	D701	Upper DMC	Ag	Upper DMC
Sunflower WD	D701	Upper DMC	Ag	Upper DMC
West Stanislaus WD	D701	Upper DMC	Ag	Upper DMC
Mustang WD	D701	Upper DMC	Ag	Upper DMC
Orestimba WD	D701	Upper DMC	Ag	Upper DMC
Patterson WD Water Rights	D701	Upper DMC	Wr	Upper DMC
Patterson WD	D701	Upper DMC	Ag	Upper DMC

[4] Demand ID
[5] Demand Arc in CalSim II
[6] Contractor ID

Table 27 (cont'd). CVP south of Delta contractors as simulated in CalLite.

Contractor	Calsim II Demand Arc	Calsim II Location	Type	CalLite Demand Node
Foothill WD	D701	Upper DMC	Ag	Upper DMC
Quinto WD	D701	Upper DMC	Ag	Upper DMC
Romero WD	D701	Upper DMC	Ag	Upper DMC
Centinella WD	D701	Upper DMC	Ag	Upper DMC
Losses	D702	Upper DMC	Loss	Upper DMC
Exchange Contractors	D707	DMC Downstream from O'Neill	Ex	CVP Joint Use
Panoche WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
San Luis WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
Broadview WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
Laguna WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
Eagle Field WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
Mercy Springs WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
Oro Loma WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
Widren WD	D706	DMC Downstream from O'Neill	Ag	CVP Joint Use
Grasslands via CCID	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
Los Banos WMA	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
Kesterson NWR	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
Freitas - SJBAP	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
Salt Slough - SJBAP	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
China Island - SJBAP	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
Volta WMA	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
Grassland via Volta Wasteway	D708	DMC Downstream from O'Neill	Ref	CVP Joint Use
Westlands WD (incl. Barcellos)	D607A	Mendota Pool	Ag	Mendota Pool
Fresno Slough WD	D607A	Mendota Pool	Ag	Mendota Pool
James ID	D607A	Mendota Pool	Ag	Mendota Pool
Traction Ranch/F&G	D607A	Mendota Pool	Ag	Mendota Pool
Tranquillity ID	D607A	Mendota Pool	Ag	Mendota Pool
Hughes, Melvin	D607A	Mendota Pool	Ag	Mendota Pool
R.D. 1606	D607A	Mendota Pool	Ag	Mendota Pool
Exchange Contractors	D607B	Mendota Pool	Ex	Mendota Pool
Sch. II W.R.-	D607A	Mendota Pool	Wr	Mendota Pool
Sch. II W.R.-James ID	D607A	Mendota Pool	Wr	Mendota Pool
Sch. II W.R.-Traction Ranch	D607A	Mendota Pool	Wr	Mendota Pool
Sch. II W.R.-Tranquility I	D607A	Mendota Pool	Wr	Mendota Pool
Sch. II W.R.-Hughes, Melvin	D607A	Mendota Pool	Wr	Mendota Pool
Sch. II W.R.-R.D. 1606	D607A	Mendota Pool	Wr	Mendota Pool
Sch. II W.R.-Dudley	D607A	Mendota Pool	Wr	Mendota Pool
Grasslands WD	D607C	Mendota Pool	Ref	Mendota Pool
Los Banos WMA	D607C	Mendota Pool	Ref	Mendota Pool
San Luis NWR	D607C	Mendota Pool	Ref	Mendota Pool

Table 27 (cont'd). CVP south of Delta contractors as simulated in CalLite.

Contractor	Calsim II Demand Arc	Calsim II Location	Type	CalLite Demand Node
Mendota WMA	D607C	Mendota Pool	Ref	Mendota Pool
West Gallo - SJBAP	D607C	Mendota Pool	Ref	Mendota Pool
East Gallo - SJBAP	D607C	Mendota Pool	Ref	Mendota Pool
Losses	D607D	Mendota Pool	Loss	Mendota Pool
San Benito County WD MI	D711	San Felipe	Mi	CVP SL Reservoir
San Benito County WD AG	D710	San Felipe	Ag	CVP SL Reservoir
Santa Clara Valley WD PMI	D711	San Felipe	Mi	CVP SL Reservoir
Santa Clara Valley WD PAG	D710	San Felipe	Ag	CVP SL Reservoir
Pajaro Valley Wtr Mgmt Agency	D710	San Felipe	Ag	CVP SL Reservoir
San Luis Interim		San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
Westlands WD	D836, D837, D839, D841, D843	San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
San Luis WD	D833	San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
Panoche WD	D835	San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
Pacheco WD	D835	San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
Grasslands WD	D833	San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
CA, State Parks and Rec	D833	San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
Affonso/Los Banos Gravel Co.	D833	San Luis Unit (Joint Reach)	Ag	CVP Dos Amigos
Avenal, City of	D844	San Luis Unit (Joint Reach)	Mi	CVP Dos Amigos
Coalinga, City of	D844	San Luis Unit (Joint Reach)	Mi	CVP Dos Amigos
Huron, City of	D844	San Luis Unit (Joint Reach)	Mi	CVP Dos Amigos
Loss	D834, D837, D838, D840, D842, D845	San Luis Unit (Joint Reach)	Loss	CVP Dos Amigos
Ducor ID	D855	Cross Valley Canal	Ag	Cross Valley Canal
Hope Valley	D855	Cross Valley Canal	Ag	Cross Valley Canal
Fresno, County of	D855	Cross Valley Canal	Ag	Cross Valley Canal
Hills Valley ID	D855	Cross Valley Canal	Ag	Cross Valley Canal
Kern-Tulare ID	D855	Cross Valley Canal	Ag	Cross Valley Canal
Lower Tule River ID	D855	Cross Valley Canal	Ag	Cross Valley Canal
Pixley ID	D855	Cross Valley Canal	Ag	Cross Valley Canal
Rag Gulch WD	D855	Cross Valley Canal	Ag	Cross Valley Canal
Tri-Valley WD	D855	Cross Valley Canal	Ag	Cross Valley Canal
Tulare, County of	D855	Cross Valley Canal	Ag	Cross Valley Canal
Kern NWR	D856	Cross Valley Canal	Ref	Cross Valley Canal
Pixley NWR	D856	Cross Valley Canal	Ref	Cross Valley Canal
Loss	D854	Cross Valley Canal	Loss	Cross Valley Canal

A.7 References

California Department of Water Resources (DWR). 2009. *Common Assumptions Common Model Package.* Sacramento, Calif.

A.8 Hydrology Figures

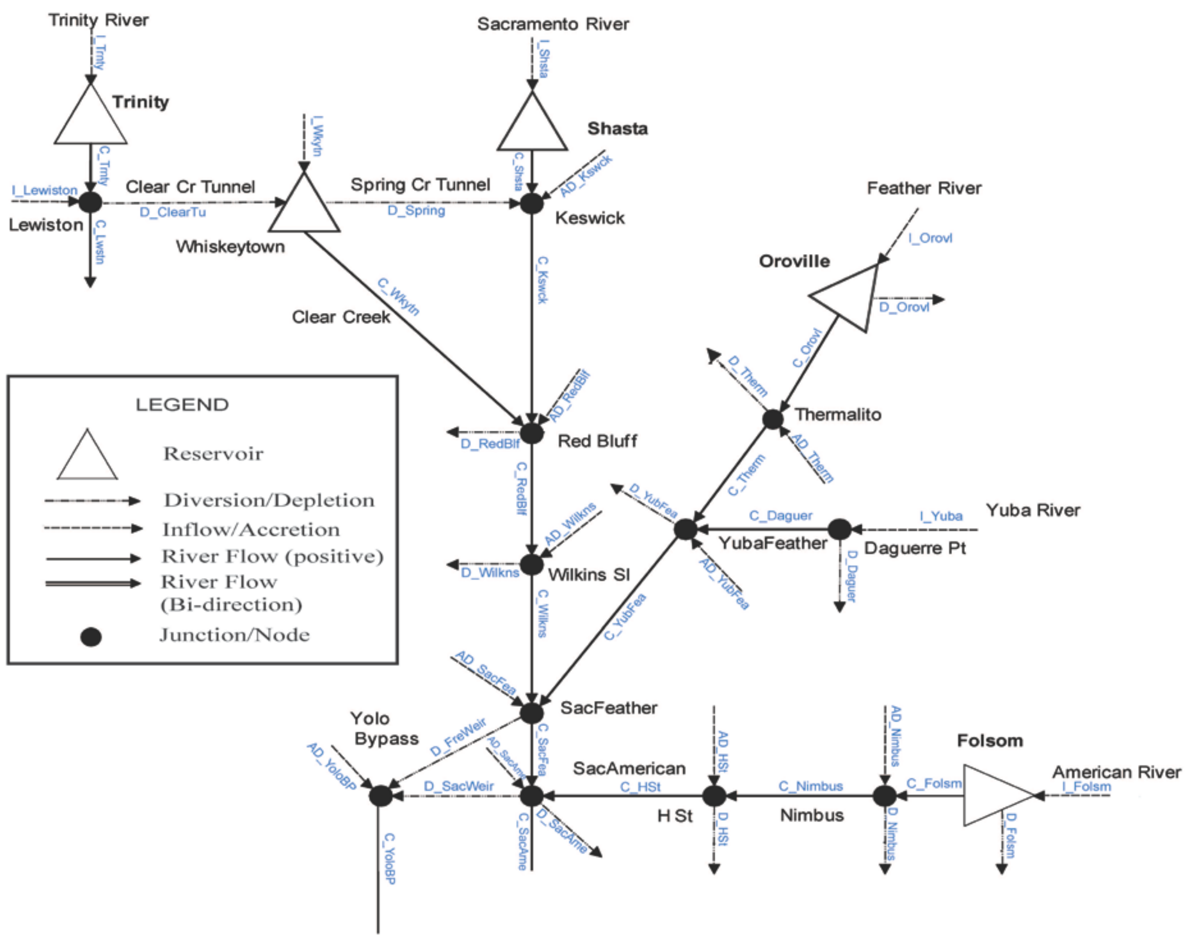


Figure 42. CalLite Schematic (North of Delta).

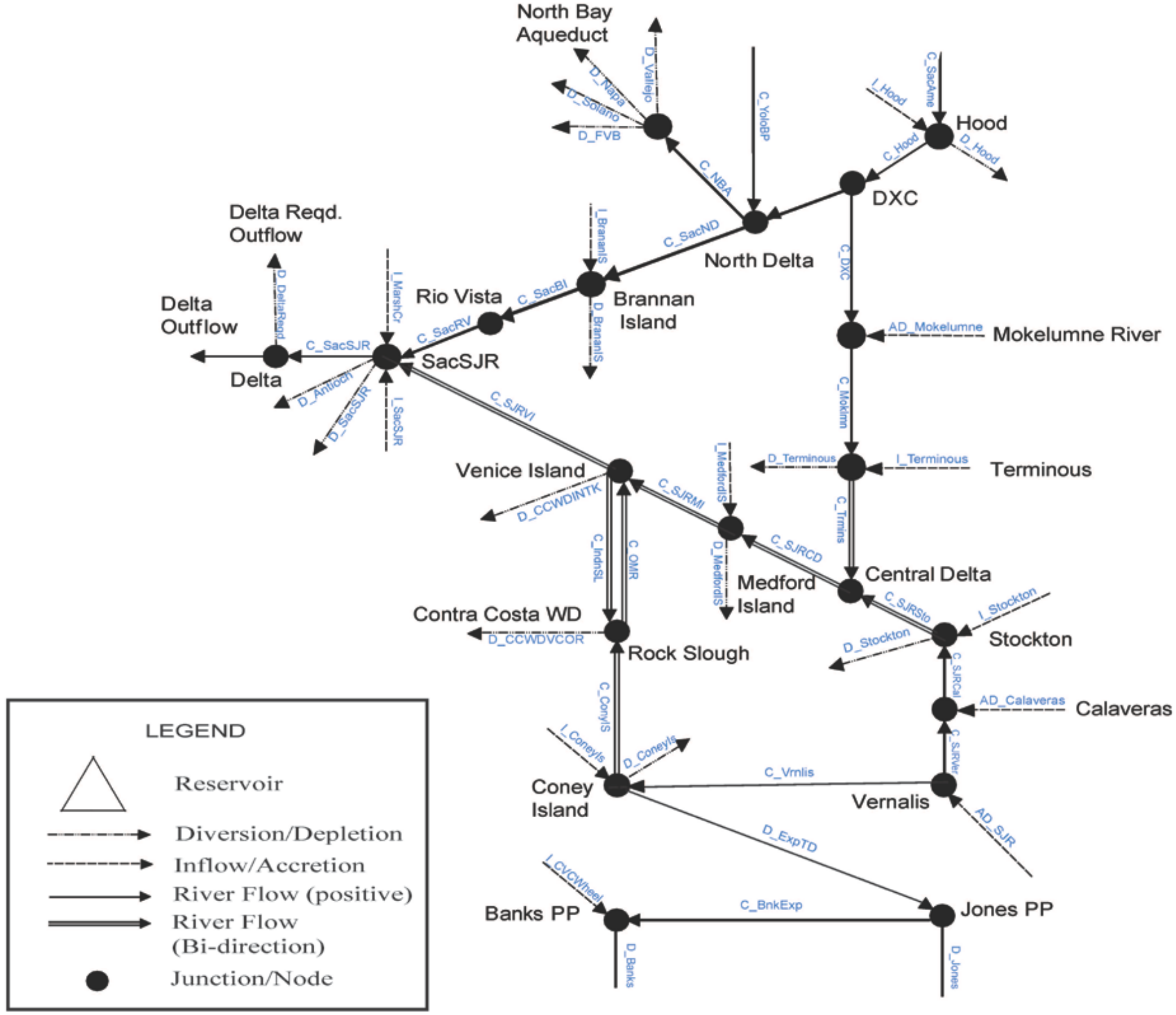


Figure 43. CalLite Schematic (Delta).

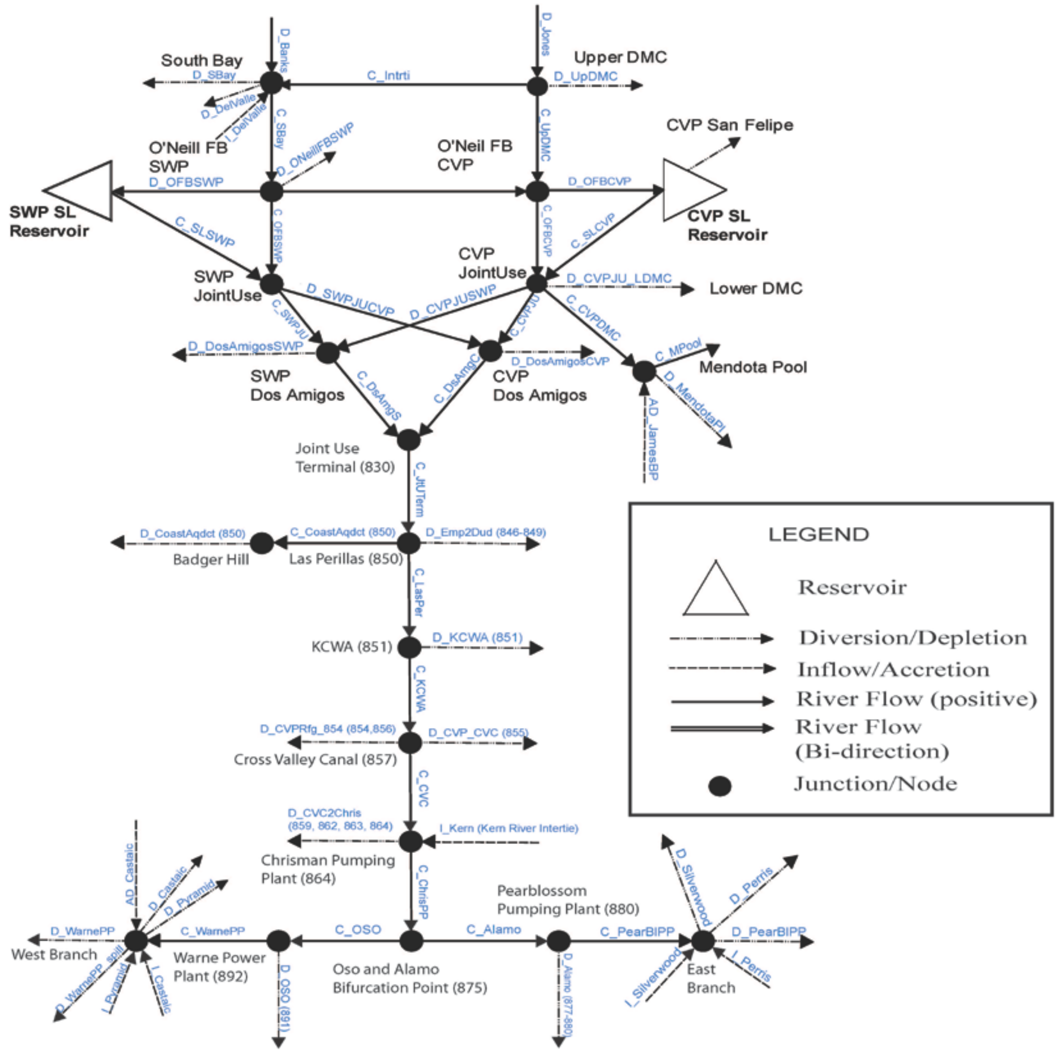


Figure 44. CalLite Schematic (South of Delta).

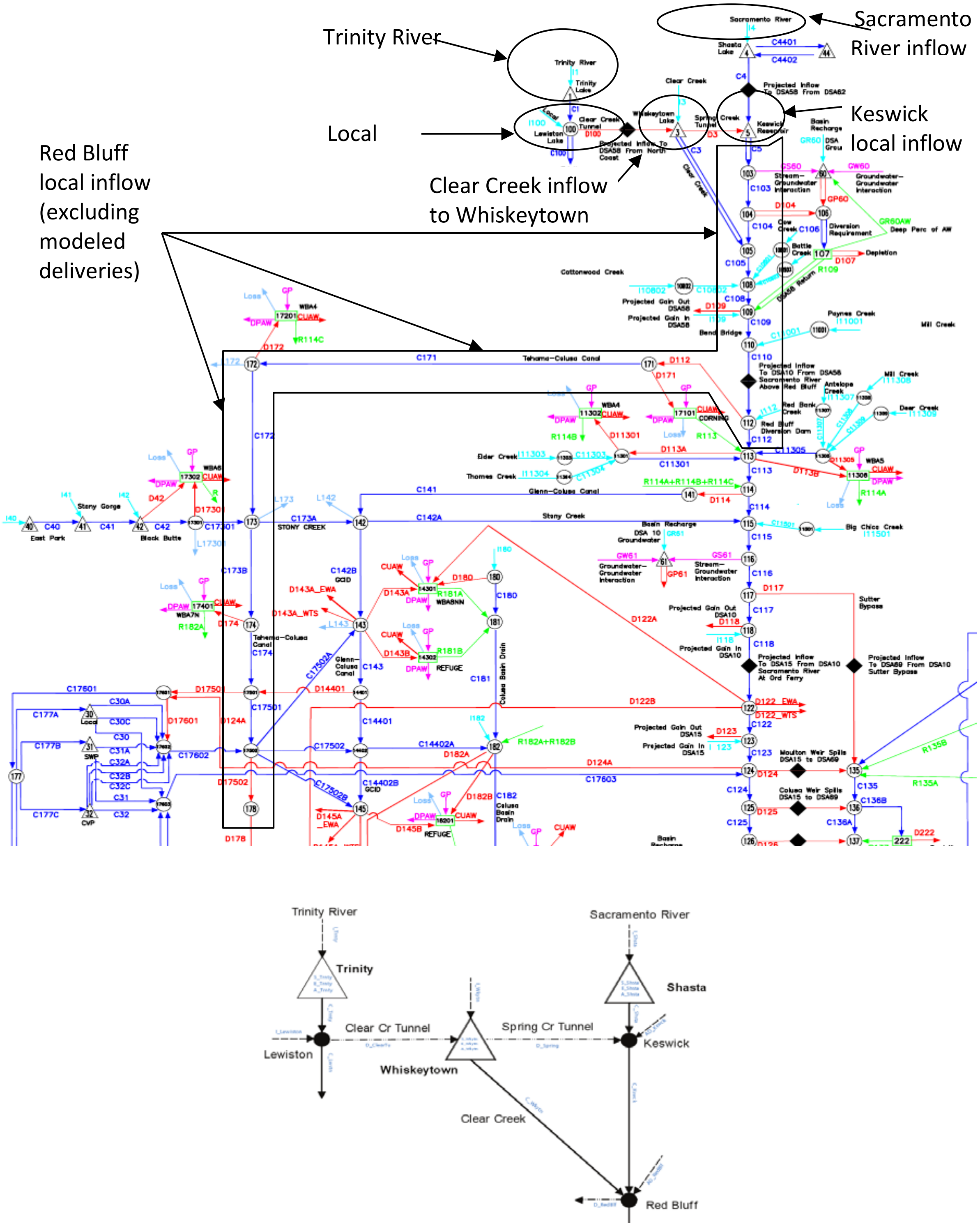


Figure 45. CalLite Upper Sacramento River Representation.

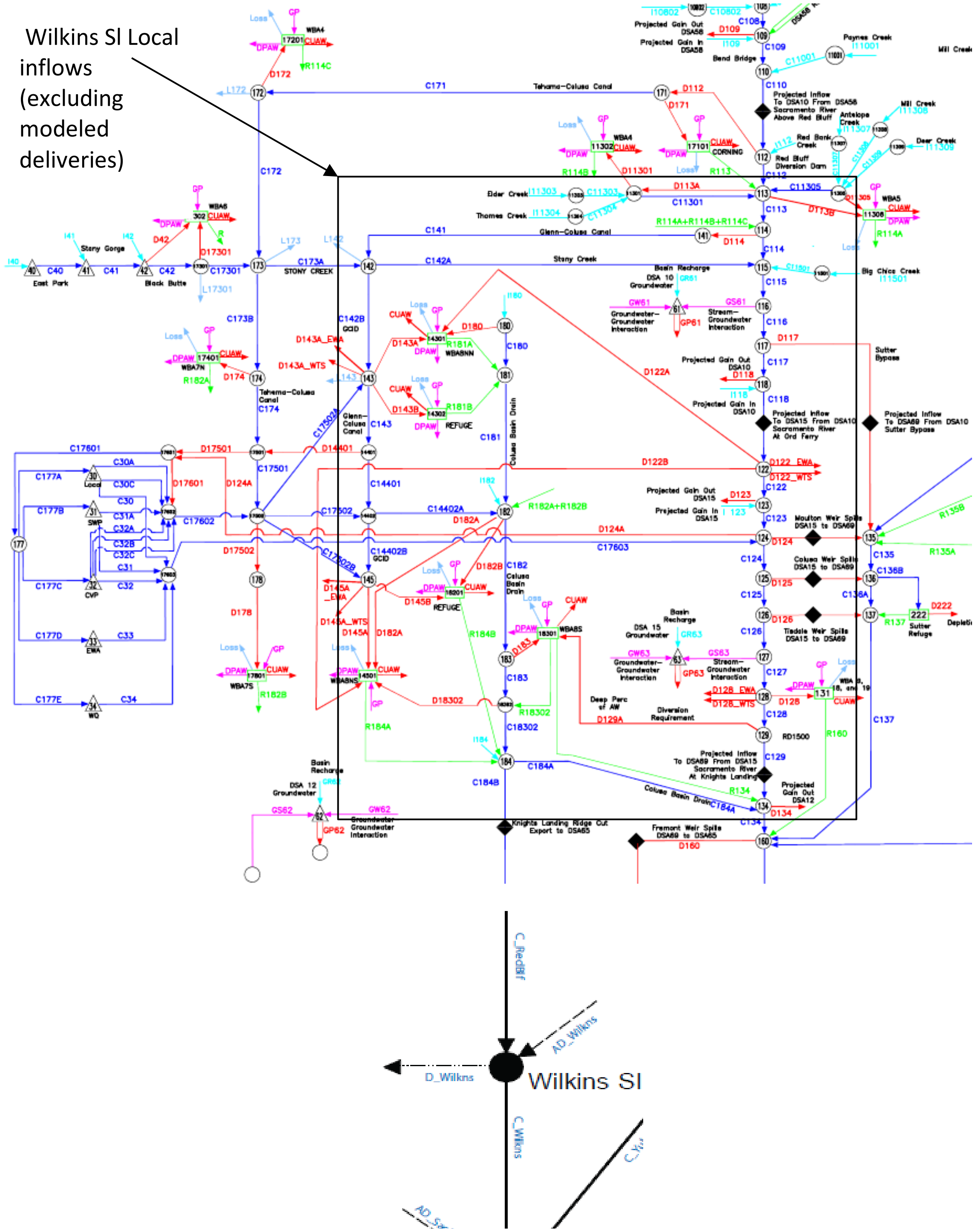


Figure 46. CalLite Colusa Basin representation.

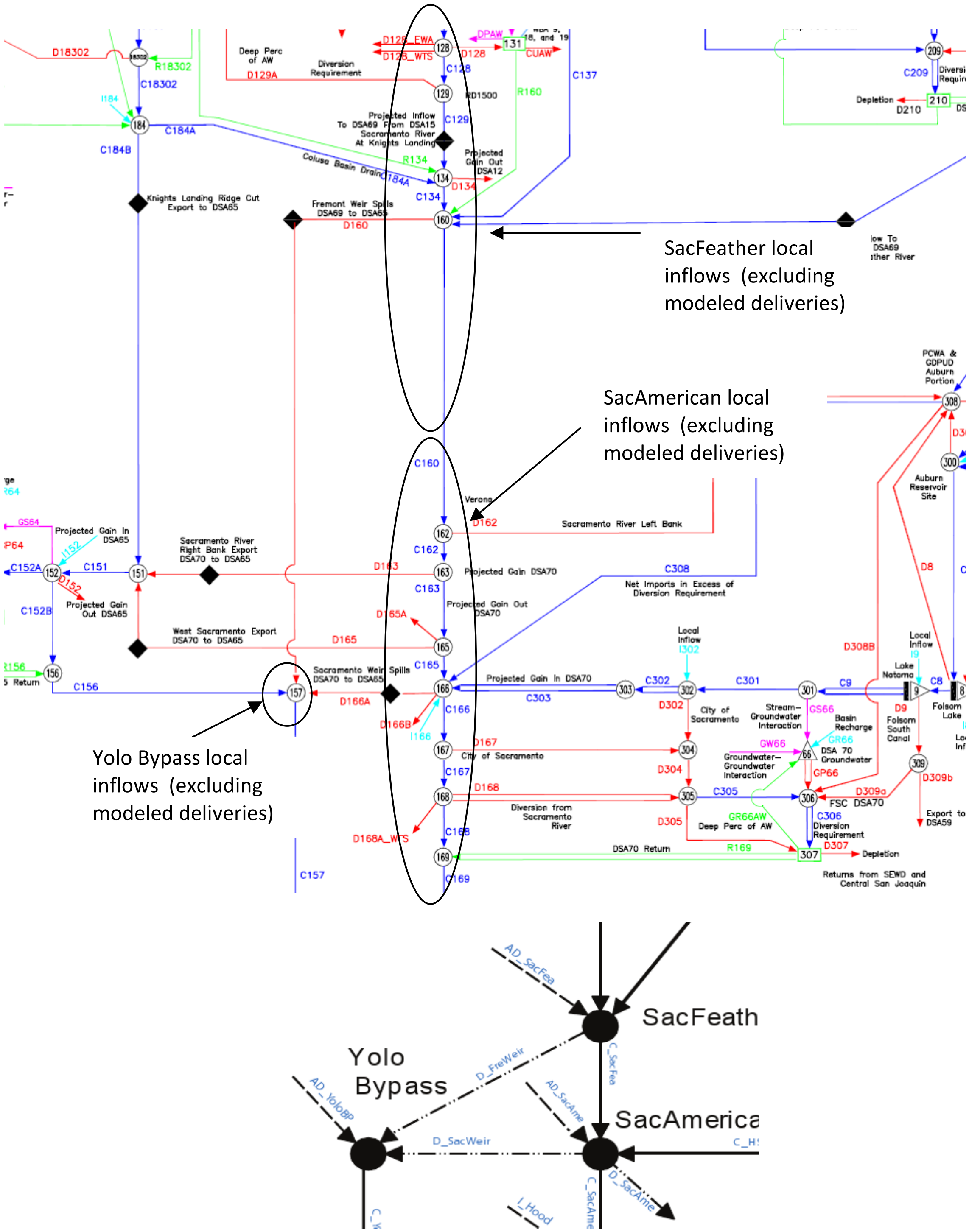


Figure 47. CalLite lower Sacramento River representation.

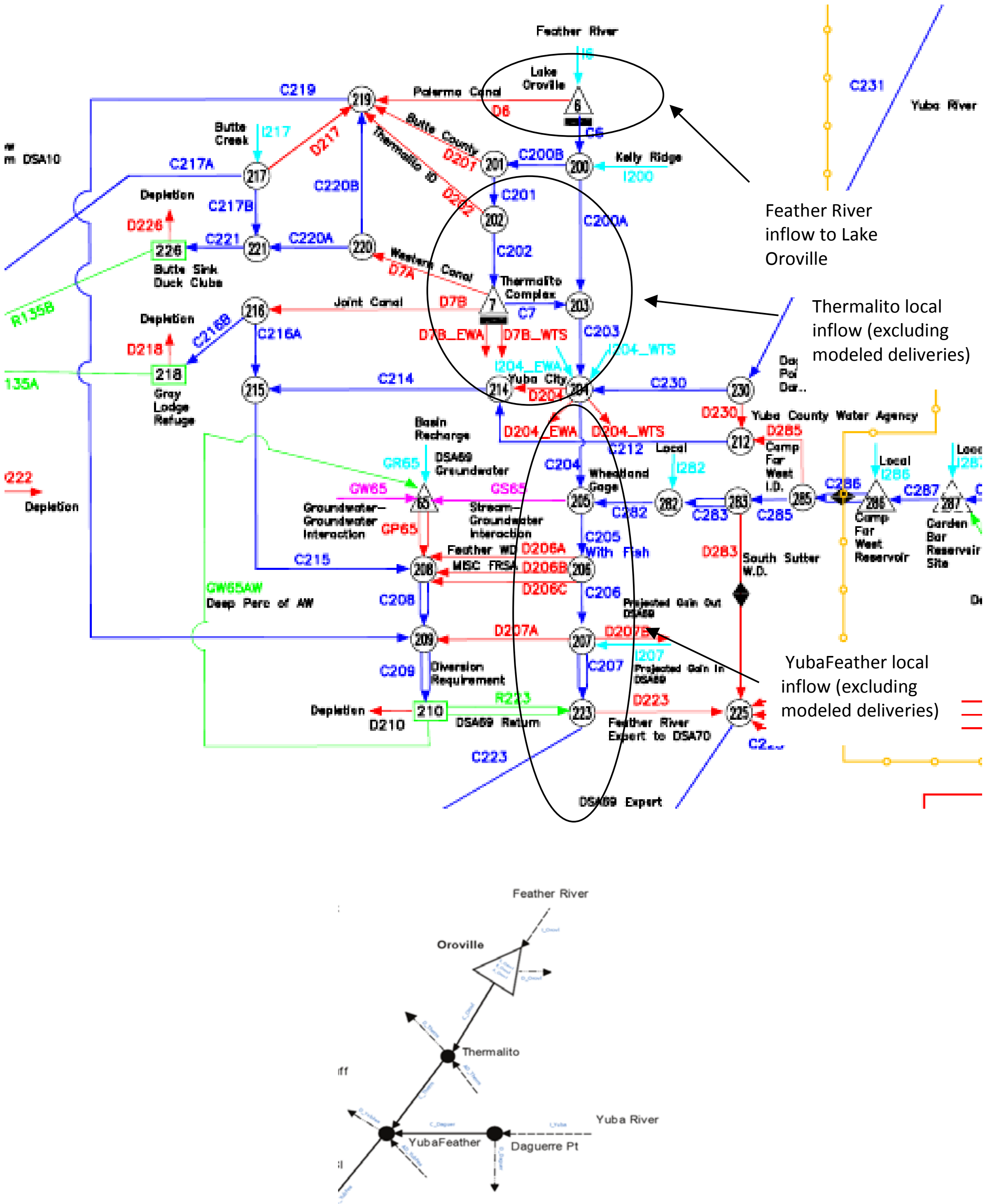
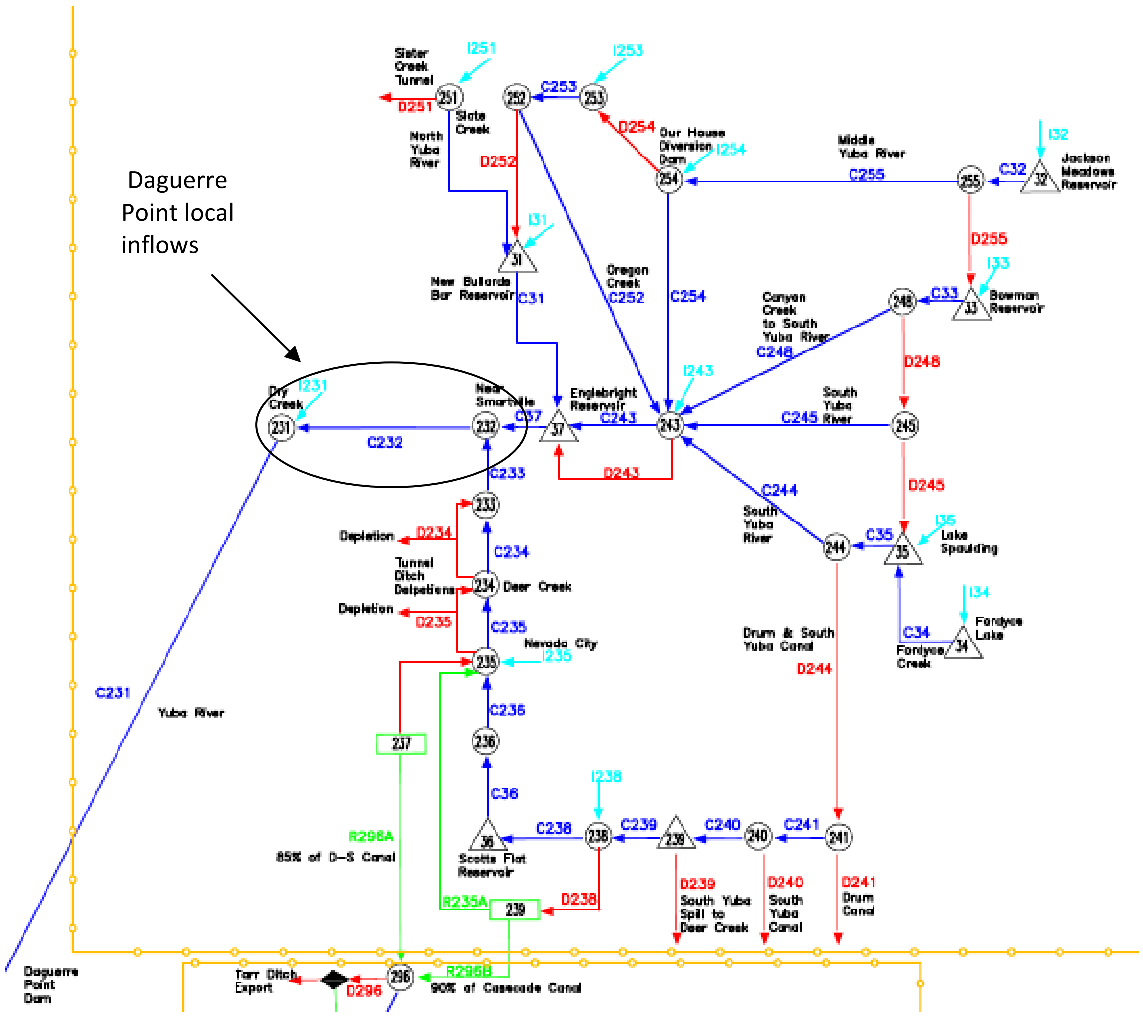


Figure 48. CalLite Feather River Representation.



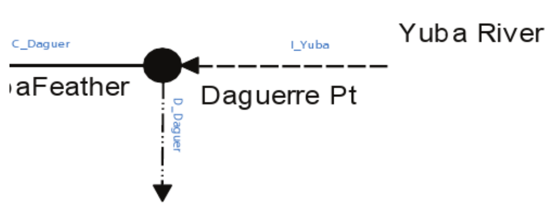


Figure 49. CalLite Yuba River Representation.

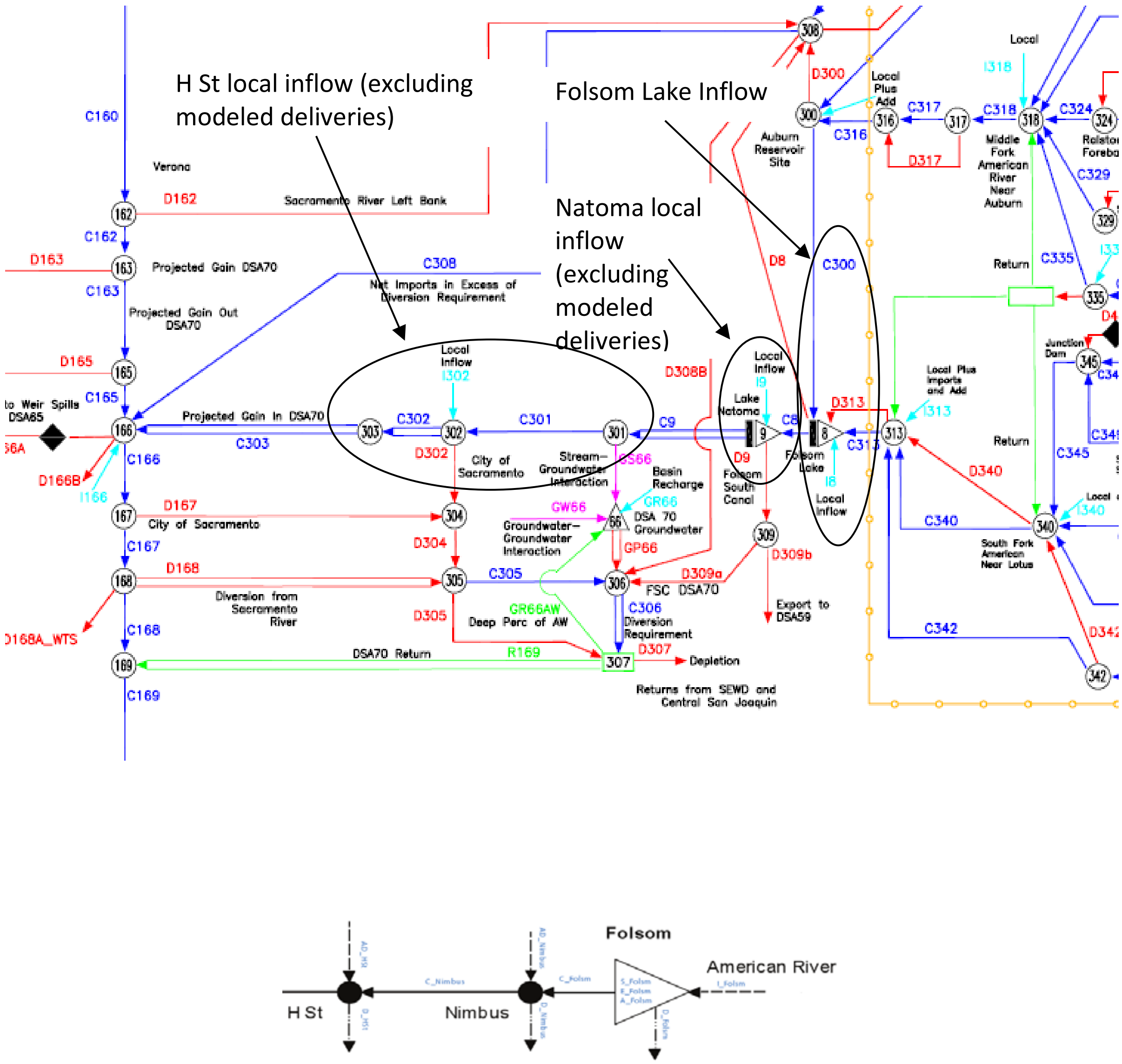


Figure 50. CalLite American River Representation.

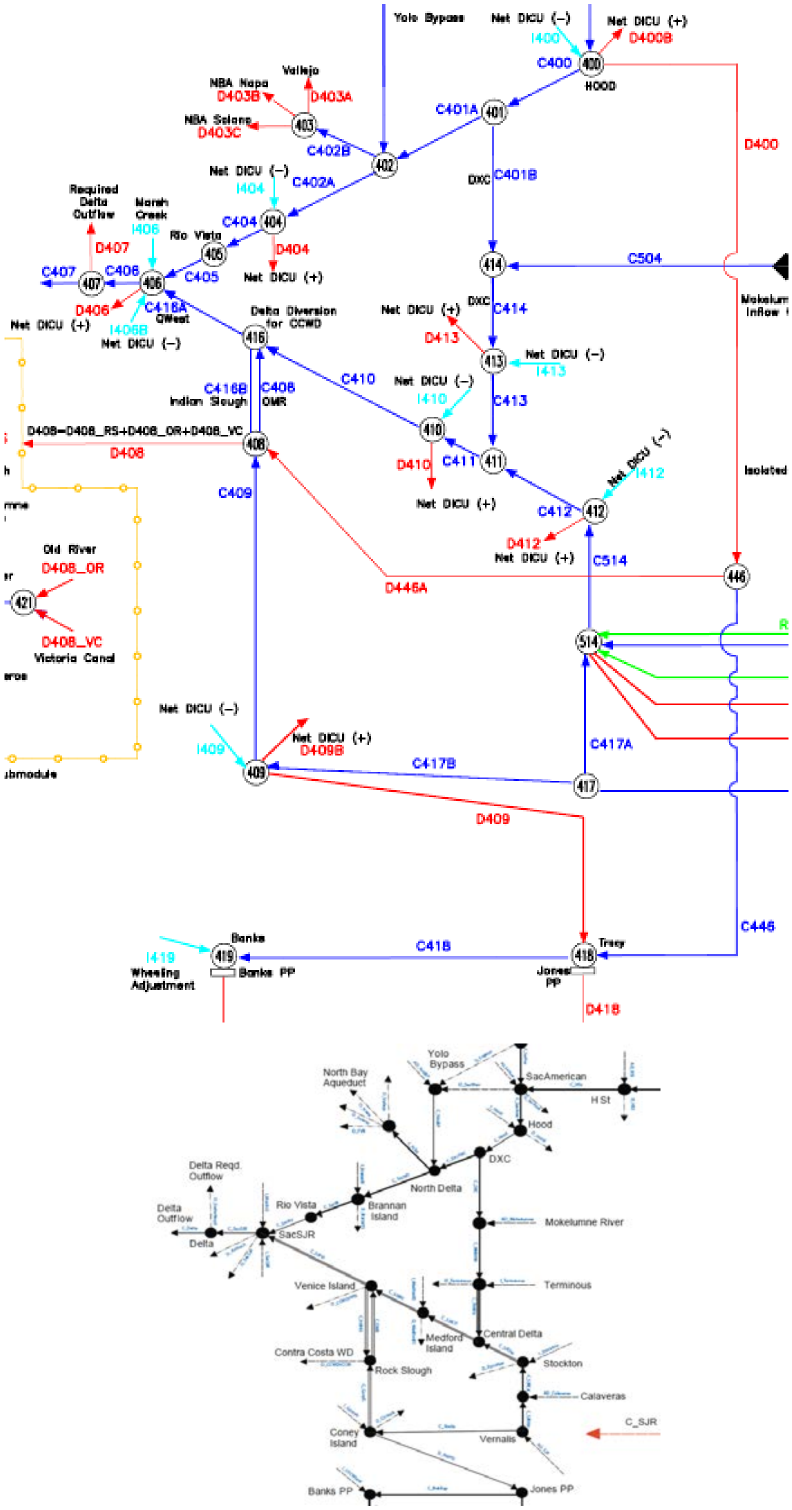


Figure 51. CalLite Delta Representation.

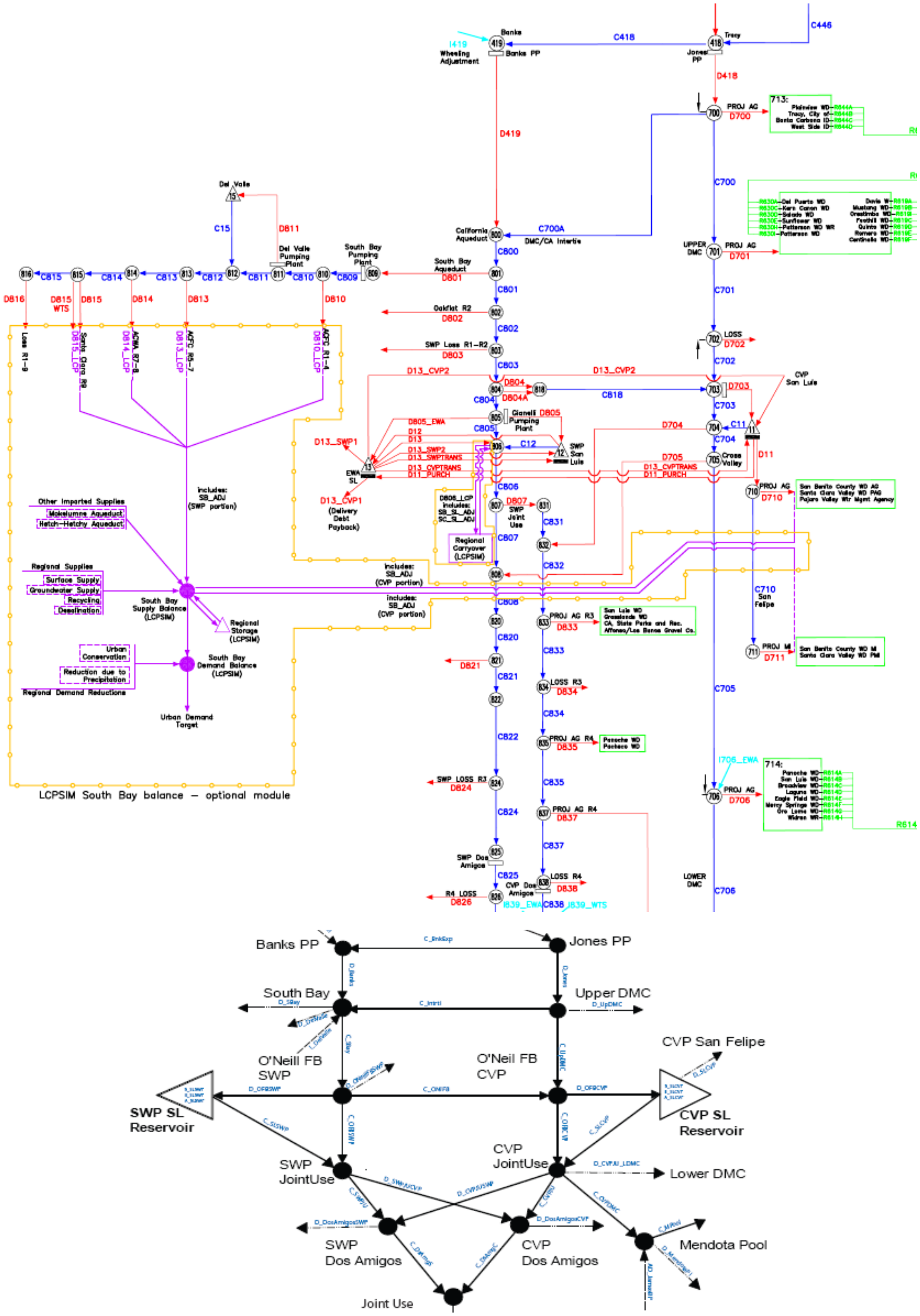


Figure 52. CalLite Representation from Delta to San Luis.

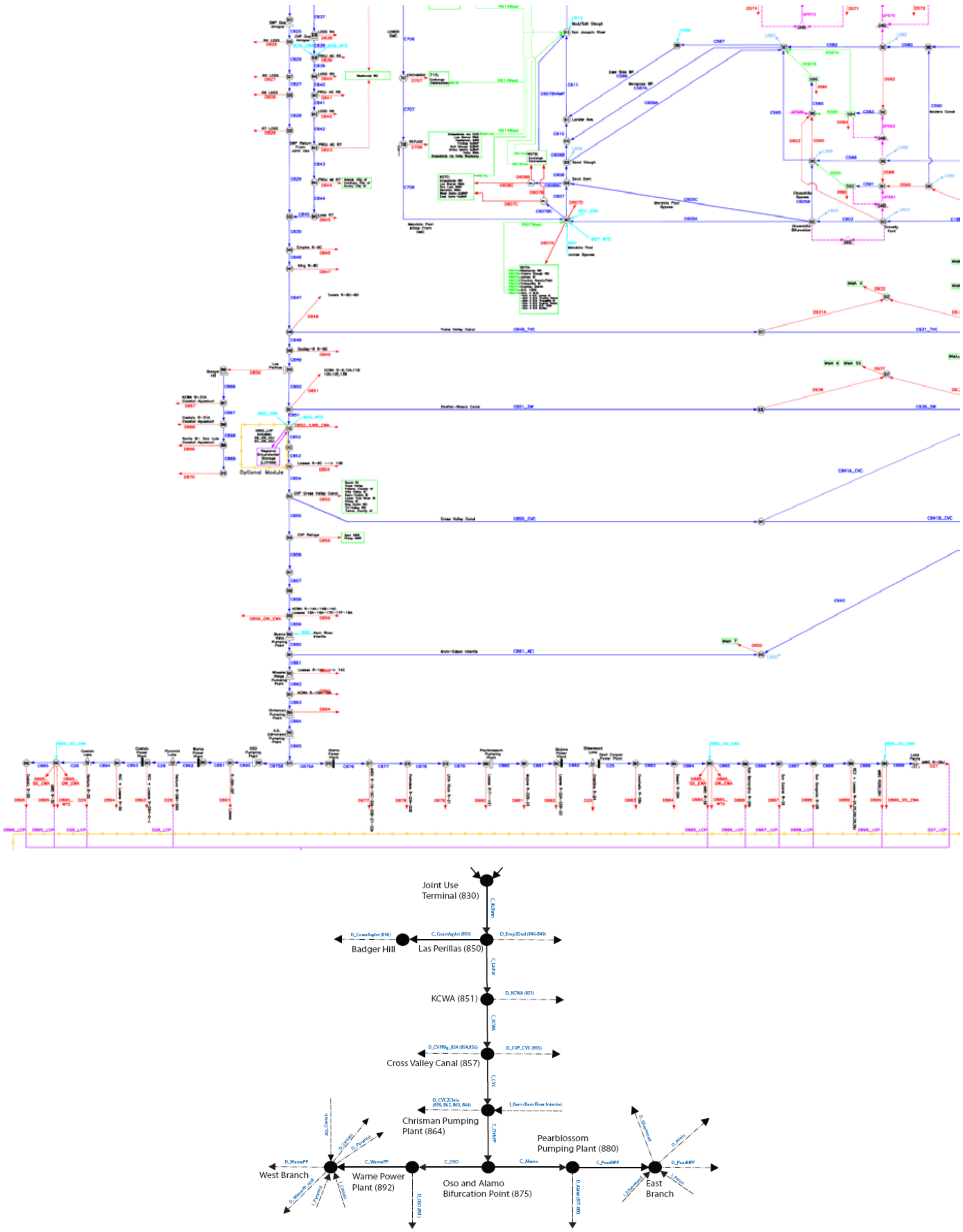


Figure 53. CalLite Representation South of Dos Amigos.

Appendix B Future Water Management Actions

B.1 Shasta Enlargement

Version 3.00 of CalLite includes the option to model the enlargement of Shasta Lake. The primary objectives of the alternatives identified in the Shasta Lake Water Resources Investigation (SLWRI) are (1) to increase survival of anadromous fish populations in the Sacramento River primarily upstream from the Red Bluff Diversion Dam, and (2) to increase water supplies and water supply reliability for agricultural, municipal and industrial, and environmental purposes to help meet future water demands, with a focus on enlarging Shasta Dam and Reservoir.

For the purposes of the screening model implementation, three Shasta Dam enlargement alternative dam raises of 6.5-feet (256 TAF), 12.5-feet (443 TAF), and 18.5-feet (634 TAF) are considered. These are the three raise sizes analyzed in the SLWRI Draft Feasibility Report and Preliminary Draft EIS released in February 2012 (Reclamation 2012), though the modeling in those reports included specialized operations for M&I water supply that are not in CalLite.

With the exception of the specialized M&I water supply operation, implementation of the three raise options in CalLite is identical to the CalSim II model, with an additional storage element added to the model to represent the enlarged part of Shasta Reservoir. Flood control space in Shasta does not change when Shasta is enlarged, hence the increased space is treated as additional conservation pool. Trinity Reservoir operations are held constant for the three raises, by adjusting the balancing logic used to trigger imports from Trinity into the Sacramento Basin.

The Shasta enlargement options are considered a component of the CVP, and increased Shasta storage is directly integrated into COA, water supply indices, and operational decisions, etc. It is recommended that if enlarged Shasta is activated in the model, the WSI-DI curves be recalculated to take into account the impacts of enlarging Shasta on CVP (and SWP) water supply and operations.

B.2 Los Vaqueros Enlargement

The Los Vaqueros Expansion Model was developed to run planning and operations simulations of key Contra Costa Water District facilities. Those facilities include Delta intakes at Rock Slough, Old River, and Middle River (Victoria Canal), Los Vaqueros Reservoir, Old River Pipeline, the Transfer Facility and Transfer Pipeline, Los Vaqueros Pipeline, and the Contra Costa Canal. Los Vaqueros Reservoir was built and expanded to reduce the salinity of water delivered to the CCWD service area. This is done by filling Los Vaqueros when there is low salinity at the Old and Middle River intakes and releasing water for blending when Delta salinity is high.

There are proposals to expand Los Vaqueros beyond its current 160 TAF capacity. The CalLite user is allowed to test different Los Vaqueros storage capacities to see how the system responds. Increased capacity will result in increased Delta diversions when salinity is low and reduced Delta diversions when salinity is high. This can effect CVP and SWP export operations if there are changes at Old and Middle River intake diversions when Old and Middle River flow criteria are controlling exports. Changes in storage capacity can also affect diversions of CCWD CVP contract supply.

Appendix C Simulation of Delta Regulatory Requirements

Unless otherwise noted, the water year types discussed in the following sections are based on the D-1641 Sacramento River 40-30-30 Index (SWRCB 1995).

- *W = Wet*
- *AN = Above Normal*
- *BN = Below Normal*
- *D = Dry*
- *C = Critical*
- *Subnormal Snowmelt = whenever the forecast of April through July unimpaired runoff is less than 5.9 MAF during an otherwise wet, above normal, or below normal year.*

This appendix describes the implementation of Delta regulatory controls in CalLite. The regulatory controls in CalLite allow users to specify requirements for interior Delta flows, minimum river flows, Delta outflows, export restrictions, and salinity objectives. The regulatory requirements modeled in CalLite Version 3.00 are based on D-1485, D-1641, the 2008 FWS BO RPA, the 2009 NMFS BO RPA, and other agreements relating to operation of the CVP and SWP. Figure 54 shows a map of the Delta with the locations of Delta regulatory controls (see Section 7.4).

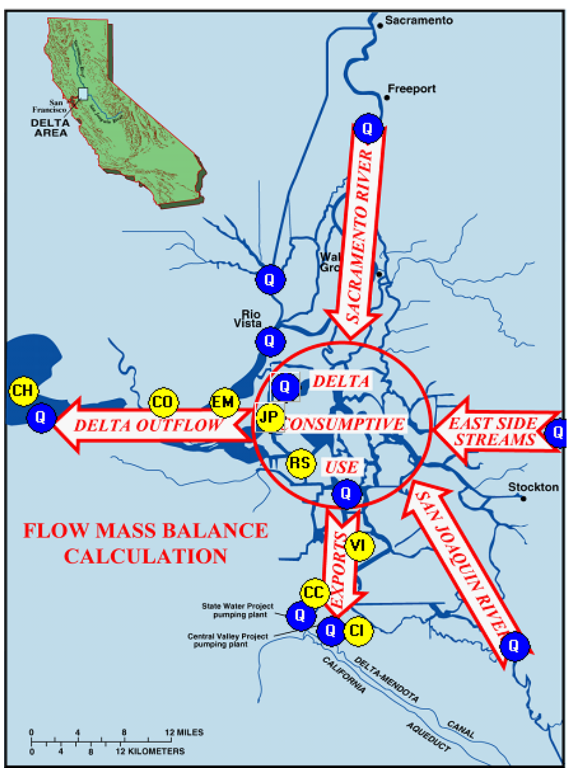


Figure 54. Delta regulatory control locations.

The methodology used in the implementation of Delta regulatory controls is identical to that used in the CalSim II model. However, in CalLite Version 3.00, the user can switch certain D-1485, D-1641, and BO RPA regulations on or off, enter user-defined values for some D-1485 and D-1641 requirements, and also add other user-defined regulations. These user selections are specified through dashboards in the GUI as shown in Figure 55, Figure 56, and Figure 58. If the user-defined button is selected for a D-1485, D-1641 or other regulation, a unique table is activated to enable custom inputs for the appropriate criteria.

The sections that follow describe the main Delta regulatory controls, assumptions, and method of implementation. The main controls are:

- Sacramento River at Rio Vista minimum flow
- Minimum Delta outflow
- X2 requirements
- Trigger for implementation of X2 Roe Island standard
- San Joaquin River near Jersey Point minimum flow (QWEST)
- Old and Middle River (OMR) maximum allowable negative (reverse) flows
- Delta Cross Channel gate position
- Export-inflow ratio based on total Delta inflow
- Export-inflow ratio based on San Joaquin River flow at Vernalis
- Vernalis Adaptive Management Plan (VAMP) export restrictions
- Salinity standards at Emmaton, Jersey Point, Rock Slough, Collinsville, Chipps, and Antioch

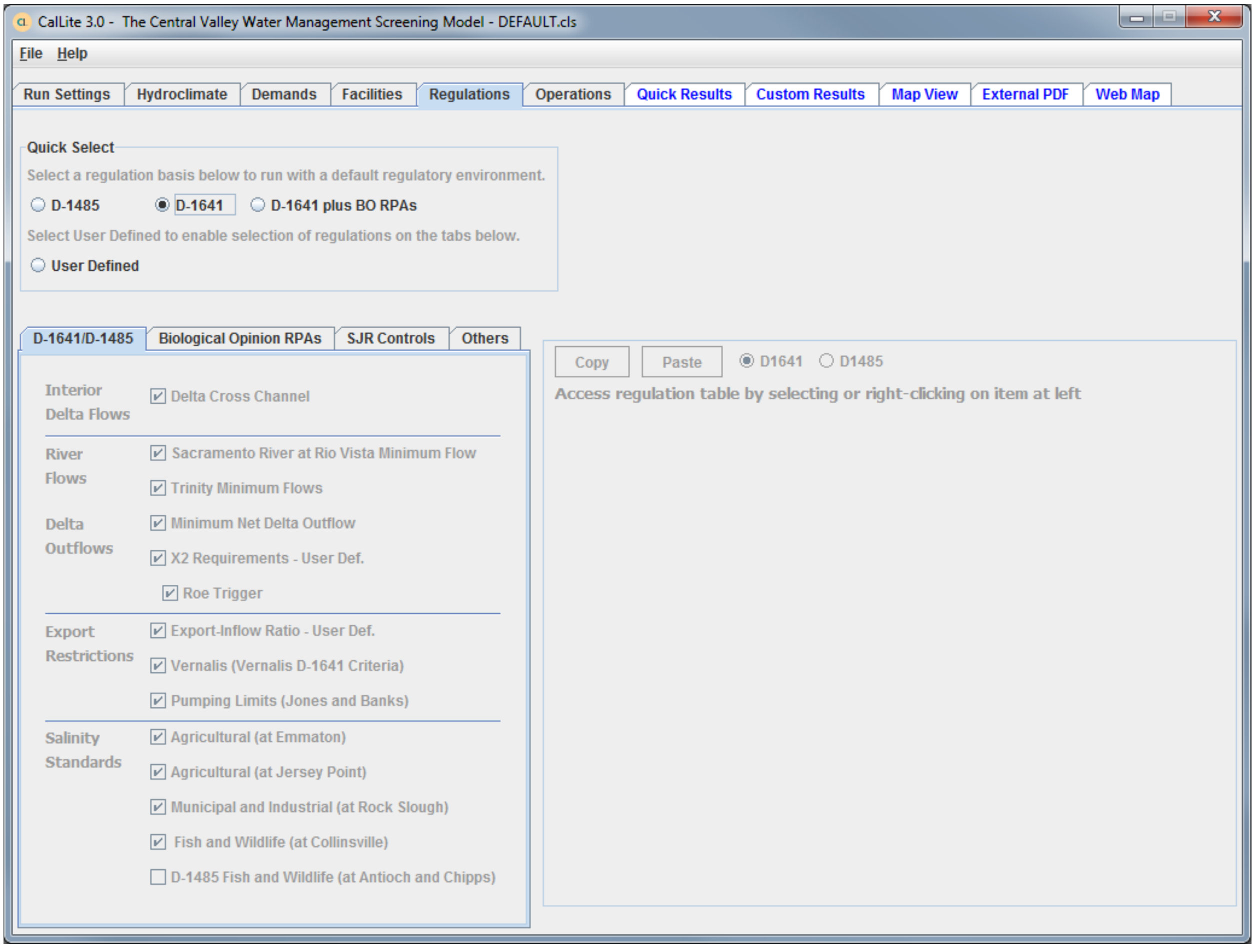


Figure 55. Delta regulatory control dashboard in CalLite - D-1641 standards.

NOTE: San Joaquin River at Vernalis minimum flow target cannot currently be modified by the user.

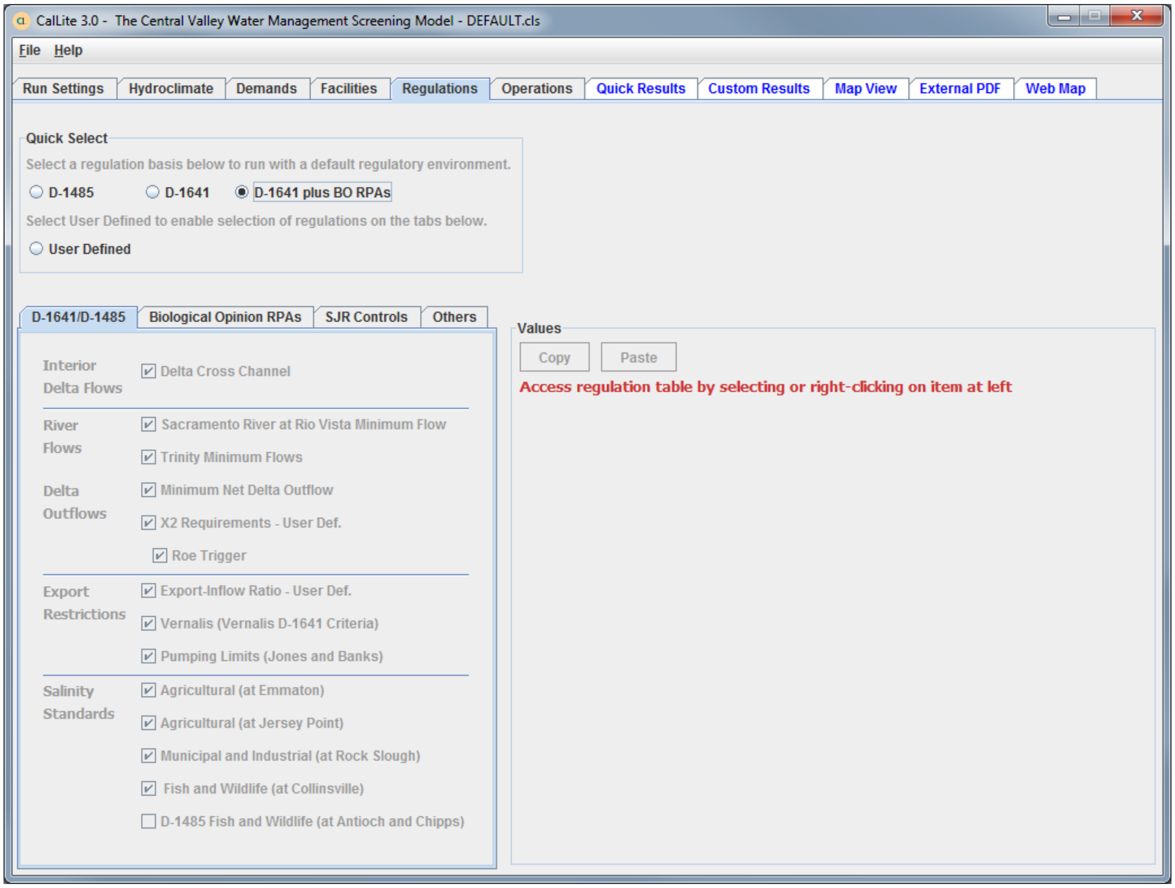


Figure 56. Delta regulatory control dashboard in CalLite - BO RPA standards.

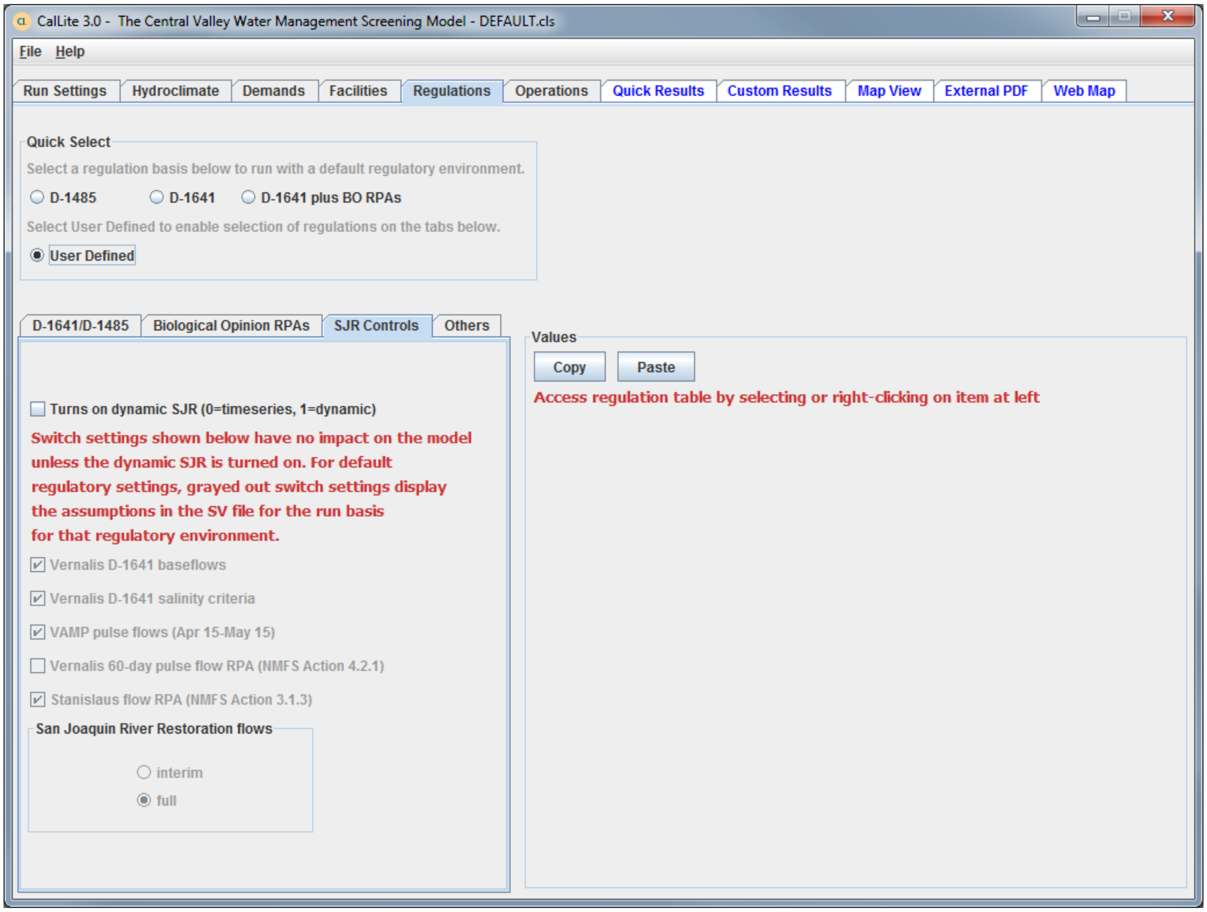


Figure 57. SJR Controls tab in CalLite

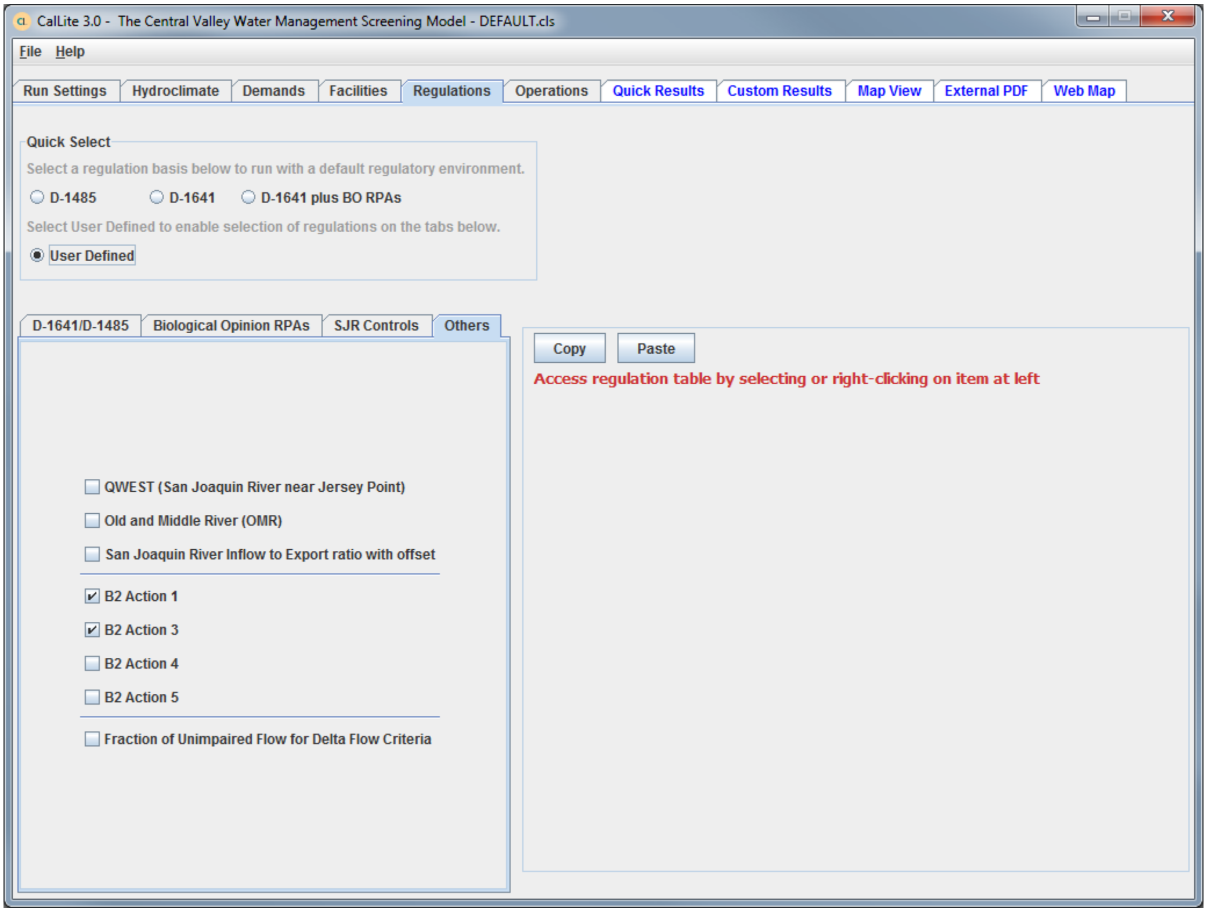


Figure 58. Delta regulatory control dashboard in CalLite - Other standards.

C.1 River Flows

C.1.1 Sacramento River at Rio Vista Minimum Flow

The minimum flow in the Sacramento River at Rio Vista is specified by month and water year type. The D-1485 standards include minimum flow requirements at Rio Vista throughout the whole year (see Table 29), while the D-1641 standards only have requirements Sep-Nov (see Table 28). While there are more D-1485 Rio Vista requirements throughout the year, the standards in Sep-Nov are typically lower than those of D-1641.

If incidental flow is insufficient to meet the requirement, additional flow is provided through releases from CVP and SWP reservoirs. Calculations of additional releases account for upstream loss of water through the Delta Cross Channel and Georgianna Slough, depending on Delta Cross Channel gate position.

Table 28. D-1641 requirements for Sacramento River at Rio Vista (cfs).

Year Type	Jan	Feb 1 - Mar 15	Mar 16 - Jun 30	Jul	Aug	Sep	Oct	Nov	Dec
W						3,000	4,000	4,500	
AN						3,000	4,000	4,500	
BN						3,000	4,000	4,500	
D						3,000	4,000	4,500	
C						3,000	3,000	3,500	

For D-1641, the 7-day running average shall not be less than 1,000 below the monthly objective.

Table 29. D-1485 requirements for Sacramento River at Rio Vista (cfs).

Year Type	Jan	Feb 1 - Mar 15	Mar 16 - Jun 30	Jul	Aug	Sep	Oct	Nov	Dec
W	2,500	3,000	5,000	3,000	1,000	5,000	5,000	5,000	5,000
AN	2,500	2,000	3,000	2,000	1,000	2,500	2,500	2,500	2,500
BN	2,500	2,000	3,000	2,000	1,000	2,500	2,500	2,500	2,500
D or C	1,500	1,000	2,000	1,000	1,000	1,500	1,500	1,500	1,500

In CalLite, the D-1485 Rio Vista requirement in March is assumed to be the average of the two surrounding standards. Thus the March D-1485 minimum flow requirements at Rio Vista are actually modeled in CalLite as shown in **Table 30**.

Table 30. CalLite representation of D-1485 March minimum flow requirements at Rio Vista.

Year type	March
W	4,000
AN	2,500
BN	2,500
D or C	1,500

C.1.2 San Joaquin River at Vernalis Minimum Flow

Version 3.00 of CalLite has an option for using either a fixed or dynamic representation of San Joaquin River operations. If the fixed option is chosen, the San Joaquin River flow at Vernalis is an input timeseries derived from CalSim II model results, which include the effects of D-1641 Vernalis minimum flow requirements. The dynamic option allows user selection or variation of the Vernalis Minimum Flow.

C.2 Delta Outflow

Calculation of total required Delta outflow considers the NDO flow requirement (D-1641 and D-1485) and the X2 required outflows (D-1641 only) described below.

C.2.1 Minimum Net Delta Outflow (NDO)

Under D-1641 standards, the minimum net Delta outflow is specified by month and water year type (see Table 31). Under D-1641 regulation, the X2 standard is used during Feb–Jun.

Table 31. D-1641 minimum average monthly net delta outflow requirements.

Year Type	JAN	FEB-JUN	JUL	AUG	SEP	OCT	NOV-DEC
W	4,500 (6,000 if Dec 8RI > 800 TAF)	X2 Standard	8,000	4,000	3,000	4,000	4,500
AN			8,000	4,000	3,000	4,000	4,500
BN			6,500	4,000	3,000	4,000	4,500
D			5,000	3,500	3,000	4,000	4,500
C			4,000	3,000	3,000	3,000	3,500

Note: 8RI refers to the Eight River Index which is the sum of the unimpaired forecasted flow for:

1) Sacramento River at Bend Bridge;
2) Feather River at Lake Oroville;
3) Yuba River at Smartsville;
4) American River at Folsom Lake;
5) Stanislaus River at New Melones Reservoir;
6) Tuolumne River at Don Pedro Reservoir;
7) Merced River at Exchequer Reservoir; and
8) San Joaquin River at Millerton Lake.

Under D-1485 standards, the minimum Delta outflow is based on several requirements at Chipps Island (see Table 32).

Table 32. D-1485 minimum average monthly Delta outflow requirements at Chipps Island.

Year Type	JAN	FEB	MAR	APR 1 - 14	APR 15 - 30	MAY 6 - 31	JUN	JUL
W		10,000	10,000	6,700 APR 1-14 and 10,000 APR 1-30		14,000	14,000	10,000
AN				6,700		14,000	10,700	7,700
BN				6,700		11,400	9,500	6,500
Subnormal Snowmelt		10,000	10,000	6,700 APR 1-14 and 10,000 APR 1-30		6,500	5,400	3,600
D (after a W/AB/BN)				6,700		4,300	3,600	3,200
D (after a D/C) or C				6,700		3,300	3,100	2,900

The specific Chipps Island requirements under D-1485 are:

1) 6,700 cfs during Apr 1st – Apr 14th for Striped Bass Spawning
2) 2,900-14,000 cfs during May 6th – Jul for Striped Bass Survival
3) 10,000 cfs during Feb-May of Wet years, 10,000 cfs during Feb-Apr of Subnormal Snowmelt years for Suisun Marsh.

4) 12,000 cfs for 60 consecutive days during Jan-Apr of Above Normal or Below Normal years for Suisun Marsh.
5) 6,600 cfs during Jan-May when storage is at or above the minimum flood control level at two out of three of: Shasta, Oroville, and CVP storage on the American.

Unlike D1641, D1485 does not include an X2 requirement. In CalLite, the partial month standards for minimum Delta outflow are handled in the mrdo-final.wresl file, which calculates an overall Delta outflow necessary to meet all of the standards. In August-December and sometimes in January-March (whenever the 12,000 cfs or 6,600 cfs Suisun Marsh requirements do not apply) a minimum monthly delta outflow requirement of 2,500 cfs is assumed in CalLite. The 12,000 cfs Suisun Marsh requirement for 60 consecutive days is represented in CalLite by checking January's Net Delta Outflow Index[7] (NDOI) level when the model timestep is in February. If January's (the previous month's) NDOI was above 12,000 cfs, the model forces the required Delta outflow in February to be 12,000 cfs (thus fulfilling the 60 day requirement). If NDOI is not above 12,000 cfs in January, the model checks NDOI in February and repeats the logic. If NDOI is not above 12,000 cfs in January *or* February, the model will require delta outflow during March and April to be above 12,000 cfs

If incidental flow is insufficient to meet the requirement, additional flow is provided through releases from CVP and SWP reservoirs.

C.2.2 X2 Requirements

X2 is the location of the 2 parts per thousand salinity contour (isohaline), one meter off the bottom of the estuary, as measured in kilometers upstream from the Golden Gate Bridge. In D-1641, an electrical conductivity (EC) value of 2.64 mmhos/cm is used to represent the X2 location. In CalLite the X2 position is estimated using an Artificial Neural Network (ANN) Dynamic Link Library. The ANN is briefly described in Appendix F.2.

There is no X2 requirement under a D-1485 regulatory environment.

The D-1641 X2 standard is specified in terms of the number of days in a given month X2 has to be located at or west of a particular compliance location. There are three possible compliance locations: Collinsville, Chipps Island, and Roe Island. Each day the requirement may be satisfied any of three ways: 1) the daily salinity at the compliance location is at or less than 2.64 mmhos/cm; 2) The 14 day running average at the compliance location is at or less than 2.64 mmhos/cm; or 3) The daily Net Delta Outflow Index equals or exceeds the compliance location's maximum flow effort threshold (Collinsville = 7,100 cfs; Chipps Island = 11,400 cfs; Roe Island = 29,200 cfs). In each month from Feb-June the X2 standard has to be met for a specified number of days at each of the three compliance locations, as described below.

At Collinsville, X2 compliance is required February through June for the entire month. The only exception to this is that if the Sacramento River Index (SRI) is less than 8.1 MAF (90% exceedance),

[7] NDOI is defined in D-1641 regulations.

the Collinsville standard does not apply in May and June and the minimum 14 day running average of 4,000 cfs is used instead. The SRI is the sum of the unimpaired forecasted flow for: 1) Sacramento River at Bend Bridge; 2) Feather River at Lake Oroville; 3) Yuba River at Smartsville; and 4) American River at Folsom Lake.

At Chipps Island, X2 compliance is required for at least the number of days shown in Table 33. The required days are linearly interpolated between the values shown in the table. The same 90% exceedance exception for Collinsville applies here as well. Obviously, a day of X2 compliance at Chipps would simultaneously satisfy the Collinsville X2 requirement.

Table 33. D-1641 Required X2 compliance days at Chipps Island (days).

Previous Month's 8RI (TAF)	Feb	Mar	Apr	May	Jun
<= 500	0	0	0	0	0
750		0	0	0	0
800	0				
1000	28	12	2	0	0
1250	28	31	6	0	0
1500	28	31	13	0	0
1750	28	31	20	0	0
2000	28	31	25	1	0
2250	28	31	27	3	0
2500	28	31	29	11	1
2750	28	31	29	20	2
3000	28	31	30	27	4
3250	28	31	30	29	8
3500	28	31	30	30	13
3750	28	31	30	31	18
4000	28	31	30	31	23
4250	28	31	30	31	25
4500	28	31	30	31	27
4750	28	31	30	31	28
5000	28	31	30	31	29
5250	28	31	30	31	29
>=5250	28	31	30	31	30

When triggered at Roe Island (Port Chicago), X2 compliance is required for at least the number of days shown in

Table 34. This requirement is "triggered" if the 14-day running average EC at Roe Island is less than or equal to 2.64 mmhos/cm on the last day of the previous month. The required days are linearly interpolated between the values shown in the table. The same 90% exceedance exception for Collinsville applies here as well.

Table 34. Required X2 compliance days at Roe Island (days).

Previous Month's 8RI (TAF)	Feb	Mar	Apr	May	Jun
0	0	0	0	0	0
250	1	0	0	0	0
500	4	1	0	0	0
750	8	2	0	0	0
1000	12	4	0	0	0
1250	15	6	1	0	0
1500	18	9	1	0	0
1750	20	12	2	0	0
2000	21	15	4	0	0
2250	22	17	5	1	0
2500	23	19	8	1	0
2750	24	21	10	2	0
3000	25	23	12	4	0
3250	25	24	14	6	0
3500	25	25	16	9	0
3750	26	26	18	12	0
4000	26	27	20	15	0
4250	26	27	21	18	1
4500	26	28	23	21	2
4750	27	28	24	23	3
5000	27	28	25	25	4
5250	27	29	25	26	6
5500	27	29	26	28	9
5750	27	29	27	28	13
6000	27	29	27	29	16
6250	27	30	27	29	19
6500	27	30	28	30	22
6750	27	30	28	30	24
7000	27	30	28	30	26
7250	27	30	28	30	27
7500	27	30	29	30	28
7750	27	30	29	31	28
8000	27	30	29	31	29
8250	28	30	29	31	29
8500	28	30	29	31	29
8750	28	30	29	31	30
9000	28	30	29	31	30
9250	28	30	29	31	30
9500	28	31	29	31	30
9750	28	31	29	31	30
10000	28	31	30	31	30
>10000	28	31	30	31	30

If the user wants to specify alternative X2 requirements, first it is necessary to select the months in which the standard is to be active. Once these months are selected, the user enters desired monthly average X2 position by month and water year type.

C.2.3 Trigger for Implementation of X2 Roe Island standard

This Roe Trigger is normally a part of D-1641 regulations. Under D-1641 standards, X2 is required to be at or west of Roe Island for the number of days defined in Table 34 if the preceding month's X2 position is west of Roe. If the preceding month's X2 position was east of Roe, then the required number of X2 compliance days for Roe is automatically set to 0. CalLite provides an option to include or exclude this trigger. If the trigger is not used, then the required number of X2 compliance days for Roe is always 0.

C.3 Interior Delta Flows

Regulations of the Interior Delta flows are handled on the “Others” regulation tab in CalLite.

C.3.1 San Joaquin River near Jersey Point (QWEST)

The San Joaquin River flow near Jersey Point, also known as QWEST, is often used as an indicator of flow reversals in the lower San Joaquin River. While there is no current regulatory standard for QWEST, some (e.g. NMFS 1993) have proposed minimum flow requirements based on QWEST to sustain transport flows in the westward direction.

In CalLite there is a user-defined standard for QWEST flow that can be activated. The standard is specified by month and water year type.

C.3.2 Old and Middle River combined flow (OMR)

Combined Old and Middle River flows restrictions are proposed as a means for reducing flow reversals in these channels and limiting entrainment of Delta smelt and anadromous fish at the SWP and CVP export facilities.

CalLite approximates the OMR flows by using a regression equation (see below) developed by Hutton (2008), which has been calibrated to historical flow conditions as well as a full range of hydrodynamic simulation results from the Delta Simulation Model II (DSM2) model. This equation relates OMR flow to south Delta diversions (including some of CCWD diversions and local Delta Island channel depletions) and the flow in the San Joaquin River at Vernalis. The equation includes differing coefficients depending on Vernalis flow, head of Old River barrier (HORB) operation, and Grant Line Canal (GLC) barrier operation as shown below. This equation is reported to be the most accurate of existing equations designed for this purpose, but no independent analysis has been performed.

$$Q_{OMR}\ (cfs) = A * Q_{Vernalis} + B * Q_{South\ Delta\ Diversions} + C$$

Where: $Q_{South\ Delta\ Diversions} = Q_{CCF} + Q_{Jones} + Q_{CCWD} + Q_{South\ Delta\ NCD}$

Table 35. Coefficients for the OMR flow equation for various combinations of Vernalis flow, HORB operation and GLC operation.

HORB	GLC Barrier	Vernalis (cfs)	A	B	C
Out	Out	< 16,000	0.471	-0.911	83
Out	Out	16,000-28,000	0.681	-0.940	-3008
Out	Out	> 28,000	0.633	-0.940	-1644
Out	In	All	0.419	-0.924	-26
In (Spring)	Out/In	All	0.079	-0.940	69
In (Fall)	Out/In	All	0.238	-0.930	-51

OMR restrictions in CalLite are applied by preventing flow from being less (more negative) than a defined standard, and are also translated into a maximum export restriction which allows for the proper OMR flows. Allowable pumping when the OMR requirement is governing export operations is currently shared equally between the SWP and CVP. Logic attempting to reflect USFWS' Dec 2008 OCAP BO RPA Actions 1, 2, and 3 for OMR was developed for CalSim II by a multi-agency group in 2009, and CalLite uses this same logic for applying OMR flow restrictions. The specifics of the OMR RPA standard are described in a later section of this appendix on BO RPA actions. CalLite also has a user-defined OMR option that specifies minimum allowable OMR values by month and water year type.

C.4 Delta Cross Channel (DCC)

Operation of the Delta Cross Channel assists in transferring fresh water from the Sacramento River across the Delta (DWR 1993). Flow from the Sacramento River into the DCC is controlled by two radial arm gates located at the Sacramento River end of the DCC. These gates can be opened and closed depending on water quality, flood protection, recreation, and fish protection requirements. Historically during periods of high salinity the DCC gates have been opened, and during periods of low salinity the DCC gates have been closed. See Table 36 for the monthly DCC gate closures as implemented in CalLite under a D-1641 or a D-1485 scenario.

Table 36. CalLite implementation of closure of the Delta Cross Channel for D-1641 and D-1485 scenarios.

	Days Closed	
	D1641	D1485
Oct	0	0
Nov	10	0
Dec	15	0
Jan	20	31
Feb	28	28
Mar	31	31
Apr	30	21
May	31	14
Jun	4	0
Jul	0	0
Aug	0	0
Sep	0	0

Over the long term, the Delta cross channel gates are open for more days with a D-1485 scenario (see Table 37). Details of the operation under each decision are provided below.

Table 37. Cross channel days open with D-1485 (Scenario 7) minus days open with D-1641 (Scenario 9) over the long term.

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
AVG:	0	9	10	7	7	8	15	20	4	0	0	0
MIN:	0	0	-16	-11	0	0	0	0	0	0	0	0
MAX:	0	30	15	20	29	31	30	31	4	0	0	0

C.4.1 D-1485 Regulation

Under D-1485 regulation, there are two requirements for closure of the delta cross channel gates. The first is to minimize diversions of young striped bass into the Central Delta and requires closure of the gates for up to 20 days between April 16th and May 31st when the daily Delta outflow index is greater than 12,000 cfs. In CalLite, the Delta outflow index for use in D-1485 scenarios is calculated slightly differently, it is represented as the Net Delta Outflow Index (NDOI)[8]. This striped bass requirement also states that the gates should not be closed for more than two out of four consecutive days, but this is not implemented in CalLite since it is a monthly timestep model.

The second D-1485 cross channel gate requirement is for closure of the gates anytime daily Delta ouflow index is greater than 12,000 cfs between Jan 1st and April 16th. This standard minimizes cross Delta movement of Salmon.

[8] NDOI is defined in D-1641 regulations.

To implement these two April cross channel gate standards in CalLite, it is assumed that the gates are closed for 21 days total during this month: six days to meet the striped bass requirement and an additional 15 days to meet the salmon requirement. The other 14 days needed to meet the striped bass requirement are made up in May.

The D1485 model is also run with a flood flow requirement that will close the gates if C_Hood is greater than 25,000 cfs. To handle both the 12,000 cfs delta outflow requirement and the 25,000 cfs flood flow requirement, it is assumed in the first model cycle that the gates are open in all months. By the second cycle, however, the model is able to accurately predict a flood flow and so the cross channel gate closure is also accurate.

A few checks were completed to ensure that the model closes the cross channel gates as required by the D-1485 standards. By the final cycle, the model performs exactly as expected given the D-1485 standards and the flood flow requirement.

C.4.2 D-1641 Regulation

Under D-1641, the Cross Channel Gates may be closed for up to 45 days during the Nov – Jan period for fishery protection. CalLite assumes a fixed schedule: 1) Nov, 10 days closed; 2) Dec, 15 days closed; and 3) Jan, 20 days closed. The Cross Channel Gates are closed Feb – May 20, and closed for 14 days between May 21 – Jun 15. In addition, to prevent channel scour, the gates are closed whenever Freeport flows are sustained above 25,000 CFS. CalLite also has an option to implement NMFS' June 2009 OCAP BO RPA Action IV.1.2 for the DCC operation on top of the D-1641 standard. This is described in a later section of this Appendix on BO RPAs. A user-defined option is also available. Under D-1641, RPA, or user-defined operations, the number of days “open” are specified and a fraction is computed internally depending on the number of days in the month.

The flows through the DCC and Georgianna Slough are estimated based on the regression equations that relate DCC+GEO flow to upstream Sacramento River flow and gate position. These equations are:

$$Q_{dcc+geo\_open} = 0.293*Q_{sac}+2090 \text{ cfs (DCC gates open)}$$

$$Q_{dcc+geo\_closed} = 0.133*Q_{sac}+829 \text{ cfs (DCC gates closed)}$$

The diversion from Sacramento River to the Central Delta is then calculated as:

$$Q_{dcc+geo\_open}*\text{DCC\_FractOpen}+Q_{dcc+geo\_closed}*(1\text{-DCC\_FractOpen})$$

The DCC impact on salinity is considered in the Artificial Neural Network (ANN) flow-salinity computations.

C.5 Export Restrictions

CalLite monthly exports are typically restricted according the following constraints: pumping and conveyance restrictions, export-inflow (EI) ratio, VAMP period export limits, and salinity controls. In addition, OMR restrictions (Section C.3.2) and BO RPA actions for Fall X2 (Section C.7.2) and the DCC (Section C.7.4) are also translated into export constraints under certain conditions. Pumping restrictions (D-1485 and D-1641), the EI ratio (D-1641 only), and VAMP limits (D-1641 only) are discussed below.

C.5.1 Pumping Restrictions

D-1485 places a 3,000 cfs export restriction in May and June for Jones and Banks pumping plants and an additional restriction of 4,600 cfs in July for Banks (see Table 38).

Table 38. Jones and Banks monthly pumping limits under D-1485 and D-1641 standards.

		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT
Jones	D-1485	4,600	4,600	4,600	4,600	**3,000**	**3,000**	4,600	4,600	4,600	4,600
	D-1641	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600	4,600
Banks	D-1485	6,680	6,680	6,680	6,680	**3,000**	**3,000**	**4,600**	6,680	6,680	6,680
	D-1641	6,680	6,680	6,680	6,680	6,680	6,680	6,680	6,680	6,680	6,680

Condition 3 of D-1485 allows the CVP to make up any deficiency caused by the May/June 3,000 cfs restriction through coordinated operations with the SWP in later months ("payback wheeling", see Section 6.5.4.2). This may be achieved by either direct diversion or re-diversion of releases of stored water through SWP facilities. The CalLite model handles this operation through the addition of payback wheeling terms.

C.5.2 Export-Inflow Ratio

EI ratios limit the combined export rate of the SWP and CVP to a specified percentage of the total Delta inflow. Under default D-1641 criteria, the February value is computed based on the January Eight River Index, while all other months have a specific maximum EI ratio (see Table 39). If user-defined EI values are specified, all months have specific maximum ratios. If EI ratio limits total project exports, the allowable export capacity is theoretically shared equally between the SWP and CVP, although under the Coordinated Operations Agreement (COA), if one project cannot use its full share due to operational limitations, the unused share can be used by the other party.

Table 39. D-1641 Export/Inflow Restrictions.

Monthly Periods	Maximum Allowable Export/Inflow Ratio Restriction
Oct – Jan	65 %
Feb	35 % (If Jan 8RI >= 1.5 MAF) 45 % (If Jan 8RI <= 1.0 MAF) 35% - 45% (If Jan 8RI between 1.0 & 1.5 MAF)
Mar - Jun	35%
Jul – Sep	65%

C.5.3 Export-San Joaquin River Inflow Ratio

A user-defined ratio of export to San Joaquin inflow is included in CalLite and works similarly to the EI ratio described in the above section. This implementation relates the maximum allowable export to the San Joaquin River flow at Vernalis. The user has the ability to define this cap using a multiplier and offset in the form:

$$\text{Exports} \leq [A + (B * Q_{\text{San Joaquin at Vernalis}})]$$

Both coefficients A and B can vary by month and water year type, and are entered by the user in the Regulations/Others dashboard. This criteria differs from the D-1641 EI ratio criteria not only in the format (i.e. offset and multiplier vs. the specification of a ratio) but also in that this export cap has no effect on increasing inflow to the Delta from the San Joaquin River, since these flows are not controlled by COA.

NMFS' June 2009 OCAP BO RPA Action IV.2.1 Phase II for the San Joaquin River is also available to the user as an option for specifying export limits based on Vernalis flow. This is described later in Appendix C.7.

C.5.4 Vernalis Adaptive Management Plan (VAMP) Export Limits

D-1641 restricts SWP and CVP exports during the Spring pulse window of April 15 – May 15 to a combined rate of the maximum of 1500 cfs or 100% of the 3-day running average of the flow at Vernalis. As with other export limits, the allowable export capacity is shared equally between the SWP and CVP.

An additional Spring pulse period export cap is imposed on the CVP as a B2 action (§3406(b)(2) of the Central Valley Project Improvement Act (CVPIA), which directs the CVP to dedicate up to 800 TAF of project yield to beneficial uses for fish, habitat, and other environmental purposes). This B2 Action 3 export cap on CVP pumping is 750 cfs when the VAMP flow target is 2000, 3200, or 4450 cfs; 1125 cfs when the flow target is 5700 cfs; and alternates between 750 and 1500 when the flow target is 7000 cfs. The only exception is that when Vernalis flow is > 8600 cfs, the limit is the maximum of Vernalis flow/2 and 3000 cfs. This same additional Spring pulse period export cap is imposed on the SWP under operational assumptions adopted during testing of the Environmental Water Account.

In certain situations, it is possible for the user to have the VAMP export cap turned on while the VAMP pulse flows are turned off (either when using the dynamic San Joaquin module or when using a D-1485 run basis, which has no VAMP pulse flows). In these cases the VAMP export cap will be de-activated, since that cap is based on the pulse flow requirement, so cannot be accurately set without it. In these cases the D-1641 export cap will remain active.

VAMP export limits do not occur under a D-1485 regulatory environment, but there is the option in CalLite to use D-1641 VAMP “on” hydrology with a D-1485 regulatory environment (to allow better isolation of various criteria effects).

C.6 Salinity

The salinity in the Delta is estimated in the CalLite model through implementation of the most recent ANNs developed by DWR (1995). The ANNs receive inputs of boundary flows, DCC gates position, exports, San Joaquin salinity, and tides to estimate salinity (electrical conductivity) at each of these locations. Through a linkage to the external ANNs, the CalLite model can both simulate the monthly and 14-day average salinity in the forward direction, and approximate the maximum allowable export for a given maximum salinity in the reverse direction. The allowable export capacity for SWP and CVP is shared per COA, since meeting salinity is an in-basin use under COA. The CalLite model allows the user to turn on and off specific standards, but the ability to specify new standards is not currently enabled.

D-1485 and D-1641 regulations lay out several standards (detailed below) to protect the following beneficial uses: municipal and industrial, agriculture, and fish and wildlife. Note that the physical standards are sometimes buffered (lowered) or ramped (preceded) when implemented in CalLite in order to ensure compliance.

C.6.1 Municipal and Industrial Water Quality Standards

To protect municipal and industrial beneficial uses, D-1485 regulation sets maximum mean daily chloride standards at five locations: Contra Costa Canal Intake (or at Antioch Water Works Intake on the San Joaquin River), City of Vallejo Intake at Cache Slough, Clifton Court Forebay Intake at West Canal, and Delta Mendota Canal at Tracy Pumping Plant. These requirements are identical to those in D-1641 regulations, with the exception of an additional standard location (Barker Slough at North Bay Aqueduct Intake) in D-1641. In CalLite, we only model the chloride standards at the Contra Costa Canal Intake and this standard is applied at the Rock Slough junction.

C.6.1.1 Rock Slough

The D-1485/D-1641 requirements set two Chloride standards at Rock Slough. The first is a maximum mean daily chloride level of 250 mg/L throughout the year. The second is a requirement to keep mean daily Chloride levels under 150 mg/L for a certain amount of days per year, depending on the water year type (see Table 40).

Table 40. Maximum allowable salinity at Rock Slough.

	Number of Days Each Calendar Year Less than 150 mg/L Cl	Percent of Calendar Year
W	240	66%
AN	190	52%
BN	175	48%
D	165	45%
C	155	42%

The Chloride standards at Rock Slough are modeled as shown in Table 41. Notice that a compliance buffer is created in CalLite by using 225 mg/L and 130 mg/L as the maximum Chloride levels instead of 250 mg/L and 150 mg/L, respectively. This buffer is necessary in CalLite because of uncertainty in

ANN calculations. Also, ramping occurs on either ends of the 130 mg/L standard during some water year types to prevent large jumps in the Chloride levels.

Table 41. Maximum Rock Slough salinity requirement as modeled in CalLite (in mg/L Chloride).

	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
W	225	225	225	130	130	130	130	130	130	130	130	225
AN	225	225	225	225	130	130	130	130	130	130	151	225
BN	225	225	225	225	130	130	130	130	130	130	225	225
D	225	225	225	172	138	130	130	130	130	130	225	225
C	225	225	225	172	130	130	130	130	130	172	225	225

C.6.2 Agriculture Water Quality Standards

The D-1485 and D-1641 requirements for protecting agriculture are identical. Both regulations place requirements in the Western and Interior Delta at Emmaton, Jersey Point, Terminous, and San Andreas Landing. The standards at Terminous and San Andreas Landing are not included in the CalLite Model.

C.6.2.1 Emmaton

D-1485/D-1641 regulations place a maximum 14-day running average of mean daily electrical conductivity (EC) at Emmaton on the Sacramento River. This standard is applied from April 1st to August 15th during all year types (see Table 42).

Table 42. Maximum allowable salinity at Emmaton (in mmhos).

<table>
<tr><th>Year Type</th><th>APR</th><th>MAY</th><th colspan="2">JUN</th><th>JUL</th><th colspan="2">AUG</th></tr>
<tr><td>W</td><td colspan="6">0.45</td><td></td></tr>
<tr><td>AN</td><td colspan="4">0.45</td><td colspan="2">0.63</td><td></td></tr>
<tr><td>BN</td><td colspan="3">0.45 (until June 20)</td><td colspan="3">1.14</td><td></td></tr>
<tr><td>D</td><td colspan="3">0.45 (until June 15)</td><td colspan="3">1.67</td><td></td></tr>
<tr><td>C</td><td colspan="6">2.78</td><td></td></tr>
</table>

To implement these EC requirements in CalLite, the standards are modified slightly as shown below in Table 43. The standard for June during Below Normal and Dry years is calculated from a day-weighted average of the May and July standards. The standards for August (for all years except Critical) are also calculated from a day-weighted average by assuming that salinity is 2.25 mmhos for August 15th-31st. This helps ensure that a large jump in salinity does not occur immediately after relaxation of the standard. The August standard during a critical year is assumed to be continued from the April-July requirement (2.78 mmhos). There is no EC standard for September-March.

Table 43. Implementation of maximum Emmaton EC standards in CalLite (in mmhos).

Year Type	APR	MAY	JUN	JUL	AUG
W	0.45				1.65
AN	0.45			0.63	1.74
BN	0.45		0.68	1.14	1.99
D	0.45		1.06	1.67	2.24
C	2.78				

C.6.2.2 Jersey Point

D-1485/D-1641 regulations place a maximum 14-day running average of mean daily EC at Jersey Point on the San Joaquin River. This standard is applied from April 1st to August 15th during all year types (see Table 44).

Table 44. Maximum allowable salinity at Jersey Point (in mmhos).

Year Type	APR	MAY	JUN	JUL	AUG
W	0.45				
AN	0.45				
BN	0.45 (until June 20)		0.74		
D	0.45 (until June 15)		1.35		
C	2.2				

To implement these EC requirements in CalLite, the standards are modified slightly as shown below in Table 45. The process is the same as that described above for Emmaton EC standards. The standard for June during Below Normal and Dry years is calculated from a day-weighted average of the May and July standards. The standards for August are also calculated from a day-weighted average by assuming that salinity is 2.25 mmhos for August 15th-31st. This helps ensure that a large jump in salinity does not occur immediately after relaxation of the standard. There is no EC standard for September-March.

Table 45. Implementation of Jersey Point EC standards in CalLite (in mmhos).

Year Type	APR	MAY	JUN	JUL	AUG
W	0.45				1.35
AN	0.45				1.35
BN	0.45		0.55	0.74	1.49
D	0.45		0.9	1.35	1.79
C	2.2				

C.6.3 Fish and Wildlife Water Quality Standards

To protect water quality for fish and wildlife, D-1485/D-1641 regulations set maximum EC levels at Prisoners Point, Antioch Waterworks Intake, Chipps Island, Collinsville, and several miscellaneous locations near Suisun Marsh. Only the Salinity standards at Antioch (D-1485 only), Chipps Island (D-1485 only), and Collinsville (D-1485 and D-1641) are modeled in CalLite.

C.6.3.1 Antioch Waterworks Intake

There are two D-1485 EC standards at Antioch Waterworks Intake on the San Joaquin River. Both standards are for striped bass spawning. The first standard is a 1.5 mmhos maximum for the average of mean daily EC from April 15th through May 1st. This is implemented in CalLite by assuming the standard only exists for the full month of April. The second standard is a relaxation provision that replaces the first Antioch standard whenever the projects impose deficiencies in firm supplies. This second EC standard is in place during April 1st to May 5th and ranges from a maximum of 1.5 mmhos to 25.2 mmhos (depending on total annual imposed deficiencies). This relaxation provision is not implemented in the CalLite model.

C.6.3.2 Chipps Island

D-1485 regulations place a maximum 28-day running average of mean daily EC at Chipps Island in Suisun Marsh. A maximum average EC of 12.5 mmhos is required October through May and an EC of 15.6 mmhos is required October through December only when project water users are taking deficiencies in scheduled water supplies and it is a Dry or Critical year. In CalLite, the 28-day running average is implemented as a monthly standard. It is assumed that projects take deficiencies during the 14 dry/critical years listed in Table 46.

Table 46. List of critical years when projects deficiencies are assumed[9].

1924	1926
1930	1931
1932	1933
1934	1977
1988	1989
1990	1991
1992	1994

C.6.3.3 Collinsville

D-1485/D-1641 requires the monthly average of both daily high tide values at Collinsville on the Sacramento River to no exceed the values shown in Table 47. These monthly EC requirements are modeled in CalLite exactly as shown in Table 47, but they are assumed to be average monthly requirements (not average of both high tide values, as specified in D-1485/D-1641 regulation). There is no EC standard implemented in CalLite for June through September.

[9] This list of project deficient years was copied from the 2008 OCAP CalSim study.

Table 47. Maximum allowable salinity at Collinsville (in mmhos).

	EC (mmhos)
OCT	19.0
NOV	15.5
DEC	15.5
JAN	12.5
FEB	8.0
MAR	8.0
APR	11.0
MAY	11.0

C.7 Biological Opinion Reasonable and Prudent Alternative (BO RPA) Actions

The CalLite model uses the same implementations of the USFWS OCAP Smelt BO (FWS 2008) and NMFS OCAP Salmon BO (NMFS 2009) actions that were developed for CalSim II. Switches built into CalLite allow the user the option to turn each RPA on or off individually. The modeling logic is described below – as with the CalSim II model, given the dynamic, real world data-conditioned nature of the RPA actions and the relatively generalized representation of the RPA actions in the model, much caution is required when interpreting outputs from the model.

C.7.1 Old and Middle River Flow Criteria (FWS RPA Actions 1-3)

Actions 1-3 of the FWS Smelt RPA specify limits on how negative the combined flows in Old and Middle River (OMR) may be. As described in the earlier OMR section, limits on negative flow may limit exports at Jones (CVP) and Banks (SWP) pumping plants. The three actions generally follow one another sequentially, potentially limiting exports in any month from December through June. The actions are based on triggers for turbidity, salvage, temperature, and spawning. CalSim II uses hydrologic conditions and historical air temperature as surrogates for determining turbidity and temperature triggers. Specific standards vary from -1,250 to -5,000 cfs depending on which Action is being implemented and other criteria described in the BO. OMR criteria are relaxed if necessary such that any effective limit on combined Jones and Banks exports does not drop below 1,500 cfs, for health and safety purposes.

The three OMR actions are not easily toggled on and off independently given the interdependent manner in which they are specified in the Smelt BO, so the user can either turn them all on or all off using the GUI. Because there is also a user-defined option for OMR flows which could conflict with the RPA standard, if the user-defined option is activated, the RPA standard is automatically deactivated even if its checkbox is on, and only the user-defined standard applies.

To be consistent with CalSim II, the smelt OMR actions are assumed to by and large cover similar OMR actions contained in the NMFS Salmon BO.

C.7.2 Fall X2 Requirements (FWS RPA Action 4)

This action requires the X2 position in each of the months of September and October to be no farther east than 74km following wet water years and 81km following above normal water years. In November, continued adherence to the Fall X2 target can require release of up to the total inflow to CVP/SWP reservoirs in the Sacramento Basin. The action is modeled in CalLite in the same manner as in CalSim II, as summarized in Table 48 below. If reservoir releases are not sufficient to meet the X2 requirement in September and October, exports may also be restricted, though never below 1,500 cfs for health and safety reasons.

Table 48. Summary of FWS RPA Action 4 implementation.

Fall Months following Wet or Above Normal Years	Action Implementation
September (last month of Wet or Above Normal water years) and October (first month immediately following Wet or Above Normal water years)	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
November (2nd month following Wet or Above Normal water years)	Make additional reservoir releases up to natural inflow as needed to continue to meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)

Note: The description in this table refers to the Oct-Sept water year, as used in CalSim/CalLite computations.

This action can be turned on or off in CalLite using the GUI. Both D-1641 and RPA X2 standards can be applied at the same time, since they apply in different months. But if the user has specified user-defined criteria for X2, then the RPA X2 standard is always turned off even if its checkbox is on, to prevent confusion about which standard applies.

C.7.3 Clear Creek Flows (NMFS RPA Action 1.1.1)

This action calls for spring attraction flows to encourage fish to move upstream for spawning in Clear Creek. Although the action specifies 2 pulse flows of 600 cfs for 3 days in each of the months of May and June, as in the CalSim II model, CalLite implements the criteria by increasing required Clear Creek flows by 600 cfs for 6 days all in the month of May. This approach accommodates the underestimate of the actual flows that would occur subject to the daily operational constraints of Whiskeytown Reservoir. The implementation of the RPA maintains the B2 stability criteria, which seeks to prevent precipitous drops in flow from one month to the next.

C.7.4 Delta Cross Channel Gate Operation (NMFS RPA Action 4.1.2)

This action modifies the D-1641 DCC criteria, potentially decreasing the number of days that the Delta Cross Channel gates may be open in October through January. The increase in the number of days that the gates are closed is a function of the likelihood for flushing flows (> 7500 cfs) in the

Sacramento River, computed from flow at Wilkins Slough. Gate closure days are not increased if this would result in the violation of D-1641 salinity standards at Rock Slough. During each additional day that the DCC Gate would close under the RPA, but doesn't due to salinity considerations, combined CVP and SWP exports are limited to 2000 cfs.

DCC operations under this RPA will always have no more days open than the D-1641 DCC standard, and in some months the gates may be closed more frequently. Since this RPA was crafted as extra protection above and beyond the D-1641 standard, it will operate identically whether or not the D-1641 DCC standard is explicitly activated in the GUI. Because there is also a user-defined DCC standard which could conflict with the RPA standard, if the user-defined option is activated, the RPA standard is automatically de-activated even if its checkbox is on, and only the user-defined standard applies.

C.7.5 San Joaquin River Inflow to Export Ratio (NMFS RPA Action 4.2.1)

This action limits combined CVP and SWP exports relative to San Joaquin River flow at Vernalis as described by the ratios in Table 49 below, based on the San Joaquin River 60-20-20 Index (SWRCB 1995), in April and May. The export limit cannot be less than 1500 cfs to be consistent with health and safety provisions of project operations.

Table 49. Maximum combined CVP and SWP exports during April and May.

San Joaquin River 60-20-20 Index	(Vernalis Flow) : (CVP and SWP Export) Ratio
Critically dry	1:1
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1

C.8 SWRCB Delta Flow Criteria

Senate Bill No. 1 (SB 1) contains the Sacramento-San Joaquin Delta Act, which requires the SWRCB to use a public process to develop new flow criteria for the Delta ecosystem. In 2010 the SWRCB issued a report on this topic (SWRCB 2010).

Major components of the Delta Flow Criteria included in the report require the flows for Delta outflow, the Sacramento River at Rio Vista, and the San Joaquin River at Vernalis to be at or above certain percentages of unimpaired flow. Table 50 shows these criteria, which are from the Delta Flow Criteria CalSim II study Scenario A. In CalLite the user can compare the flow at these three locations to the criteria. The user can also adjust the percent of unimpaired inflow used as the criteria for each month. Note that unlike all of the other regulations described in this Appendix, when this option is activated, CalLite does not force flows at these locations to meet these criteria. It only compares simulated flows to the criteria and computes how much additional water would be needed to meet the criteria, if it is not met.

Table 50. Flow criteria developed by SWRCB based on the percentages of unimpaired flow.

Flow Targets (percent of unimpaired flow)			
	Scenario A		
	Delta Outflow	Sacramento River	San Joaquin River
Jan	75%	---	---
Feb	75%	---	75%
Mar	75%	---	75%
Apr	75%	75%	75%
May	75%	75%	75%
Jun	75%	75%	75%
Jul	---	---	---
Aug	---	---	---
Sep	---	---	---
Oct	---	---	---
Nov	---	---	---
Dec	---	---	---

C.9 References

California Department of Water Resources (DWR). 1993. *Sacramento-San Joaquin Delta Atlas.* Sacramento, Calif.

California Department of Water Resources (DWR). 1995. Methodology for flow and salinity estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. Sixteenth annual progress report to the State Water Resources Control Board. Sacramento, Calif.

Fish and Wildlife Service (FWS). 2008. Biological Opinion on the Long-Term Operational Criteria and Plan for Coordination of the Central Valley Project and State Water Project. Website:

Hutton P., 2008. A Model to Estimate Combined OMR Flows.

National Marine Fisheries Service (NMFS). 2009. *Biological Opinion and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project.* Website:

National Marine Fisheries Service (NMFS). 1993. *Biological Opinion for the Operation of the Federal Central Valley Project and the California State Water Project.* Available at: http://science.calwater.ca.gov/pdf/workshops/SP_workshop_ocap_CVP-SWP_021293.pdf

State Water Resources Control Board (SWRCB). 1995. Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. Sacramento, Calif.

State Water Resources Control Board (SWRCB). 1999. *Water Right Decision 1641.* Sacramento, Calif.

State Water Resources Control Board (SWRCB). 2010. Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem. Sacramento, Calif.

Appendix D Base Assumptions Comparison between D-1485, D-1641, and BO RPAs

Base Assumptions Comparison				
		CalLite D1485	**CalLite D1641**	**CalLite D1641 + BO**
		"Same" indicates an assumption from a column to the left		
Planning horizon		2020	Same	Same
Period of Simulation		82 years (1922-2003)	Same	Same
HYDROLOGY				
Level of development (Land Use)		Projected 2020 level	Same	Same
Sacramento Valley				
(excluding American R.)				
	CVP	CVP Land-use based, Full build out of CVP contract amounts	Same	Same
	SWP (FRSA)	Land-use based, limited by contract amounts	Same	Same
	Non-project	Land-use based, limited by water rights and SWRCB Decisions for Existing Facilities	Same	Same
	Federal refuges	Firm Level 2 water needs	Same	Same
American River				
	Water rights	Year 2025, full water rights	Same	Same
	CVP	Year 2025, full water rights, including Freeport Regional Water Project	Same	Same
San Joaquin River				
	Friant Unit	Not represented in model, but SJR inflow pre-processed under same assumptions	Same	Same

	Lower Basin	Not represented in model, but SJR inflow pre-processed under same assumptions	Same	Same
	Stanislaus River	Not represented in model, but SJR inflow pre-processed under same assumptions	Same	Same
South of Delta				
	CVP project facilities	Demand based on contract amounts	Same	Same
	Contra Costa Water District	195 TAF/yr CVP contract supply and water rights	Same	Same
	SWP Demand - Table A	Demand based on Full Table A amounts	Same	Same
	SWP Demand - Article 56 demand	Based on 2001-08 contractor amounts	Same	Same
	SWP Demand - Article 21 demand	100% maximum interruptible deliveries (full contract)	Same	Same
	North Bay Aqueduct	71 TAF/yr demand under SWP contracts, up to 43.7 cfs of excess flow under Fairfield, Vacaville and Benicia Settlement	Same	Same
	Federal refuges	Firm Level 2 water needs	Same	Same
FACILITIES				
Systemwide		Existing facilities	Same	Same
Sacramento Valley				
	Shasta Lake	Existing, 4,552 TAF capacity	Same	Same
	Red Bluff Diversion Dam	Diversion dam operated with gates out all year, NMFS BO (Jun 2009) Action I.3.1; assume permanent facilities in place	Same	Same
	Colusa Basin	Existing conveyance and storage facilities	Same	Same
	Upper American River	PCWA American River Pump Station	Same	Same
	Lower Sacramento River	Freeport Regional Water Project	Same	Same
San Joaquin River Region				
	Millerton Lake (Friant Dam)	Not represented in model, but SJR inflow pre-processed under same assumptions	Same	Same

	Lower San Joaquin River	Not represented in model, but SJR inflow pre-processed under same assumptions	Same	Same
Delta Region				
	SWP Banks Pumping Plant	Physical capacity is 10,300 cfs, but permitted capacity is 6,680 cfs for Aug-Apr, 3,000 cfs in May and Jun, and 4,600 cfs in July; Payback wheeling at Banks for Jones deficiencies in May and June may be made up during later periods of the year; Permit capacity may be increased up to 8,500 cfs during Dec 15th – Mar 15th depending on Vernalis flow conditions; Additional capacity of 500 cfs (up to 7,180 cfs) allowed for Jul – Sep for reducing impact of NMFS BO (Jun 2009) Action IV.2.1 on SWP	Physical capacity is 10,300 cfs, but permitted capacity is 6,680 cfs; Ppermit capacity may be increased up to 8,500 cfs during Dec 15th – Mar 15th depending on Vernalis flow conditions; Additional capacity of 500 cfs (up to 7,180 cfs) allowed for Jul – Sep for reducing impact of NMFS BO (Jun 2009) Action IV.2.1 on SWP; Include CVP exports	Same
	CVP C.W. Bill Jones (Tracy) Pumping Plant	Permit capacity is 4,600 cfs Jul-Apr and 3,000 cfs May-Jun; intertie can be turned on or off (exports limited to 4,200 cfs when DMC intertie is off)	Same except permit capacity is 4,600 cfs in all months	Same
	Upper Delta-Mendota Canal Capacity	Existing plus 400 cfs Delta-Mendota Canal-California Aqueduct Intertie when Intertie is turned on.	Same	Same
	Contra Costa Water District	Los Vaqueros existing storage capacity, 100 TAF, existing pump locations, Alternative Intake Project (AIP) included	Same	Same
San Francisco Bay Region				
	South Bay Aqueduct	SBA rehabilitation, 430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point	Same	Same
South Coast Region				
	California Aqueduct East Branch	Existing capacity	Same	Same
REGULATORY STANDARDS				
Trinity River				

	Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/year)	Same	Same
	Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same
Clear Creek				
	Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to USFWS and NPS, and predetermined CVPIA 3406(b)(2) flows	Same	Same plus NMFS BO (Jun 2009) Action 1.1.1
Upper Sacramento River				
	Shasta Lake	NMFS 2004 Winter-run Biological Opinion,(1900 TAF in non-critically dry years), and NMFS BO (Jun 2009) Action I.2.1	Same	Same
	Minimum flow below Keswick Dam	Not included	Same	Same
Feather River				
	Minimum flow below Thermalito Diversion Dam	2006 Settlement Agreement (700 / 800 cfs)	Same	Same
	Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1,700 cfs)	Same	Same
Yuba River				
	Minimum flow below Daguerre Point Dam	D-1644 Operations (Lower Yuba River Accord)	Same	Same
American River				
	Minimum flow below Nimbus Dam	American River Flow Managements as required by NMFS BO (Jun 2009) Action II.1	Same	Same
	Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same
Lower Sacramento River				

	Minimum flow near Rio Vista	SWRCB D-1485 (see Footnote 3 in Appendix A)	SWRCB D-1641: Minimum monthly average flow rate in cfs: Sept = 3,000 Oct = 4,000 but 3,000 in critical years Nov-Dec = 4,500 but 3,500 in critical years	Same
Mokelumne River				
	Minimum flow below Camanche Dam	Not represented in model, but Mokelumne River inflow pre-processed under FERC 2916-029, 1996 (Joint Settlement Agreement) (100-320 cfs)	Same	Same
	Minimum flow below Woodbridge Diversion Dam	Not represented in model, but Mokelumne River inflow pre-processed under FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	Same	Same
Stanislaus River				
	Minimum flow below Goodwin Dam	Not represented in model, but SJR inflow pre-processed under 1987 USBR, DFG agreement, and flows required for NMFS BO (Jun 2009) Action III.1.2 and III.1.3	Same	Same
	Minimum dissolved oxygen	Not represented in model, but SJR inflow pre-processed under SWRCB D-1422	Same	Same
Merced River				
	Minimum flow below Crocker-Huffman Diversion Dam	Not represented in model, but SJR inflow pre-processed under Davis-Grunsky (180-220 cfs, Nov-Mar), Cowell Agreement	Same	Same
	Minimum flow at Shaffer Bridge	Not represented in model, but SJR inflow pre-processed under FERC 2179 (25-100 cfs)	Same	Same
Tuolumne River				
	Minimum flow at Lagrange Bridge	Not represented in model, but SJR inflow pre-processed under FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/year)	Same	Same
San Joaquin River				
	Maximum salinity near Vernalis	No standard	SWRCB D-1641: Maximum 30-day running average of mean daily EC for Apr-Aug = 0.7	Same

			mmhos/cm and Sept-Mar = 1.0 mmhos/cm	
	Minimum flow near Vernalis	No standard	SWRCB D-1641, and Vernalis Adaptive Management Plan (VAMP) per San Joaquin River Agreement	Same
Sacramento River–San Joaquin River Delta				
	Salinity Requirements	SWRCB D-1485 standards at Emmaton, Jersey Point, Rock Slough, Collinsville, Antioch, and Chipps Island (see D-1485 Standards table in Appendix A)	Same but no standards at Antioch or Chipps Island	Same
	Delta Outflow Requirements	SWRCB D-1485: minimum Delta outflow at Chipps Island (see Footnote 1 and 2 in Appendix A): 6,700 cfs during Apr 1st – Apr 14th for Striped Bass Spawning 2,900-14,000 cfs during May 6th – Jul for Striped Bass Survival 10,000 cfs during Feb-May of Wet years, 10,000 cfs during Feb-Apr of Subnormal Snowmelt years, and 12,000 cfs for 60 consecutive days during Jan-Apr of Above Normal or Below Normal years, for Salmon Migrations 6,600 cfs during Jan-May when storage is at or above the minimum flood control level at two out of three of: Shasta, Oroville, and CVP storage on the American.	SWRCB D-1641: minimum net delta outflow index 3,000-8,000 cfs in Jul-Dec, X2 requirement, and standard at Roe Trigger	SWRCB D-1641 and FWS BO (Dec 2008) Action 4
	Delta Cross Channel gate operation	SWRCB D-1485: Jan – Apr 15th = gates closed whenever the daily Delta outflow index > 12,000 cfs Apr 16th – May 31st * = closed for up to 20 days whenever daily Delta outflow index > 12,000 cfs *Requirement of "no more than two out of four consecutive days is NOT modeled	SWRCB D-1641: Nov-Jan = closure of gates closed for up to 45 days Feb-May 20th = closed May 21st – Jun 15th = closed for up to 14 days	SRWCB D-1641 with additional days closed from Oct 1 – Jan 31 based on NMFS BO (Jun 2009) Action IV.1.2 (closed during flushing flows from Oct 1 – Dec 14 unless adverse water quality conditions)
	South Delta exports (Jones PP and Banks PP)	SWRCB D-1485 (no VAMP)	SWRCB D-1641, Vernalis flow-based export limits Apr 1st –	Same

			May 31st as required by NMFS BO (Jun, 2009) Action IV.2.1 (additional 500 cfs allowed for Jul – Sep for reducing impact on SWP)	
	Export Inflow Ratio	No standard	SWRCB D-1641: combined export rate equal to 35% of Delta Inflow in Feb-Jun and 65% of Delta Inflow in Jul-Jan	Same plus exports are limited relative to SJR flow at Vernalis in April and May.
	Combined flow in Old and Middle River	No standard	No standard	FWS BO (Dec 2008) Actions 1 through 3
OPERATIONS CRITERIA: RIVER-SPECIFIC				
Upper Sacramento River				
	Flow objective for navigation (Wilkins Slough)	NMFS BO (Jun 2009) Action I.4; 3,500 –5,000 cfs based on CVP water supply condition	Same	Same
American River				
	Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same	Same
Stanislaus River				
	Flow below Goodwin Dam	Not represented in model, but SJR inflow pre-processed under Revised Operations Plan and NMFS BO (Jun 2009) Action III.1.2 and III.1.3	Same	Same
San Joaquin River				
	Salinity at Vernalis	Not represented in model, but SJR inflow pre-processed under Grasslands Bypass Project (full implementation)	Same	Same
OPERATIONS CRITERIA: SYSTEMWIDE				
CVP water allocation				
	CVP Settlement and Exchange Contractors	100% (75% in Shasta critical water years)	Same	Same
	CVP refuges	100% (75% in Shasta critical water years)	Same	Same

	CVP agriculture	100%-0% based on supply, South-of-Delta allocations are additionally limited due to D-1485 export restrictions	100%-0% based on supply, South-of-Delta allocations are additionally limited due to D-1641 export restrictions	100%-0% based on supply, South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions
	CVP municipal & industrial	100%-0% based on supply, South-of-Delta allocations are additionally limited due to D-1485 export restrictions	100%-0% based on supply, South-of-Delta allocations are additionally limited due to D-1641 export restrictions	100%-0% based on supply, South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions
SWP water allocation				
	North of Delta (FRSA)	Contract specific	Same	Same
	South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are limited due to D-1485 export restrictions	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are limited due to D-1641 export restrictions	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are limited due to FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions
CVP-SWP coordinated operations				

	Sharing of responsibility for in-basin-use	1986 Coordinated Operations Agreement (FRWP EBMUD and 2/3 of the North Bay Aqueduct diversions are considered as Delta Export; 1/3 of the North Bay Aqueduct diversion is considered as in-basin-use)	Same	Same
	Sharing of surplus flows	1986 Coordinated Operations Agreement	Same	Same
	Sharing of restricted export capacity for project-specific priority pumping	Equal sharing of export capacity under SWRCB D-1485 export restrictions	Equal sharing of export capacity under SWRCB D-1641 export restrictions which includes code to attempt to split export during: EI control situations April-May pulse and VAMP control situations	Same but also includes code to attempt to split export during FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions
	Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users; LYRA included for SWP contractors	Same	Same
	Sharing of export capacity for lesser priority and wheeling related pumping	Cross Valley Canal (CVC) wheeling (max of 128 TAF/year)	Same plus CALFED ROD defined Joint Point of Diversion (JPOD)	Same
CVPIA 3406(b)(2)		Not included	Same	Same
Water Supply Index – Demand Index (WSI-DI) Curves		From D1485 CalSim run (2013 DRR Version)	From D1641 CalSim run (2013 DRR Version)	From D1641 + BO CalSim run (2013 DRR Version)

Appendix E Base Assumptions Comparison between CalLite v3.00 and CalSim II

This appendix lists the assumptions in CalLite Version 3.00 and the comparable assumptions in the CalSim II model. The CalLite assumptions listed below are for scenarios where SWRCB D-1641 standards and Biological Opinion Reasonable and Prudent Alternatives are turned on, and where south of Delta demands are not user-defined. The version of the CalSim II model described here was created for modeling related to the Bay Delta Conservation Plan (BDCP), as of April 2010. For reference, the BDCP model used 2005 and 2020 LOD hydrology from the Common Assumptions Common Model Package (Version 9B) (DWR 2009), but contains changes to the CalSim model code since Version 9B was developed.

		CalSim II Existing Conditions	CalLite Existing Conditions	CalSim II Future Conditions	CalLite Future Conditions
		BDCP 2005 LOD	CalLite 2005 LOD	BDCP 2020 LOD	CalLite 2020 LOD
"Same" indicates an assumption from a column to the left					
Planning horizon		2005	Same	2020	Same
Period of Simulation		82 years (1922-2003)	Same	Same	Same
HYDROLOGY					
Level of development (Land Use)		Projected 2005 level	Same	Projected 2020 level	Same
Sacramento Valley					
(Excluding American R.)					
	CVP	Land-use based, limited by contract amounts	Same	CVP Land-use based, Full build out of CVP contract amounts	Same
	SWP (FRSA)	Land-use based, limited by contract amounts	Same	Same	Same
	Non-project	Land-use based, limited by water rights and SWRCB Decisions for Existing Facilities	Same	Same	Same
	Federal refuges	Recent historical Level 2 water needs	Same	Firm Level 2 water needs	Same
American River			Same		
	Water rights	Year 2005	Same	Year 2025, full water rights	Same
	CVP	Year 2005	Same	Year 2025, full water rights, including Freeport Regional Water Project	Same
San Joaquin River					
	Friant Unit	Limited by contract amounts, based on current allocation policy	Not represented in model, but SJR inflow pre-processed under same assumptions	Same as Existing CalSim	Not represented in model, but SJR inflow pre-processed under same assumptions

	Lower Basin	Land-use based, based on district level operations and constraints	See above	Same as Existing CalSim	See above
	Stanislaus River	Land-use based, Revised Operations Plan, and NMFS BO (Jun 2009) Actions III.1.2 and III.1.3	See above	Same as Existing CalSim	See above
South of Delta					
	CVP project facilities	Demand based on contract amounts	Same	Same	Same
	Contra Costa Water District	195 TAF/yr CVP contract supply and water rights	Same	Same	Same
	SWP Demand - Table A	Variable demand, of 3.0-4.1 MAF/yr, up to Table A amounts including all Table A transfers through 2008	Same	Demand based on Full Table A amounts	Same
	SWP Demand - Article 56 demand	Based on 2001-08 contractor amounts	Same	Same	Same
	SWP Demand - Article 21 demand	Up to 134 TAF/month December to March, total of other demands up to 84 TAF/month in all months	Same	Up to 314 TAF/month from December to March, total of demands up to 214 TAF/month in all other months	Same
	North Bay Aqueduct	71 TAF/yr demand under SWP contracts, up to 43.7 cfs of excess flow under Fairfield, Vacaville and Benecia Settlement	Same	77 TAF/yr demand under SWP contracts, up to 43.7 cfs of excess flow under Fairfield, Vacaville and Benecia Settlement	Same
	Federal refuges	Recent historical Level 2 water needs	Same	Firm Level 2 water needs	Same
FACILITIES					
Systemwide		Existing facilities	Same	Same	Same
Sacramento Valley					
	Shasta Lake	Existing, 4,552 TAF capacity	Same	Same	Same
	Red Bluff Diversion Dam	Diversion dam operated gates out, except Jun 15th – Aug 31st based on NMFS BO (Jun 2009) Action I.3.2; assume interim/temporary	Same	Diversion dam operated with gates out all year, NMFS BO (Jun 2009) Action I.3.1; assume permanent facilities in place	Same

		facilities in place			
	Colusa Basin	Existing conveyance and storage facilities	Same	Same	Same
	Upper American River	PCWA American River Pump Station	Same	Same	Same
	Lower Sacramento River	None	Same	Freeport Regional Water Project	Same
San Joaquin River Region					
	Millerton Lake (Friant Dam)	Existing, 520 TAF capacity	Not represented in model, but SJR inflow pre-processed under same assumptions	Same as Existing CalSim	Not represented in model, but SJR inflow pre-processed under same assumptions
	Lower San Joaquin River	None	See above	City of Stockton Delta Water Supply Project, 30 mgd capacity	See above
Delta Region					
	SWP Banks Pumping Plant	Physical capacity is 10,300 cfs but 6,680 cfs permitted capacity in all months up to 8,500 cfs during Dec 15th – Mar 15th depending on Vernalis flow conditions; additional capacity of 500 cfs (up to 7,180 cfs) allowed for Jul – Sep for reducing impact of NMFS BO (Jun 2009) Action IV.2.1 on SWP	Same	Same	Same
	CVP C.W. Bill Jones (Tracy) Pumping Plant	Permit capacity is 4,600 cfs but exports limited to 4,200 cfs plus diversions upstream of DMC constriction	Same, except that Intertie can be turned on or off	Permit capacity is 4,600 cfs in all months (the Delta-Mendota Canal–California Aqueduct Intertie allows the export limit from DMC constriction to be avoided)	Same, except that Intertie can be turned on or off
	Upper Delta-Mendota Canal Capacity	Existing	Same, except that Intertie can be turned on or	Existing plus 400 cfs Delta-Mendota Canal-California Aqueduct Intertie	Same, except that Intertie can be turned on or

			off		off
	Contra Costa Water District	Los Vaqueros existing storage capacity, 100 TAF, existing pump locations	Same	Los Vaqueros existing storage capacity, 100 TAF, existing pump locations, Alternative Intake Project (AIP) included	Same
San Francisco Bay Region					
	South Bay Aqueduct	Existing capacity	Same	SBA rehabilitation, 430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point	Same
South Coast Region					
	California Aqueduct East Branch	Existing capacity	Same	Same	Same
REGULATORY STANDARDS					
Trinity River					
	Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369-815 TAF/year)	Same	Same	Same
	Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600 TAF as able)	Same	Same	Same
Clear Creek					
	Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 USBR Proposal to USFWS and NPS, predetermined CVPIA 3406(b)(2) flows, and NMFS BO (Jun 2009) Action I.1.1	Same	Same	Same
Upper Sacramento River					
	Shasta Lake	NMFS 2004 Winter-run Biological Opinion,(1900 TAF in non-critically dry years), and NMFS BO (Jun	Same	Same	Same

		2009) Action I.2.1			
	Minimum flow below Keswick Dam	SWRCB WR 90-5, predetermined CVPIA 3406(b)(2) flows, and NMFS BO (Jun 2009) Action I.2.2	Same	Same	Same
Feather River					
	Minimum flow below Thermalito Diversion Dam	2006 Settlement Agreement (700 / 800 cfs)	Same	Same	Same
	Minimum flow below Thermalito Afterbay outlet	1983 DWR, DFG Agreement (750-1,700 cfs)	Same	Same	Same
Yuba River					
	Minimum flow below Daguerre Point Dam	D-1644 Operations (Lower Yuba River Accord)	Same	Same	Same
American River					
	Minimum flow below Nimbus Dam	American River Flow Managements as required by NMFS BO (Jun 2009) Action II.1	Same	Same	Same
	Minimum Flow at H Street Bridge	SWRCB D-893	Same	Same	Same
Lower Sacramento River					
	Minimum flow near Rio Vista	SWRCB D-1641	Same	Same	Same
Mokelumne River					
	Minimum flow below Camanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 cfs)	Not represented in model, but Mokelumne River inflow pre-processed under same	Same as Existing CalSim	Not represented in model, but Mokelumne River inflow pre-processed under same

			assumptions		assumptions
	Minimum flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	See above	Same as Existing CalSim	See above
Stanislaus River					
	Minimum flow below Goodwin Dam	1987 USBR, DFG agreement, and flows required for NMFS BO (Jun 2009) Action III.1.2 and III.1.3	Not represented in model, but SJR inflow pre-processed under same assumptions	Same as Existing CalSim	Not represented in model, but SJR inflow pre-processed under same assumptions
	Minimum dissolved oxygen	SWRCB D-1422	See above	Same as Existing CalSim	See above
Merced River					
	Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), Cowell Agreement	See above	Same as Existing CalSim	See above
	Minimum flow at Shaffer Bridge	FERC 2179 (25-100 cfs)	See above	Same as Existing CalSim	See above
Tuolumne River					
	Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94-301 TAF/yr)	See above	Same as Existing CalSim	See above
San Joaquin River					
	Maximum salinity near Vernalis	SWRCB D-1641	See above	Same as Existing CalSim	See above
	Minimum flow near Vernalis	SWRCB D-1641, and Vernalis Adaptive Management Plan (VAMP) per San Joaquin River	See above	Same as Existing CalSim	See above

		Agreement			
Sacramento River–San Joaquin River Delta					
	Delta Outflow Index (Flow and Salinity)	SWRCB D-1641 and FWS BO (Dec 2008) Action 4	Same	Same	Same
	Delta Cross Channel gate operation	SRWCB D-1641 with additional days closed from Oct 1 – Jan 31 based on NMFS BO (Jun 2009) Action IV.1.2 (closed during flushing flows from Oct 1 – Dec 14 unless adverse water quality conditions)	Same	Same	Same
	South Delta exports (Jones PP and Banks PP)	SWRCB D-1641, Vernalis flow-based export limits Apr 1st – May 31st as required by NMFS BO (Jun, 2009) Action IV.2.1 (additional 500 cfs allowed for Jul – Sep for reducing impact on SWP)	Same	Same	Same
	Combined flow in Old and Middle River	FWS BO (Dec 2008) Actions 1 through 3 and NMFS BO (Jun 2009) Action IV.2.3			
OPERATIONS CRITERIA: RIVER-SPECIFIC					
Upper Sacramento River					
	Flow objective for navigation (Wilkins Slough)	NMFS BO (Jun 2009) Action I.4; 3,500 –5,000 cfs based on CVP water supply condition	Same	Same	Same
American River					
	Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same	Same	Same
Stanislaus River					

	Flow below Goodwin Dam	Revised Operations Plan and NMFS BO (Jun 2009) Action III.1.2 and III.1.3	Not represented in model, but SJR inflow pre-processed under same assumptions	Same as Existing CalSim	Not represented in model, but SJR inflow pre-processed under same assumptions
San Joaquin River					
	Salinity at Vernalis	Grasslands Bypass Project (partial implementation)	See above	Grasslands Bypass Project (full implementation)	See above
OPERATIONS CRITERIA: SYSTEMWIDE					
CVP water allocation					
	CVP Settlement and Exchange Contractors	100% (75% in Shasta critical water years)	Same	Same	Same
	CVP refuges	100% (75% in Shasta critical water years)	Same	Same	Same
	CVP agriculture	100%-0% based on supply, South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions	Same	Same	Same
	CVP municipal & industrial	100%-50% based on supply, South-of-Delta allocations are additionally limited due to D-1641, FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions	Same	Same	Same
SWP water allocation					
	North of Delta (FRSA)	Contract specific	Same	Same	Same
	South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between Ag and M&I based on Monterey Agreement; allocations are limited due to FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions	Same	Same	Same

CVP-SWP coordinated operations					
	Sharing of responsibility for in-basin-use	1986 Coordinated Operations Agreement (FRWP EBMUD and 2/3 of the North Bay Aqueduct diversions are considered as Delta Export; 1/3 of the North Bay Aqueduct diversion is considered as in-basin-use)	Same	Same	Same
	Sharing of surplus flows	1986 Coordinated Operations Agreement	Same	Same	Same
	Sharing of restricted export capacity for project-specific priority pumping	Equal sharing of export capacity under SWRCB D-1641, FWS BO (Dec 2008) and NMFS BO (Jun 2009) export restrictions	Same	Same	Same
	Water transfers	Acquisitions by SWP contractors are wheeled at priority in Banks Pumping Plant over non-SWP users; LYRA included for SWP contractors	Same	Same	Same
	Sharing of export capacity for lesser priority and wheeling related pumping	Cross Valley Canal (CVC) wheeling (max of 128 TAF/year), CALFED ROD defined Joint Point of Diversion (JPOD)	CVC wheeling and JPOD can be turned on or off	Same as Existing CalSim	CVC wheeling and JPOD can be turned on or off
CVPIA 3406(b)(2)					
	Policy Decision	Per May 2003 Dept. of Interior Decision:	Same	Same	Same
	Allocation	800 TAF, 700 TAF in 40-30-30 dry years, and 600 TAF in 40-30-30 critical years	Same	Same	Same
	Actions	Pre-determined non-discretionary	Same	Same	Same

		FWS BO (Dec 2008) upstream fish flow objectives (Oct-Jan) for Clear Creek and Keswick Dam, non-discretionary NMFS BO (Jun 2009) actions for the American and Stanislaus Rivers, and NMFS BO (Jun 2009) actions leading to export restrictions			
	Accounting	No discretion assumed under FWS BO (Dec 2008) and NMFS BO (Jun 2009), no accounting	Same	Same	Same

Appendix F Sea Level Rise and Climate Change Scenarios

Dynamic Link Libraries (DLL) have been developed and linked with CalLite for different sea level rise options to estimate salinity (electrical conductivity) and X2 position. This Appendix describes development of the DLL.

F.1 Background

F.1.1 Sea Level Rise Estimates

The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC AR4) released in 2007 contained the IPCC's latest projections of future climate including revised estimates of global mean sea level rise. The IPCC AR4 sea level rise estimates have been widely criticized for their failure to include the dynamic instability in the ice sheets of Greenland and Antarctica, and for their under-prediction of recent observed sea level increases (BDCP, 2012).

The CALFED Independent Science Board (ISB) recommends the empirical approach developed by Rahmstorf (2007) that projects future sea level rise rates based on the degree of global warming. This method better reproduces historical sea levels and generally produces larger estimates of sea level rise than the IPCC AR4 projections (BDCP 2012). Rahmstorf projects a sea level rise from a low range of 50-70 cm to a high range of 100-140 cm (depending on the range of uncertainty) by the end of the century (2100). The BDCP analysis used Rahmstorf projections to estimate a 2025 sea level rise of 12-18 cm (early long-term) and a 2060 sea level rise of 30-60 cm (late long-term). BDCP proposes the mid-range of these estimates for each timeline (15 cm for the early long-term and 45 cm for the late long-term) because of the uncertainty in the projections (see Figure 59).

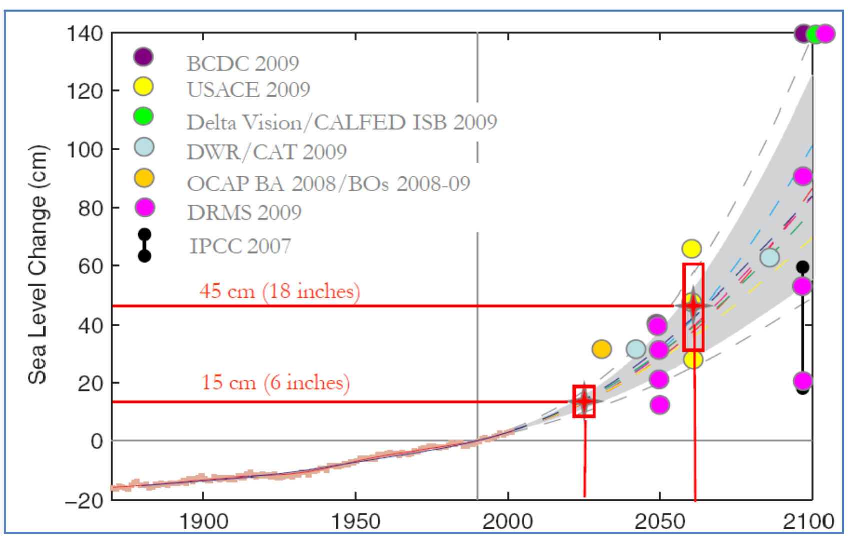


Figure 59. Location of BDCP sea level rise projections for Early Long-Term and Late Long-Term, in relation to other scientific reports.

CalLite implements three climate projection periods based on the BDCP analysis:

1. Historical Hydrology: Base 0 cm
2. Mid-Century (2030-2059): 15 cm
3. End-of-Century (2060-2099): 45 cm

The ANN for the Base 0 cm option was trained to reflect DSM2 representation of the BDCP No Action Base scenario. The 15 cm and 45 cm options correspond to the average projected sea level rises for 2025 and 2060, respectively, as selected for analysis in the BDCP study process.

F.1.2 Climate Change Scenarios

CalLite allows modeling of the five climate change scenarios (Q1-Q5, see Figure 60) used in the BDCP analysis. These scenarios were determined by mapping 112 future climate projections (shown as the small blue diamonds in Figure 60) used in the IPCC AR4 and obtained from 15 different Global Climate Models developed by various national climate centers. In Figure 60, the blue dashed lines are the median (50th percentile) change of annual temperature (horizontal line) and annual precipitation (vertical line); these lines break the graph up into four quadrants representing (1) drier, less warming, (2) drier, more warming, (3) wetter, more warming, and (4) wetter, less warming, with respect to the median. The ten nearest neighbors (10NN) to the four intersections of the 10th and 90th percentile annual temperature and precipitation lines (red lines in Figure 60) were statistically selected for defining climate change scenarios Q1-Q4. Scenario Q5 is bounded by the 25th and 75th percentile joint temperature-precipitation change and represents a central region of climate change.

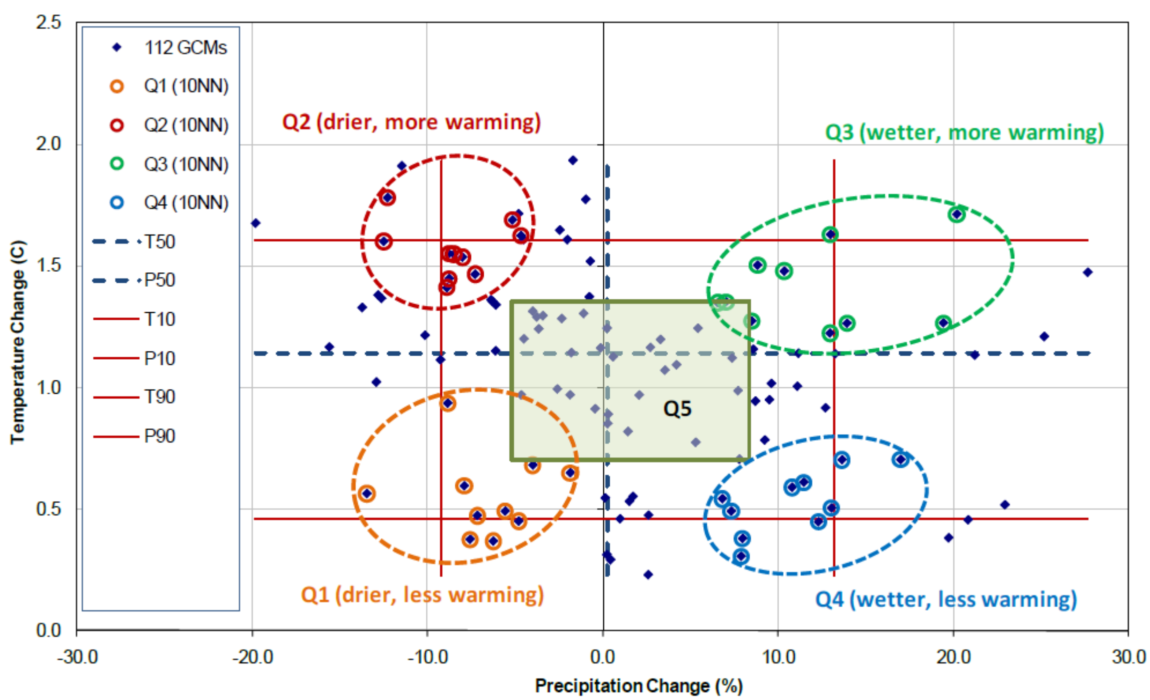


Figure 60. Selection of the 5 climate change scenarios used in the BDCP analysis (BDCP, 2013)

F.2 Development of Artificial Neural Networks

F.2.1 Salinity Estimation

Because of the projected sea level rise due to climate change, CalLite incorporates methods for estimating Delta salinity under different sea level rise assumptions and corresponding tidal boundary conditions. Artificial Neural Networks (ANN) (DWR 1995) were developed to estimate flow-salinity relationships in the Delta for different sea level rise scenarios. These ANNs were trained using results from the Delta Simulation Model II (DSM2). DSM2 is a hydrodynamic and water quality model of the Delta, developed and maintained by DWR. The DSM2 model used for ANN training was developed for simulating the Bay Delta Conservation Plan (BDCP 2011) and includes the marsh restorations of the BDCP except for the base SLR. The ANNs are incorporated into CalLite to ensure that project reservoirs and export facilities in the South Delta are operated to meet salinity standards in the Delta.

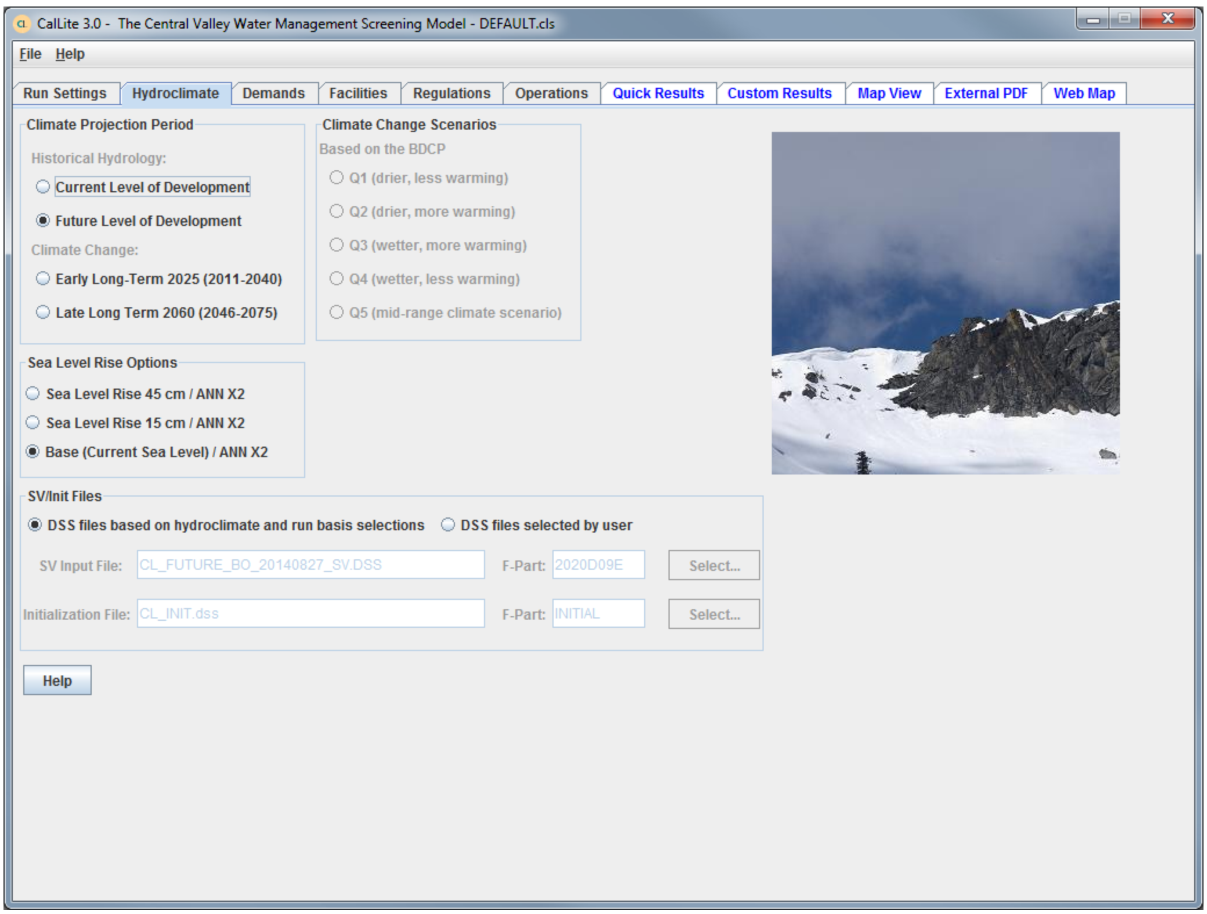


Figure 61. CalLite Hydroclimate dashboard showing options for climate projection period, sea level rise, and climate change scenario.

F.2.2 X2 Estimation

Previous versions of CalLite had the option to use the Kimmerer-Monismith (KM) equation to estimate the X2 location. However, the KM equation is empirical, developed using observed data, and cannot be used for future sea level rise scenario analysis. Therefore version 3.00 of the CalLite GUI no longer enables use of the KM equation. Advanced users may still enable the KM equation by manually running the model with the WRIMS IDE or using the batch file (see Appendix I). The ANNs discussed above are used to estimate X2 location for current sea level and future sea level rise scenarios. The ANNs use Net Delta Outflow, previous X2 locations, and tides in the previous 117 days to predict the current X2 location.

F.3 Comparison between CalSim II and CalLite results

This section is provided from the CalLite Reference manual v2.00, released October 2011. While the summary results have not been updated to match the model being released under version 3.00, the relative comparison of results remains similar.

To verify the implementation of the newly developed ANN DLLs in CalLite, comparisons have been performed on the results obtained from the CalSim II and CalLite models. Assumptions are Existing Level of Developments (2005), Current Demands (2005), Existing Facilities and BO RPA regulations. Figure 62, Figure 63, and Table 51 compare the results between CalSim II and CalLite for current (base no sea level rise) scenario. The results indicate that CalSim II and CalLite results are very similar.

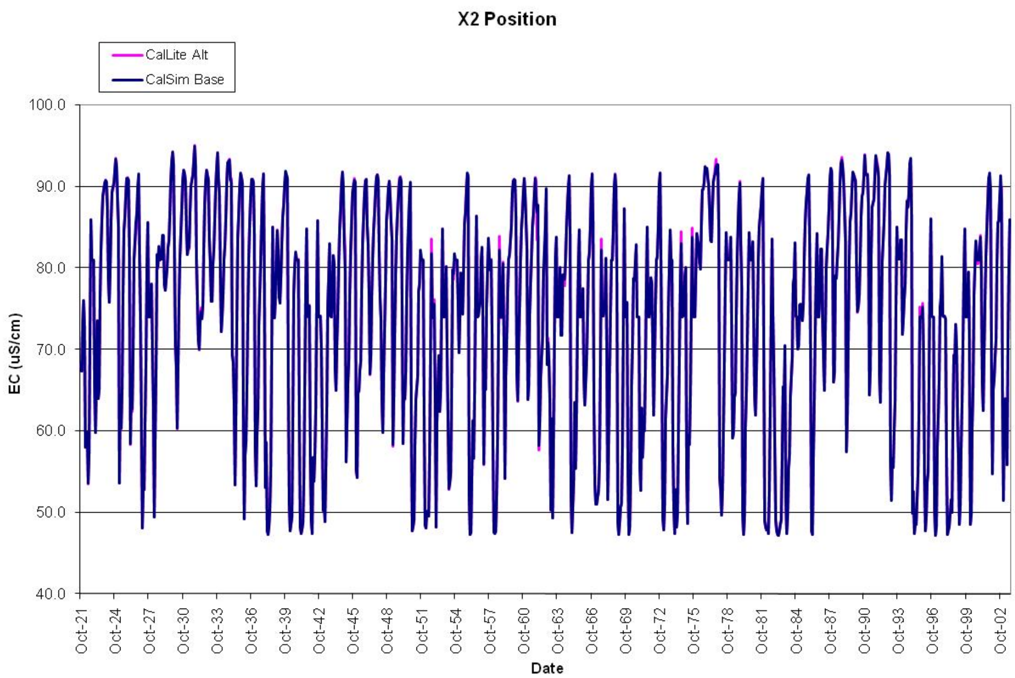


Figure 62. Simulated X2 positions for base sea level rise scenario.

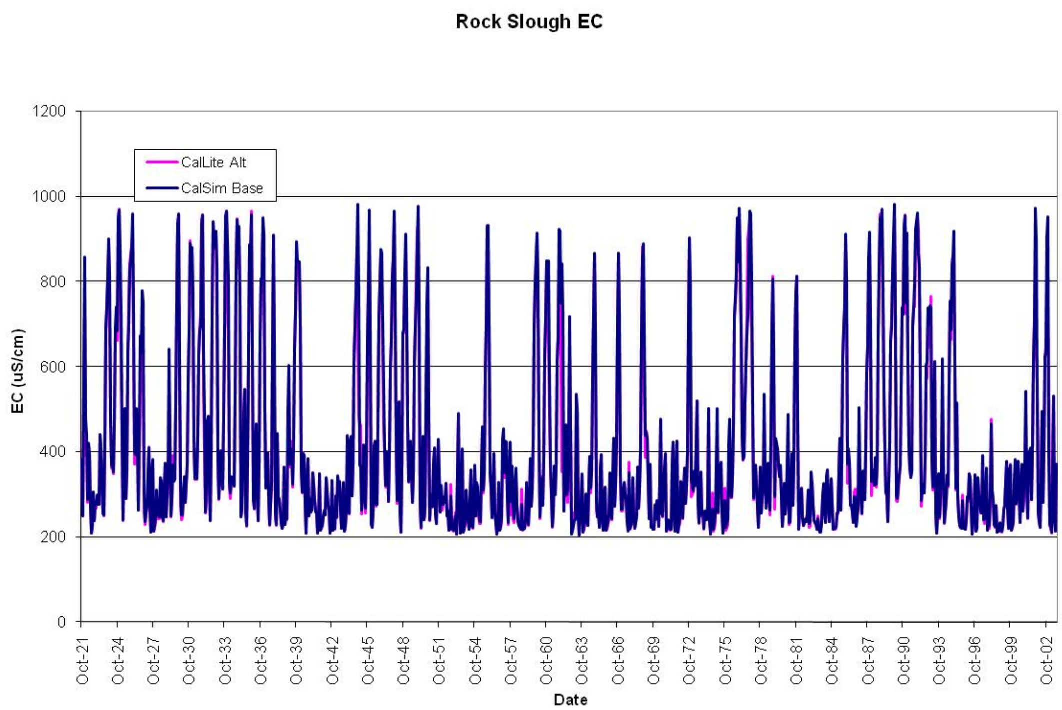


Figure 63. Simulated Rock Slough EC for base sea level rise scenario.

Table 51. System wide results for current base sea level rise scenario (TAF/yr).

	1922-2003			1929-1934			1987-1992		
	CalLite	CalSim II	Diff	CalLite	CalSim II	Diff	CalLite	CalSim II	Diff
River Flow									
Trinity R blw Lewiston	700	695	5	408	408	0	472	472	0
Trinity Export	530	536	-5	435	439	-4	511	510	1
Clear Cr blw Whiskeytown	127	125	2	87	87	0	106	106	0
Sacramento R @ Keswick	6249	6256	-7	4125	4133	-8	4666	4661	4
Sacramento R @ Wilkins Slough	6651	6655	-4	4119	4125	-6	4980	4977	3
Feather R blw Thermalito	3178	3179	-1	1598	1611	-13	1536	1567	-32
American R blw Nimbus	2477	2477	0	1328	1328	-1	1185	1183	3
Delta Inflow	**21646**	**21653**	**-7**	**10012**	**10036**	**-24**	**10659**	**10687**	**-28**
Sacramento R @ Hood	15676	15690	-14	8329	8353	-24	9280	9308	-28
Yolo Bypass	2244	2237	7	94	94	0	137	137	0
Mokelumne R	666	666	0	202	202	0	140	140	0
San Joaquin R d/s Calaveras	3060	3060	0	1386	1386	0	1102	1102	0
Delta Outflow	**15782**	**15789**	**-7**	**5547**	**5554**	**-7**	**6106**	**6115**	**-9**
Required Delta Outflow	5006	5004	2	4121	4121	0	3987	3987	0
Delta Diversions	**4912**	**4912**	**0**	**3256**	**3271**	**-15**	**3283**	**3309**	**-26**
Banks SWP	2641	2641	0	1762	1777	-16	1681	1697	-15
Banks CVP	81	72	9	13	13	-1	23	17	6
Jones	2190	2199	-9	1494	1494	0	1602	1613	-11
SWP SOD Deliveries	**2593**	**2592**	**1**	**1657**	**1676**	**-19**	**1646**	**1655**	**-9**
Table A	2261	2260	1	1558	1562	-5	1506	1517	-11
Article 21	69	68	1	51	50	2	9	8	0
Article 56	263	264	-1	48	64	-16	131	130	1
CVP SOD Deliveries	**2385**	**2386**	**0**	**1490**	**1497**	**-7**	**1651**	**1644**	**7**

F.4 References

Bay Delta Conservation Plan (BDCP). 2011. Website: http://baydeltaconservationplan.com/Home.aspx

BDCP. 2012. *Bay Delta Conservation Plan EIR/EIS Modeling Technical Appendix*. 5th Revision. Website: http://baydeltaconservationplan.com/Home.aspx

BDCP. 2013. Bay Delta Conservation Plan EIR/EIS, Appendix 5A, Modeling Technical Appendix, Public Draft – November, 2013. Website: http://baydeltaconservationplan.com/Libraries/Dynamic_Document_Library/Public_Draft_BDCP_EIR-EIS_Appendix_5A_-_EIR-EIS_Modeling_Technical_Appendix_-_Sections_A_B.sflb.ashx

California Department of Water Resources (DWR). 1995. *Methodology for flow and salinity estimates in the Sacramento-San Joaquin Delta and Suisun Marsh. Sixteenth annual progress report to the State Water Resources Control Board.* Sacramento, Calif.

Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007 - IPCC Fourth Assessment Report.* Geneva, Switzerland.

Rahmstorf, S. 2007. *A Semi-Empirical Approach to Projecting Sea-Level Rise.* Science v. 315, pp. 368-370.

Appendix G CalLite Allocation Procedures

G.1 Introduction

Version 3.00 of CalLite implements delivery allocations for the CVP and SWP using either the Water Supply Index-Delivery Index (WSI-DI) logic that is used in the CalSim II model (DWR 2002, DWR 2009 or the Forecast Allocation Method (FAM). The Operations dashboard allows selection of the different allocations options (see Figure 64).

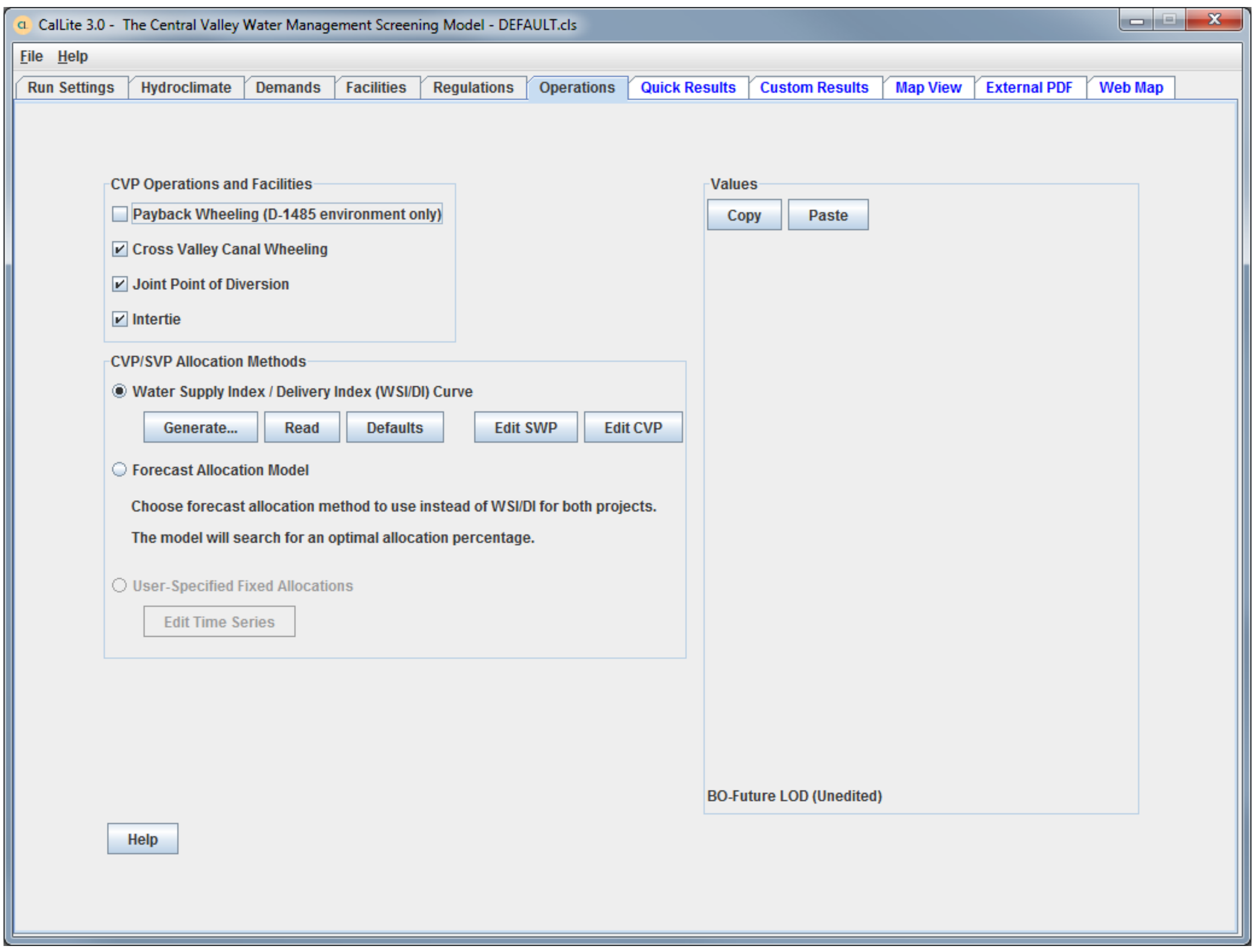


Figure 64. Operations dashboard in CalLite.

G.2 WSI-DI Method

The default option for delivery allocations for the CVP and SWP in the current version of CalLite incorporates the WSI-DI logic. The default CVP and SWP delivery logics use runoff forecast information and uncertainty (associated exceedance probability), delivery versus carryover risk curves, and standardized rules (Water Supply Index versus Demand Index Curve) to estimate the total water available for delivery and carryover storage for CVP and SWP. Each project has a separate WSI-DI process. The delivery logic updates delivery levels monthly from January through May for SWP and from March through May for CVP as water supply parameters become more certain.

During each water year, the model calculates a Water Supply Index (WSI) and determines what portion of the WSI is available for use as delivery to contractors and carryover storage. WSI is defined as the sum of the current beginning of month (BOM) storage in reservoirs that are able to supply south of Delta diversions and the forecasted remaining water year runoff. The CVP WSI components include the BOM storage in Trinity Lake, Shasta Lake, Folsom Lake, CVP-San Luis Reservoir, and the remaining water year unimpaired runoff to Sacramento River, American River, and James Bypass inflow. The SWP WSI components include the BOM storage in Oroville Lake and SWP-San Luis Reservoir, and the remaining water year unimpaired runoff to Oroville Lake. Demands are pre-processed, independent of the model. They vary according to the specified level of development (2005, 2020) and according to hydrologic conditions. Demands serve as an upper bound on deliveries. The Delivery Index (DI) that represents water available for delivery and carryover storage is estimated as a function of the WSI value through a rule curve (WSI-DI table). Once the total water available for delivery and carryover storage is estimated, it is split into target delivery and estimated carryover storage by use of a delivery versus carryover risk curve (Delivery-Carryover curve). There are filling targets for San Luis Reservoir when water is transferred from northern storage to San Luis reservoirs for later deliveries south of the Delta.

Separate WSI-DI curves are used for the SWP and CVP allocations. The north of Delta CVP allocations are determined by using a system-wide CVP WSI-DI curve. Once the water available for use by the CVP system-wide is estimated, it is split into target delivery and estimated carryover storage by use of the Delivery-Carryover curve. CVP south of Delta allocations vary depending on whether active regulations include BO RPA standards or not. Both approaches inform the allocation with estimates of export capacity. For the without-RPA option, a Delta Index is computed as the sum of January-to-May Eight River Index values, and then an Export Index is created as a function of the Delta Index. A second estimate of annual deliveries is also computed that takes into account VAMP export restrictions that occur during the Apr 15 - May 15 pulse period, and also anticipates export restrictions under CVPIA 3406(b)(2) that occur during the first half of Apr and the second half of May and the entire month of June. The final CVP SOD allocation is the minimum of the Export Index and this annual delivery estimate. The with-RPA option bases allocations on an annual estimate of deliveries that takes into account the expected impact of the RPAs on exports. Currently the with-RPA allocation option is automatically triggered when the FWS RPA for Old and Middle River is active, as this RPA accounts for the majority of CVP export limits due to RPAs.

For the SWP, the south-of-Delta SWP contractors and project M&I contractors in the Feather River Service Area (FRSA) deliveries are allocated using the WSI-DI procedure. SWP north of Delta deliveries to FRSA agricultural contractors are not subjected to the WSI-DI allocation procedure. In drought years, FRSA agricultural contractors demands can be reduced no more than 50 percent in any one year and no more than 100 percent in any series of seven consecutive years.

The WSI-DI curve and the Delivery-Carryover curve for CVP can be predetermined and imported from CalSim II simulations or generated directly in CalLite. Similarly, the WSI-DI curve for SWP can also be predetermined and imported from CalSim II simulations or generated directly in CalLite. However, CalLite and CalSim II are no longer using a predetermined Delivery - Carryover curve for SWP. CalLite and CalSim II both now compute the SWP target delivery using a predefined function. This Delivery – Carryover function is defined by the independent variable “Demand Index” and 3 internal variables: 1) Oroville storage at the end of September, 2) SWP Table A allocation, 3) Table A losses; and 3 fixed parameters: 1) a predefined DI buffer (250 TAF), 3) an initial SWP Drain Target of 110 TAF, and 3) the Oroville Lake storage level at 1067 TAF.

The WSI-DI curves should be edited with caution. They are carefully developed through iterative running of CalSim II with a particular set of water supplies and demands. More aggressive allocations may result in reservoir storage conditions that are not able to meet regulations through dry years. Relaxed allocations may result in storage levels that create higher flows in some months and unexpected modifications to Delta operations that are predicated on antecedent conditions. Results will not always be what the user intended. Careful analysis of output is always necessary.

G.3 Forecast Allocation Method (FAM)

The Forecast Allocation Method (FAM) is developed based on the California Allocation Module (CAM). The model is developed by utilizing the multi-step optimization functions in WRIMS 2. FAM is coupled with CalLite model by working as an additional cycle.

FAM’s allocation process is shown in Figure 65. The FAM model can be used to allocate water for both CVP and SWP and it can handle both existing and future hydrological conditions.

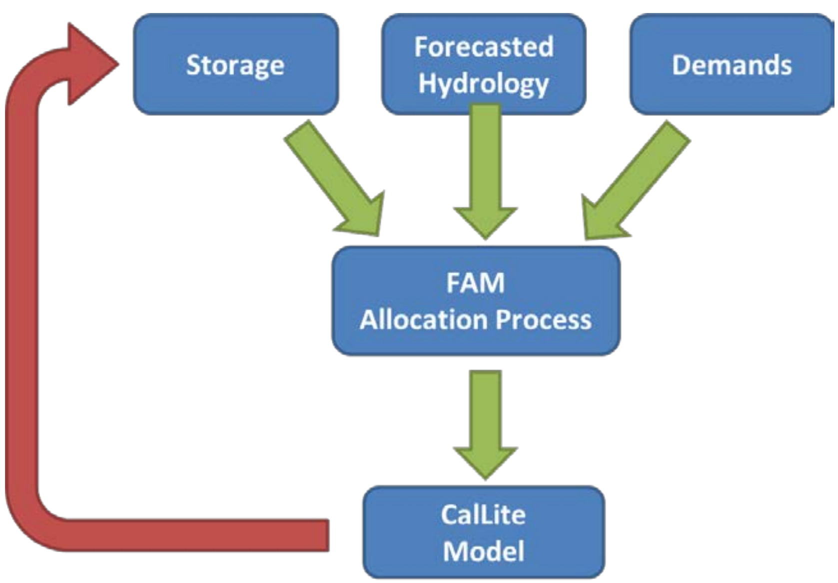


Figure 65. FAM Allocation Process in CalLite

Key Assumptions and Regulations in FAM are:

- Forecasted Hydrology to the End of the Year
- Project Demands
- Physical Representation
- Reservoir Operation Rules
- COA
- Minimum Flows Criteria
- Navigation Control Point
- Export/Inflow Ratio
- April 15 – May 15 Export Limitations
- Banks Pumping and Tracy Pumping
- Biological Opinions

The following code shows a comparison between not using the Multi-Step Optimization syntax in WRIMS 2 and using. With Multi-Step Optimization syntax in FAM, model is significantly simplified.

```
Code without using Multi-Step Optimization Syntax:
  goal set_C30_Jan {C30_Jan + D30_Jan = C3_Jan + C2_Jan + I30_Jan}
 goal set_C30_Feb {C30_Feb + D30_Feb = C3_Feb + C2_Feb + I30_Feb}
 goal set_C30_Mar{C30_Mar + D30_Mar = C3_Mar + C2_Mar + I30_Mar}
 …
 goal set_C30_Nov {C30_Nov+ D30_Nov = C3_Nov + C2_Nov+ I30_Nov}
 goal set_C30_Dec {C30_Dec + D30_Dec = C3_Dec + C2_Dec + I30_Dec}

  Code using Multi-Step Optimization Syntax:
 define FAM_Months {value 12}
  goal(FAM_Months) set_C30 {C30($m) + D30($m) = C3($m) + C2($m) + I30($m)}
```

To decrease the run time of the FAM model, FAM uses a simplified schematic as shown in Figure 66.

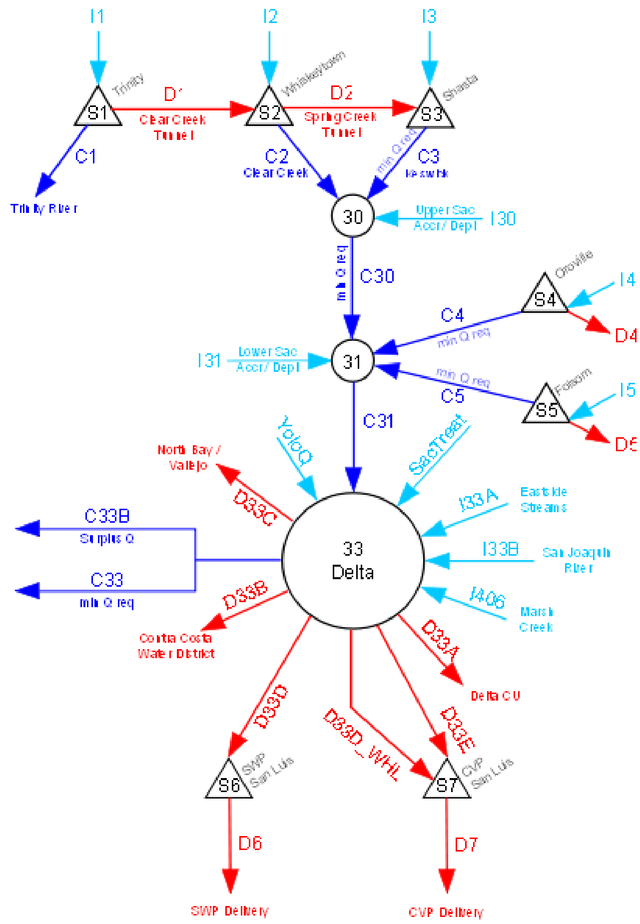


Figure 66. FAM Schematic

FAM has been reviewed by the Division of Operation and Maintenance in the California Department of Water Resources and the US Bureau of Reclamation.

G.4 References

California Department of Water Resources (DWR). 2002. *Benchmark Studies Assumptions.* Sacramento, Calif.

California Department of Water Resources (DWR). 2009. *Common Assumptions Common Model Package.* Sacramento, Calif.

Appendix H CS2CL Model Structure and Implementation

H.1 Introduction

Most of CalLite's hydrology, demand, and regulation requirement inputs are obtained by copying or aggregating CalSim II input and output timeseries. Appendix A has a list of timeseries for CalLite accretion/depletion terms and demands, which also shows the source timeseries from CalSim. The CalLite input timeseries are obtained from the CalSim timeseries by either simple copying or performing arithmetic operations. Prior to CalLite Version 2.00, MS Office Excel spreadsheets were used to create the CalLite input timeseries, but this procedure proved to be tedious and error-prone.

Starting with Version 2.00 of CalLite, all timeseries input data are now contained in a CalLite SV file in the HEC DSS format. The data in this SV DSS file are created by a WRIMS 2-based CalLite SV file generating tool, called CS2CL (CalSim to CalLite), which is coded in the Water Resources Engineering Simulation Language (WRESL). The CS2CL tool replaces the MS Office Excel method used with earlier versions of CalLite. CS2CL generates the CalLite input SV file using a DSS file which contains all timeseries from the SV (input) and DV (output) DSS files of a particular CalSim II run. Generating these timeseries in a WRIMS 2-based model has a number of advantages, including: (1) consistency in coding between the CalLite model and CS2CL, (2) easier maintenance and tracking of timeseries properties in CalSim and CalLite, and (3) automated generation of input timeseries for CalLite.

CS2CL is designed so that the user can easily update the CalLite SV file with different system assumptions and/or hydrology scenarios, by simply running a model with input and output timeseries from a different CalSim II study. The CS2CL tool can then be used to re-generate the CalLite SV DSS file automatically.

In the current CalLite release, fifteen CS2CL-generated outputted SV files are pre-generated and already included: D-1485, Existing LOD with Pre-BO, Future LOD with Pre-BO, Existing LOD with BO, Future LOD with BO, and ten climate change scenarios. When the SV and DV files of the CalSim II base study are changed, it is necessary to create a new DVSV.DSS file using these files, and then rerun CS2CL to generate a new CalLite input SV file prior to running the CalLite model.

The next sections explain the CS2CL model's structure and its implementation.

H.2 CS2CL WRIMS 2 Model Structure

Below is the directory structure of the CS2CL tool folders and a list of all of files necessary for a CS2CL WRIMS 2 model (example shown for a Current LOD plus BO model).

```
CS2CLroot:
    .\CalSimDSS
        2005A01AINIT.DSS
        2005A01ASV.DSS
        2020D09EINIT.DSS
        2020D09ESV.DSS
        Other_timeseries_2005A01A.DSS
        Other_timeseries_2020D09E.DSS
    .\DSS

    .\run
        mainCS2CL.wresl
        study.sty
        .\CS2CL_TS
            Accretion_Def.wresl
            ANN.wresl
            ANN_CCWD_NOD_WYTypes_CycleOutput_TS.wresl
            B2_TS.wresl
            BO_TS.wresl
            CVP_Dellogic_TS.wresl
            Cycle_2_TS.wersl
            DeltaFlowCriteria.wresl
            Dummy.wresl
            Hydrology_Demands_TS.wresl
            LosVaqueros.wresl
            NewMelonesForecast.wresl
            NPD_Flow.wresl
            NPR_EC.wresl
            NPR_Flow.wresl
            San_Joaquin.wresl
            San_Joaquin_CUAW.wresl
            SWP_Dellogic_TS.wresl
            System_Files_TS.wersl
            UARM.wersl
            Weirs_Refuges_TS.wresl
            WestSide_RF_Defs.wresl
            WestSideReturns.wresl
            WS_Returns_Def.wresl
            WSReturnC1.wresl
            WSReturnC2.wresl
            WSReturnC3.wresl
            WSReturnC5.wresl
```

.\lookup
CVP_RF_Split.table
CVPAnnual.table
CVPcontractRF.table
DSM2_NPD.table
DSM2_NPR.table
EC_Creek.table
EC_Table_MPool.table
EC_Table_WestRtn.table
Initial_svdv.table
SLDR.table
wytypes.table
wytypeSJR_Rest.table
.project
CS2CL_Readme.docx
CS2CL_run.bat
CS2CL_study.config

Four cycles are used in the main file: mainCS2CL.wresl:

1. The first cycle is used to generate the two timeseries, SJR_ANN and VernWQfinal, which have data for 5 steps before the first month of the simulation (Oct 1921). These timeseries are required by the ANN DLL.
2. The second cycle is used to generate the timeseries UARM (Upper American River Model), which has data for 1 step before the first month of the simulation starts. This timeseries is required for computation of the American River Flow Management Standard.
3. The third cycle generates all of the other timeseries, which start in Oct 1921 and end in Sep 2003.
4. The final cycle generates timeseries for the San Joaquin.

H.3 CS2CL Model Implementation Guide

Following is a step-by-step guide for using the CS2CL Tool to create a CalLite SV file from a CalSim study. A future study (F-Part = 2020D09E) is used for example. Replace all instances of “2020D09E” below with “2005A01A” if running an existing condition study.

1) Run CalSim, save the DV file as 2020D09EDV.DSS (for example).
2) Copy 2020D09EDV.DSS and re-save as 2020D09EDVSV.DSS
3) Open this new DVSV.DSS file in HEC-DSSVue and drag and drop the 2020D09ESV.DSS file into the list of timeseries. Click “Copy All”.
4) Repeat Step #3 to copy the timeseries over from “Other_timeseries_2020D09E”.
5) Ensure the correct pathnames are used in CS2CL_study.config. The run period should be set to Oct 1920 – Sept 2004.
6) Run the CS2CL tool by double clicking on CS2CL_run.bat. It will output a DV timeseries for use as a SV input timeseries in CalLite..

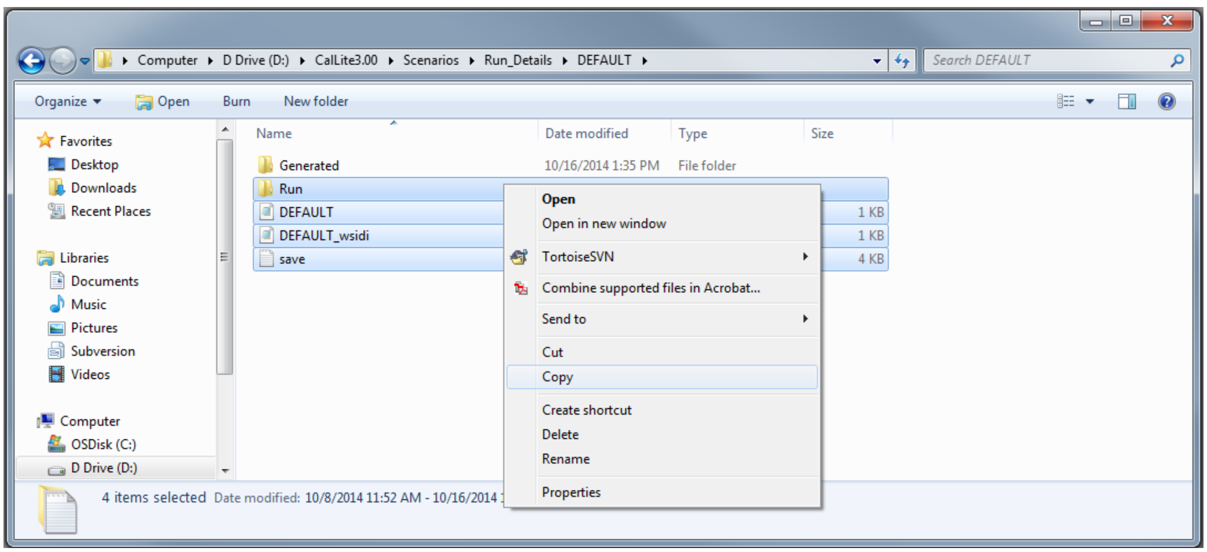
Appendix I Running CalLite without the GUI

More advanced users can run CalLite without using the GUI for greater customization and flexibility. Two methods for running CalLite without the GUI are introduced below:

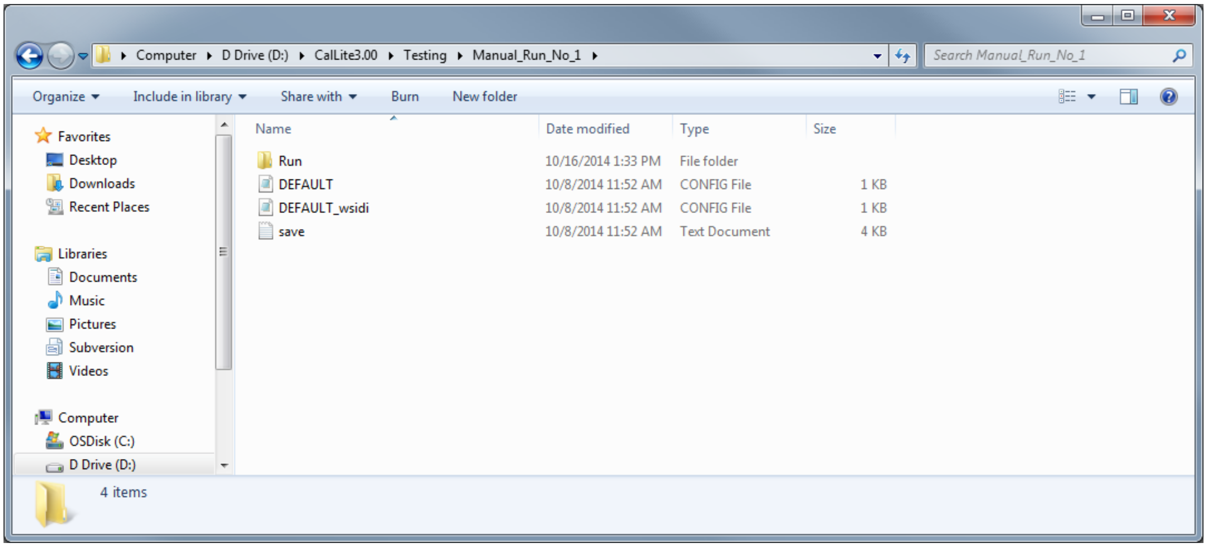
I.1 WRIMS2 IDE method

Below are the steps necessary to do the WRIMS2 IDE manual run:

Open the Default scenario under Scenarios/Run_Details and copy the selected items as shown in the below figure.

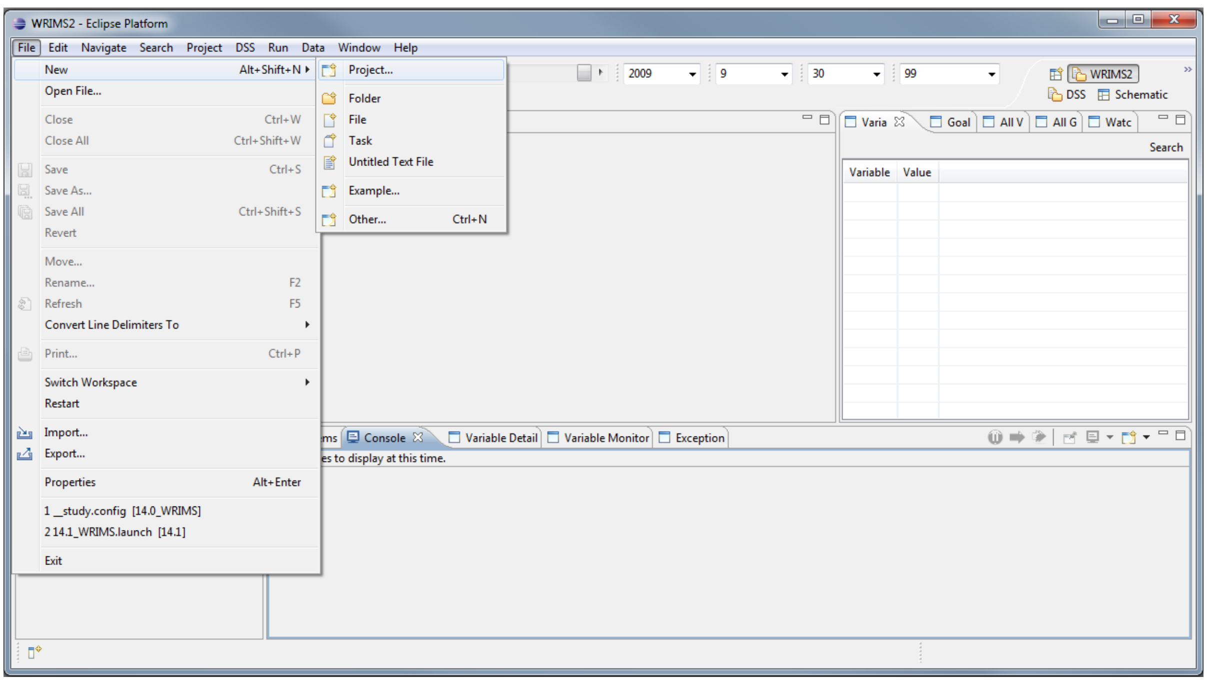


Paste the copied files in the folder you created for this scenario. For this exercise the folder name is *Manual_Run_No_1*.

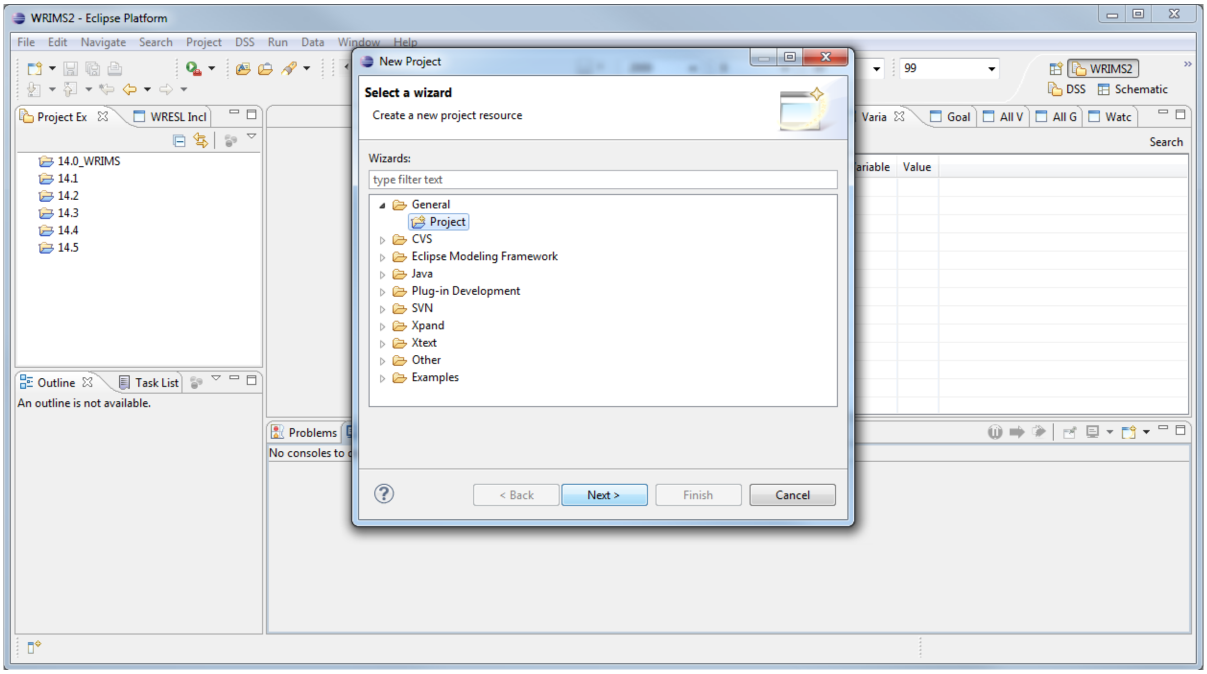


Launch the Eclipse Platform, and do the following steps:

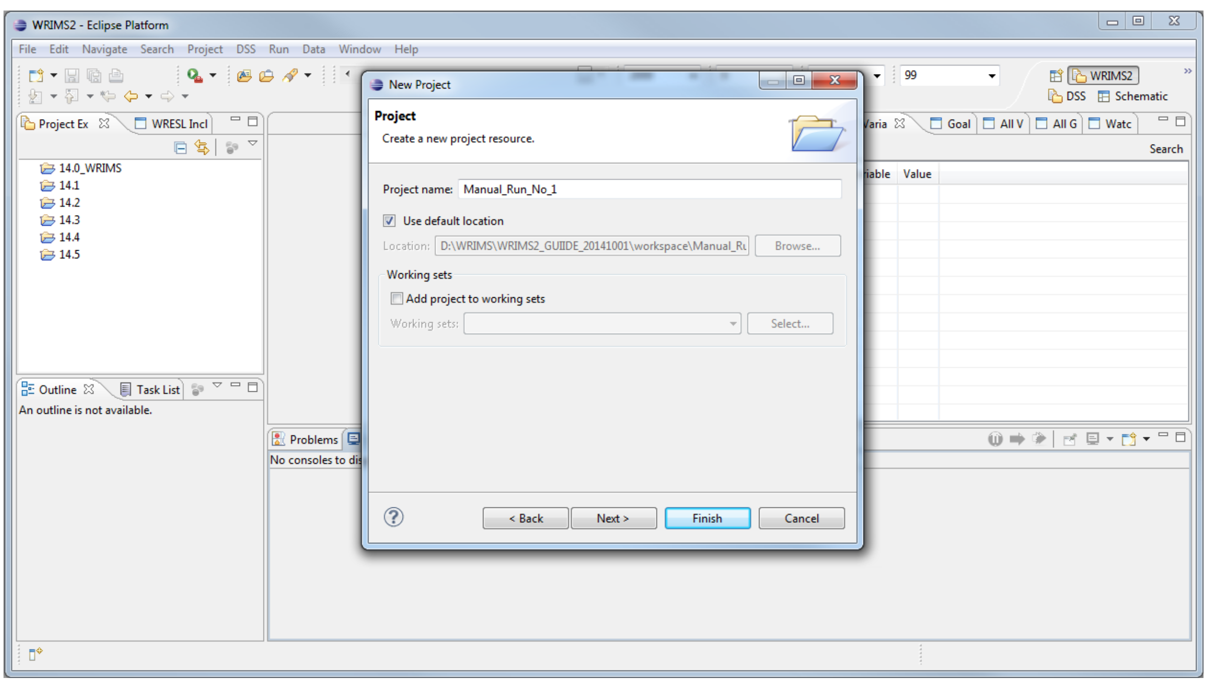
Select File | New | Project…



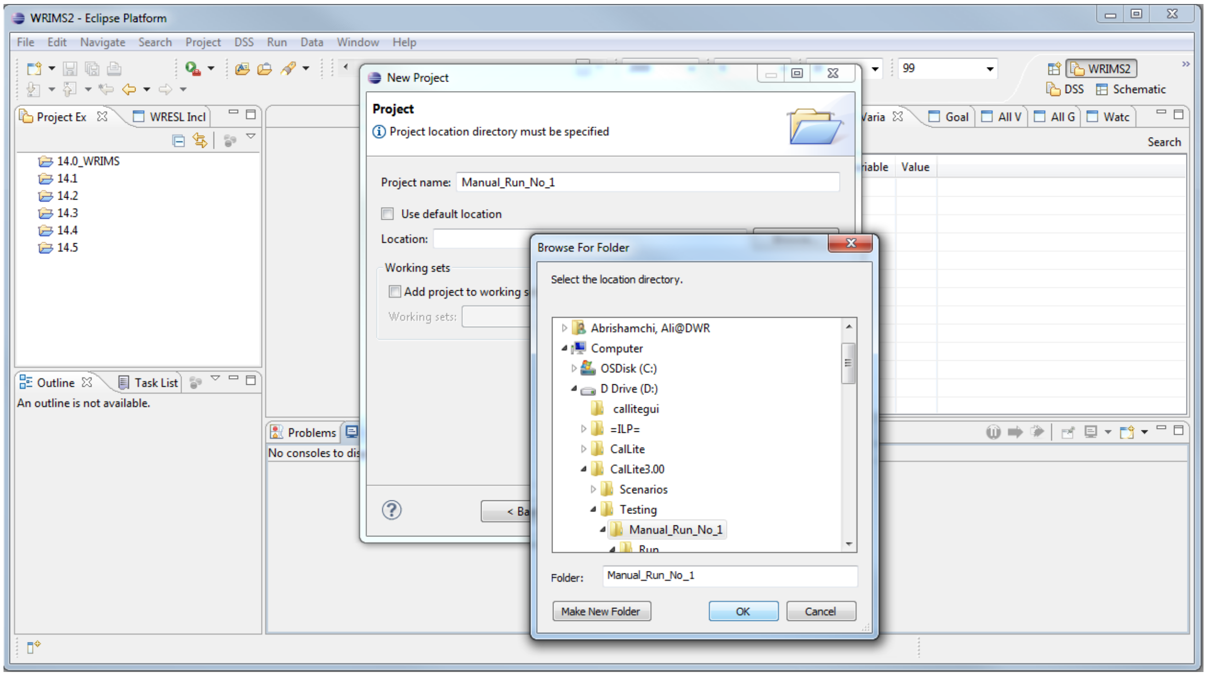
Select General | Project and then click on the Next button.



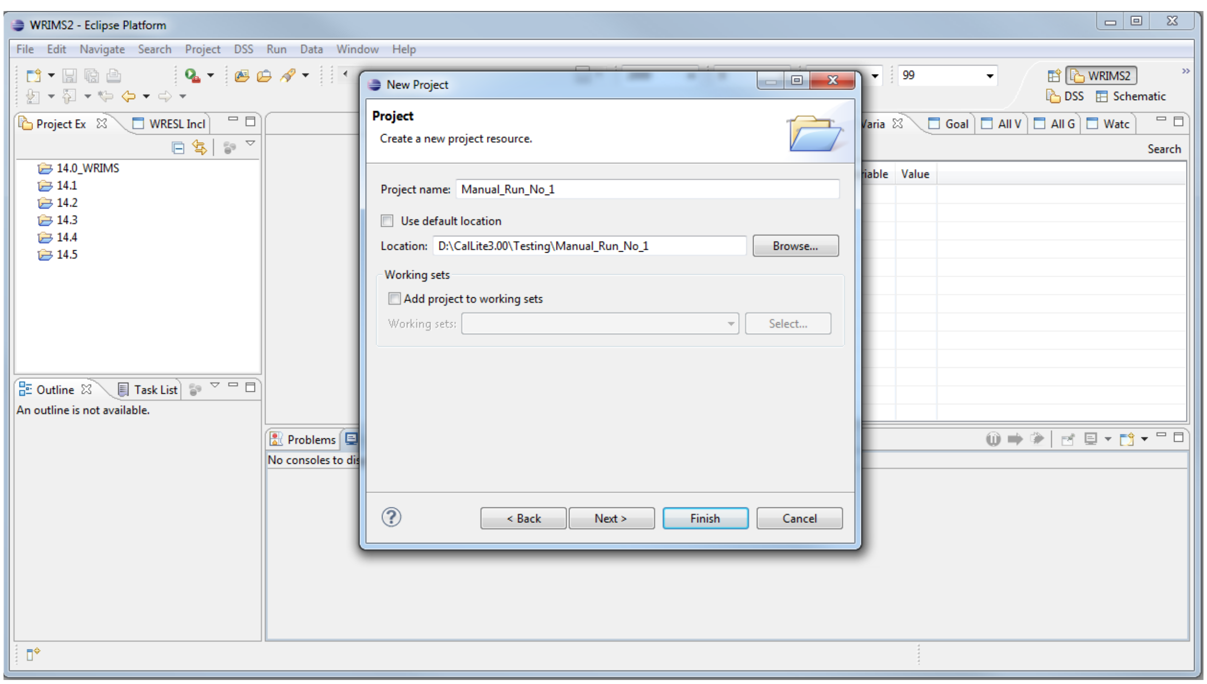
Type in the project name, in this case: Manual_Run_No_1.



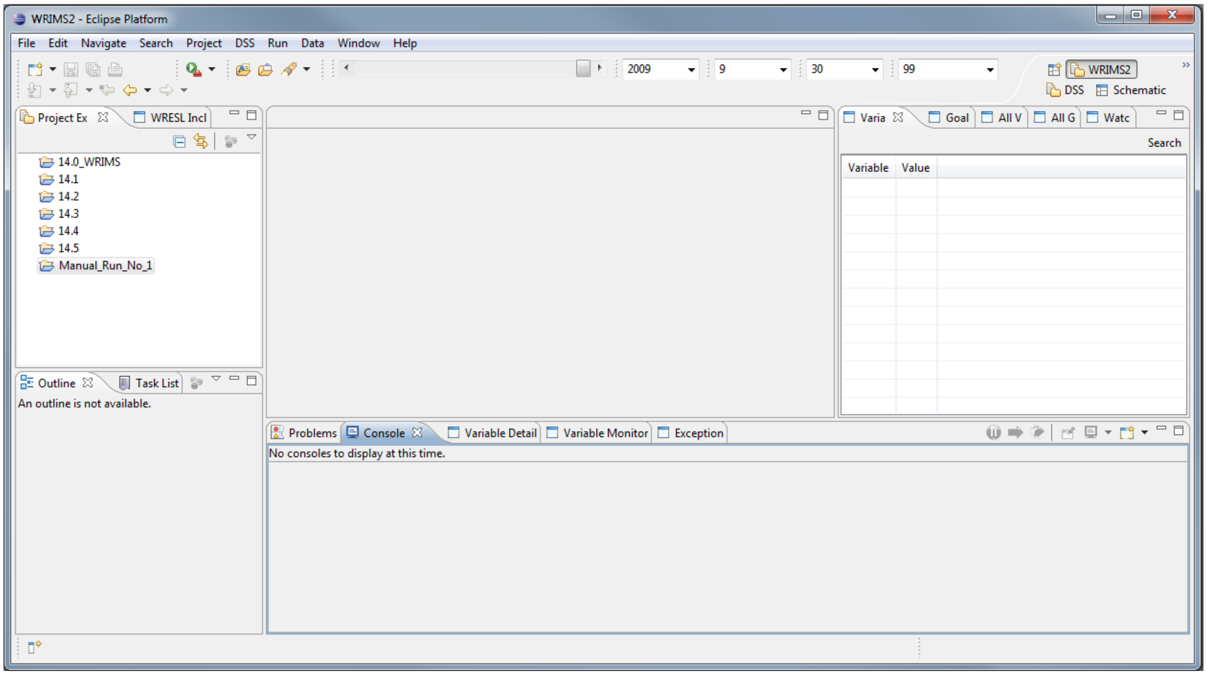
Then unselect the *Use default location*, and click on the Browse button to select the project location. In this exercise: D:\CalLite3.00\Testing\Manual_Run_No_1.



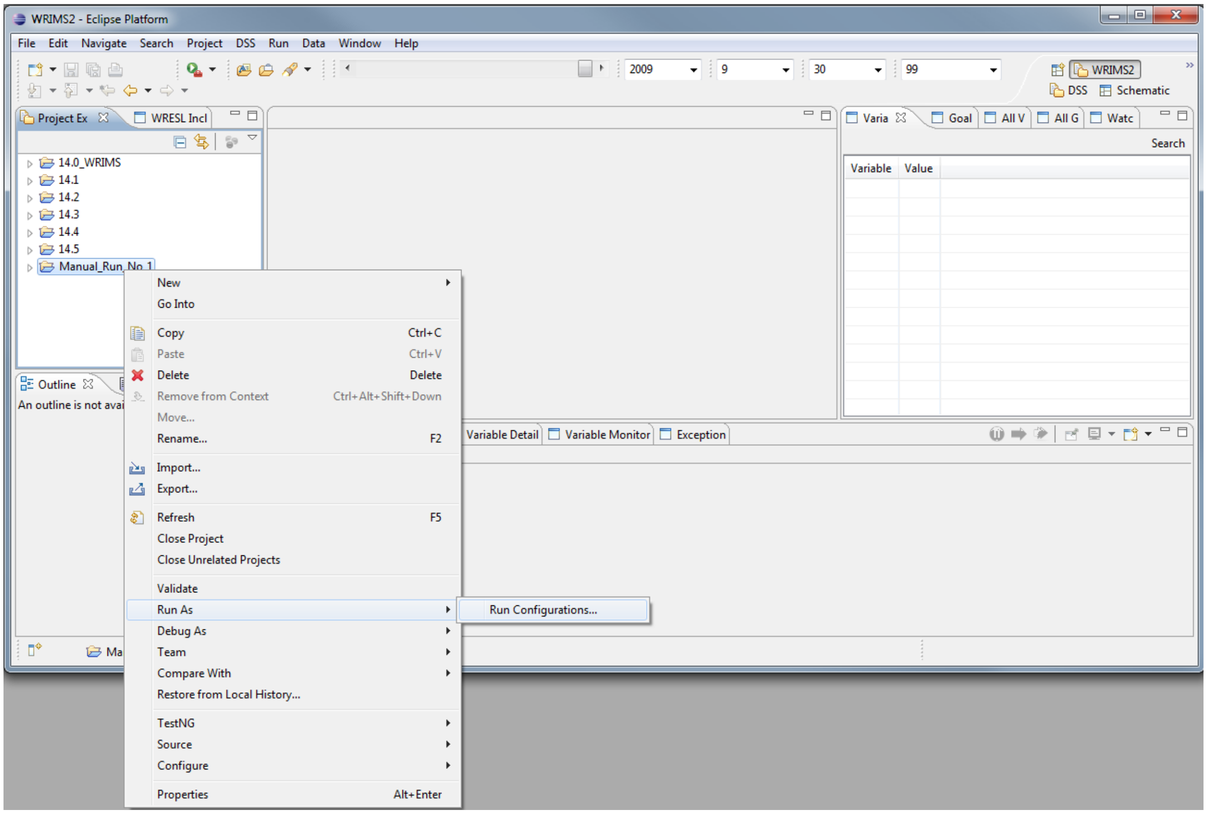
Click on the Finish button.



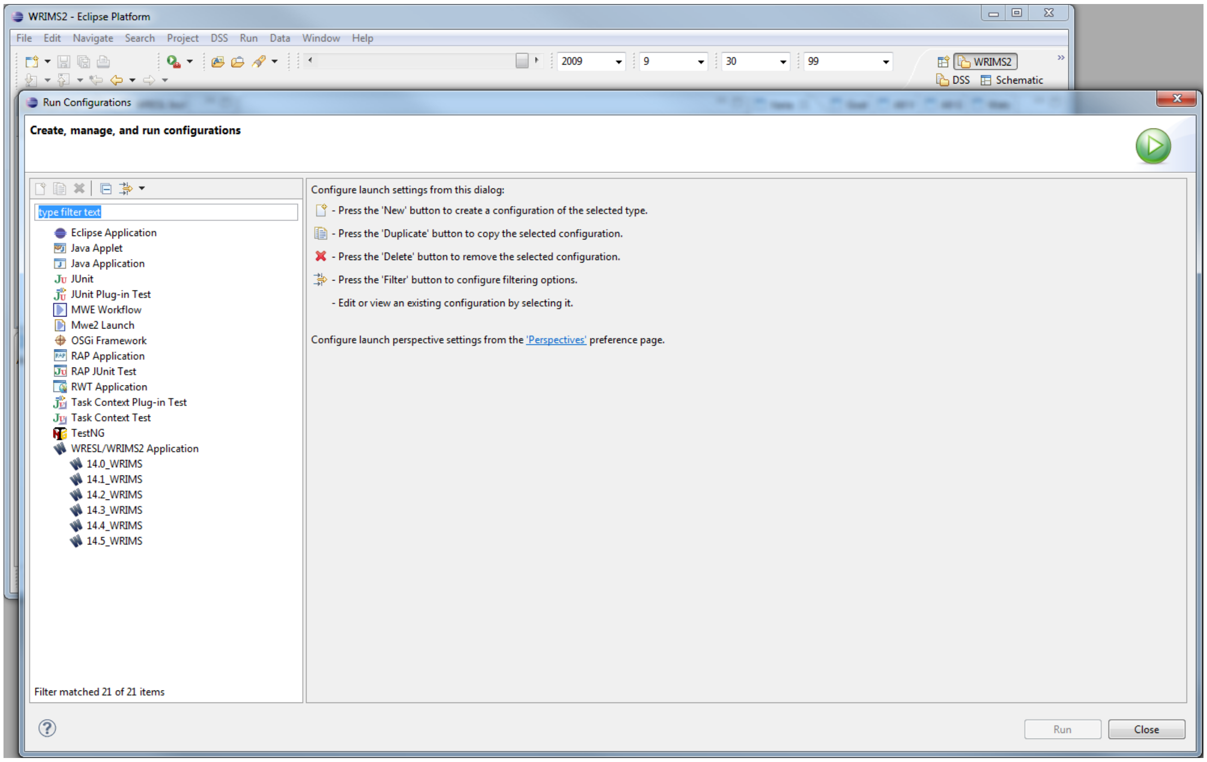
A project is added to *Project Ex* panel as shown in the below figure.



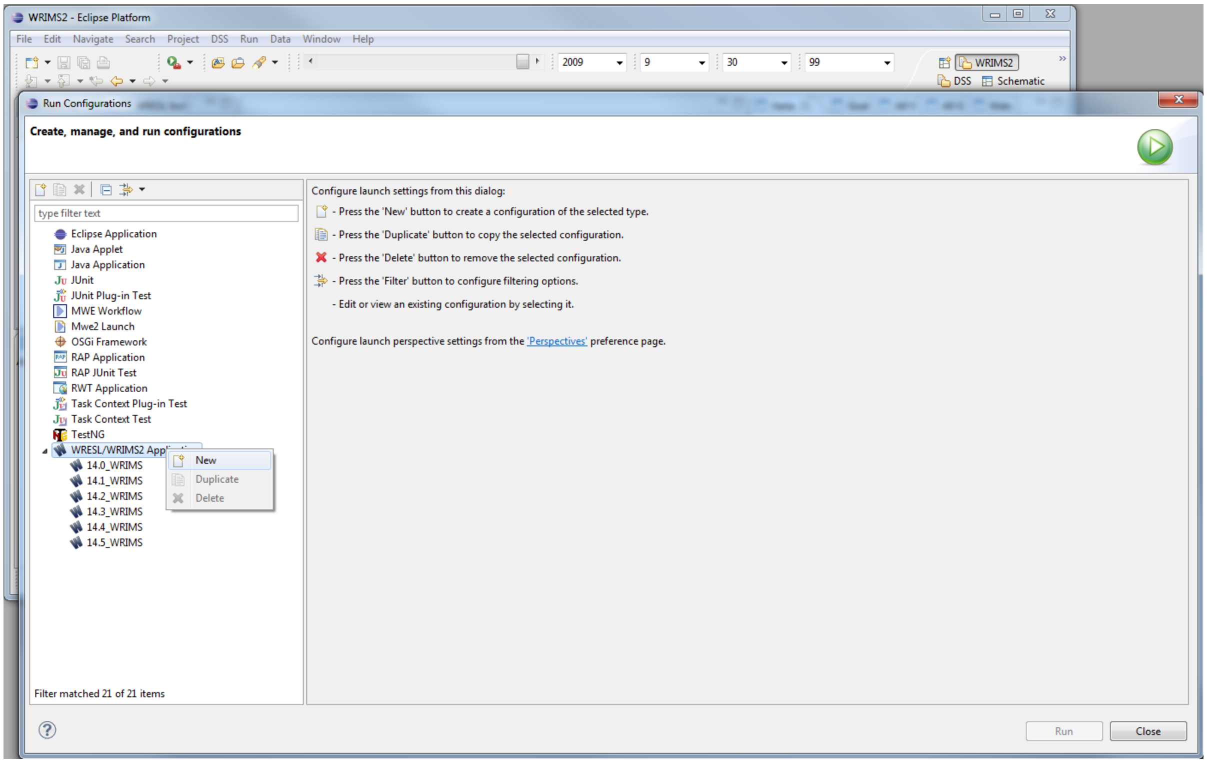
Right click on the *Manual_Run_No_1*, and then select *Run As | Run Configurations*.



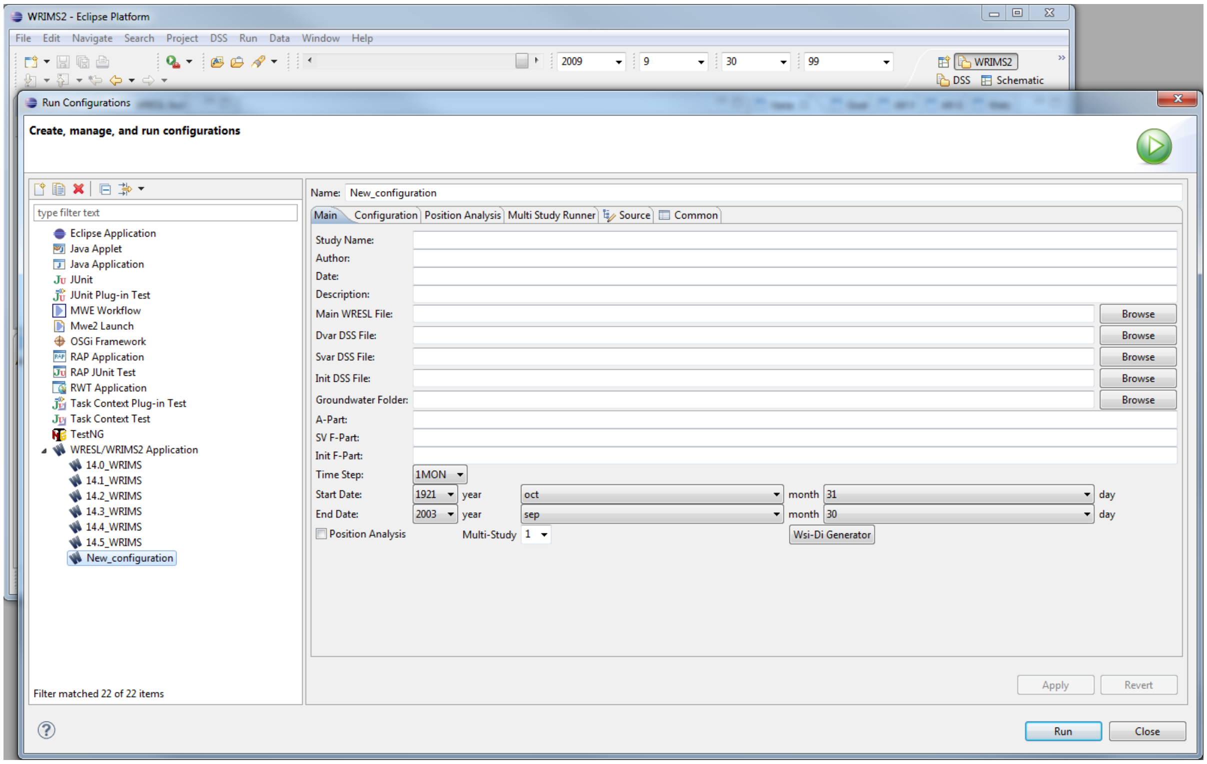
The following *Run Configurations* window opens as shown in the below figure.



Under *WRESL/WRIMS2 Application*, right click on *Manual_Run_No_1*, then select *New* to create a launch file for this project.

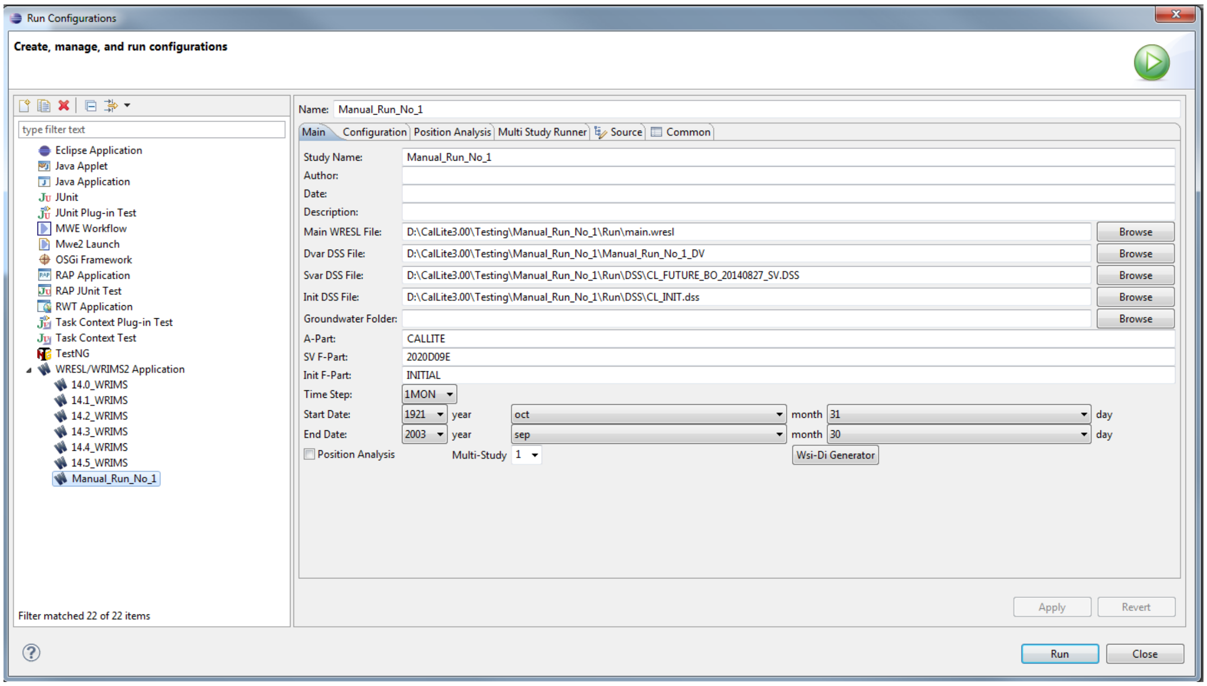


A *New_configuration* is added under *WRESL/WRIMS2 Application*.

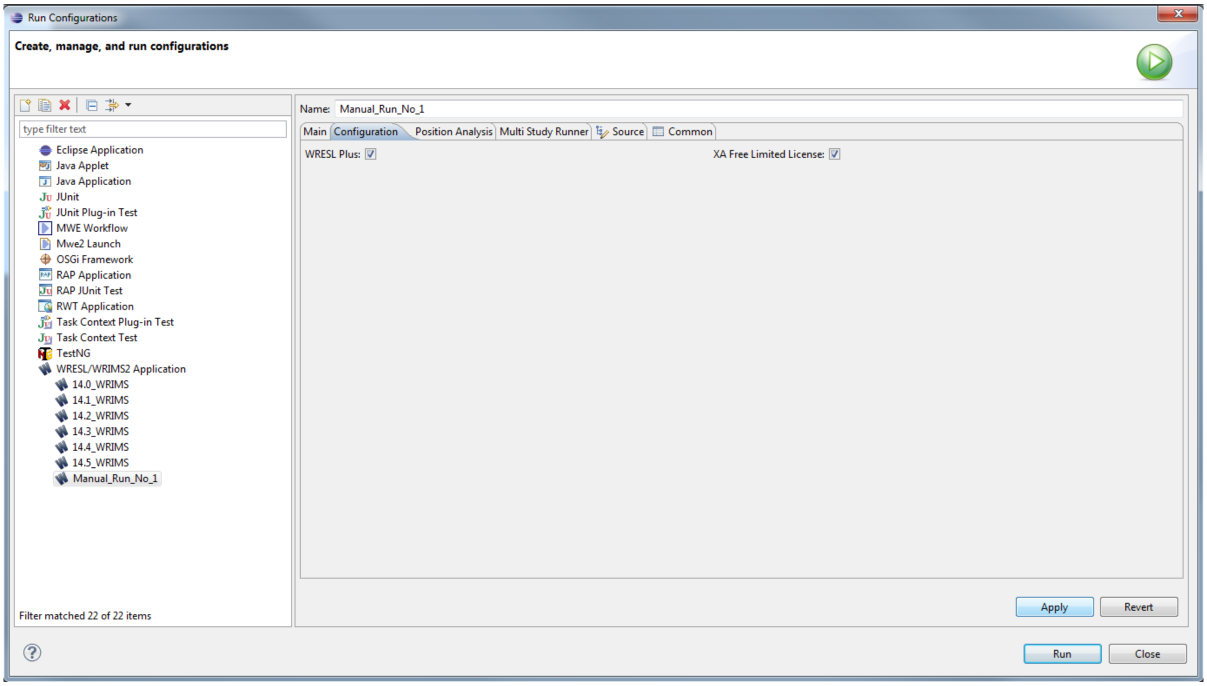


In the *Main* tab, fill out the blank space in front of the following items by typing the appropriate name/parameter or by selecting a file using the Browse button:

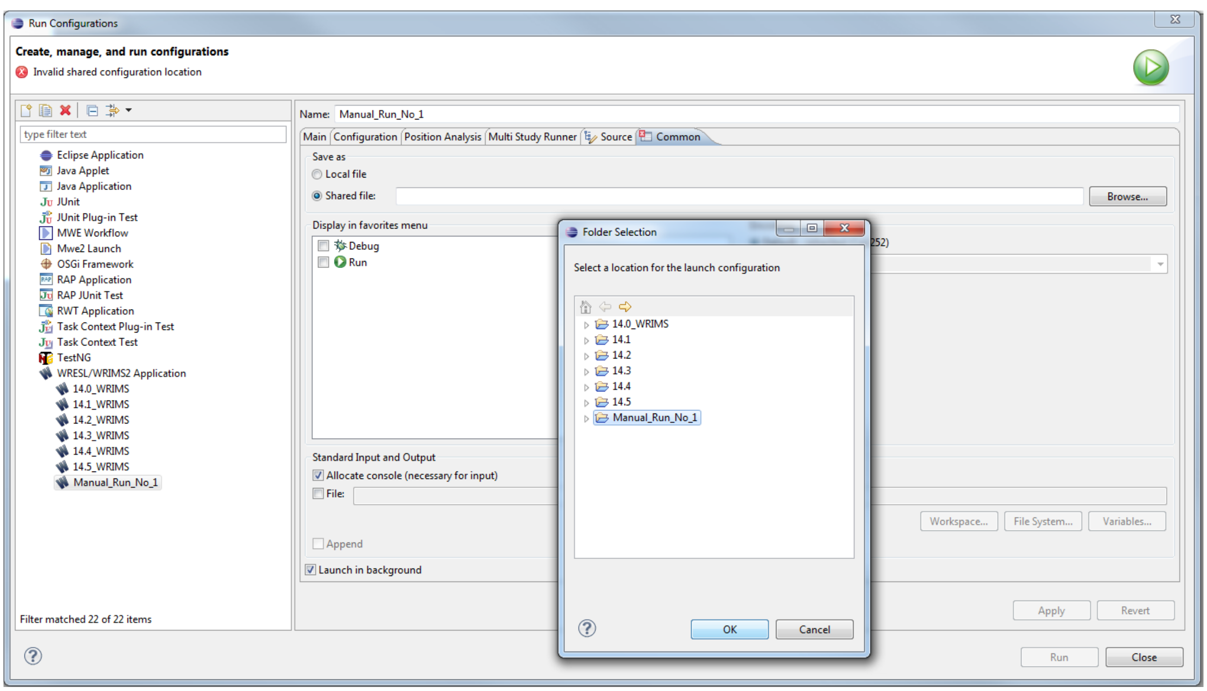
Name, Study Name, Main WRESL File, Dvar DSS File, Svar DSS File, Init DSS File, A-Part, SV F-Part and Init F-Part as shown in the below figure. Then click on the *Apply* button.



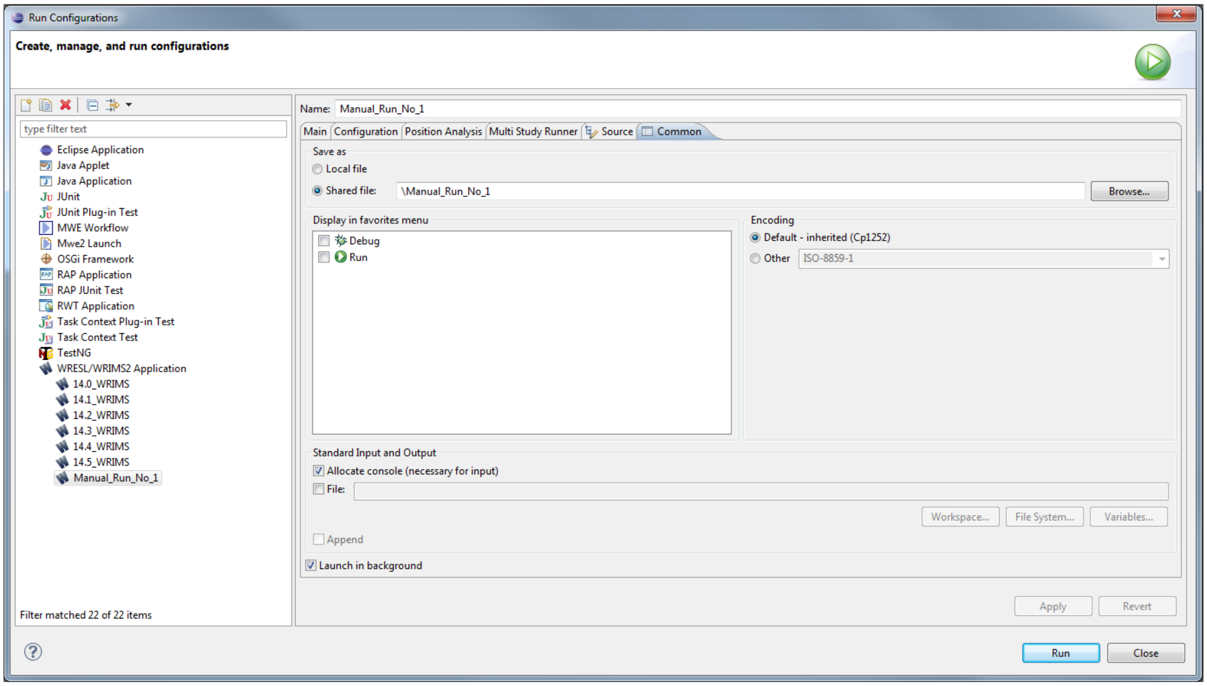
Select the Configuration tab, check *WRESL Plus* and *XA Free Limited License* and then click on the *Apply* button.



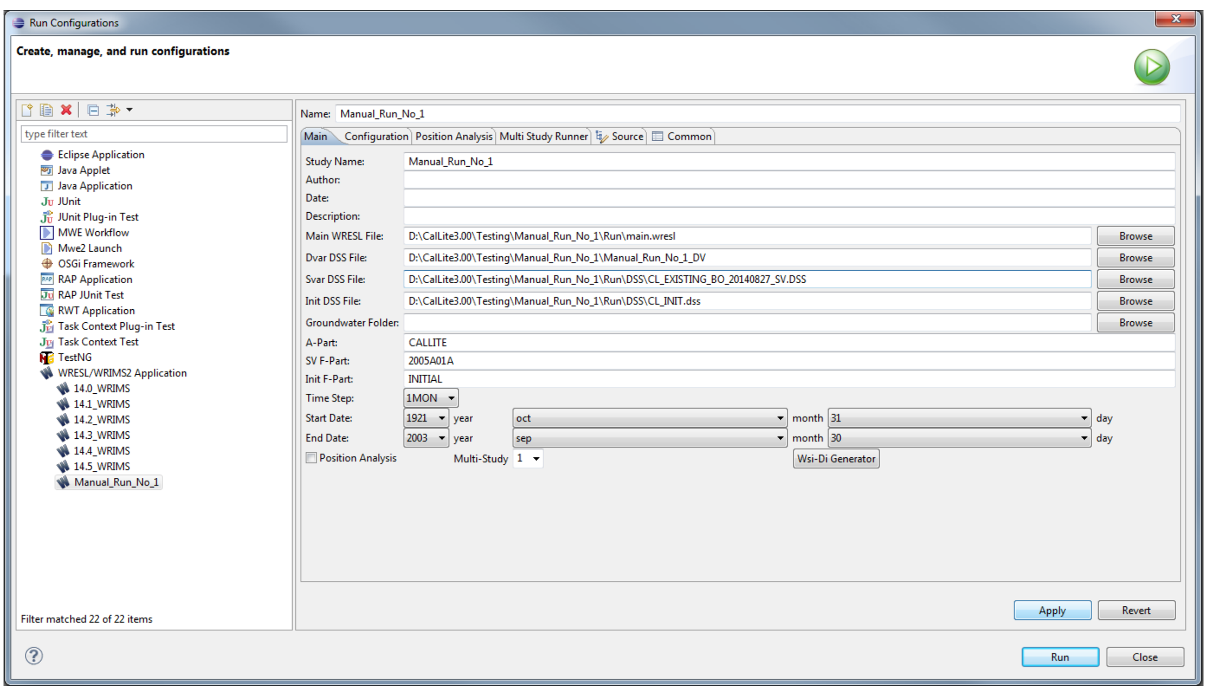
Navigate to the *Common* tab, select the *Shared file*, then click on the *Browse* button and select the *Manual_Run_No_1* location for the launch configuration then *OK*.



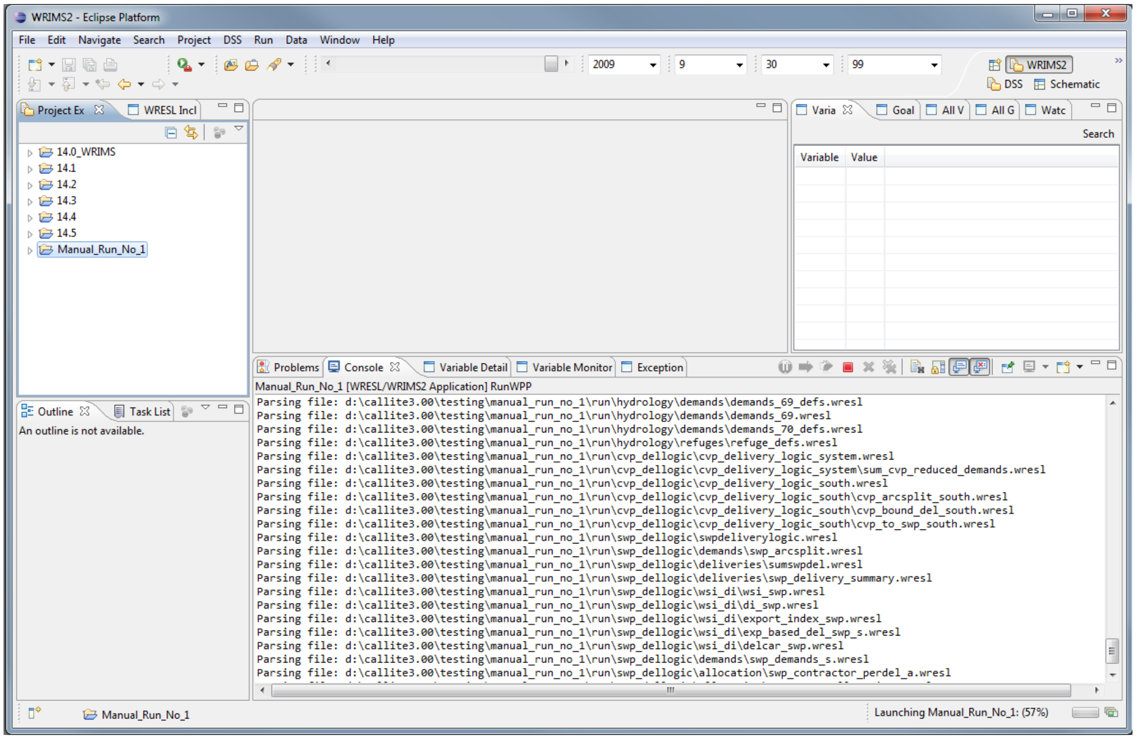
Shared file location (*Manual_Run_No_1*) is selected as shown in the below figure.



Stay on this tab or navigate back to the Main tab and click on the *Run* button to manually run your model. Make sure the *Manual_Run_No_1* is highlighted under *WRESL/WRIMS2 Application*, and that you have clicked on *Apply* to save your options.



The below figure shows the parsing stage of the manual run.



I.2 Batch file method

Below is a summary of the steps necessary to do the batch file method manual run, followed by a more detailed step-by-step guide. The three steps are creating a directory, modifying the input files, and running the batch file.

Creating the Manual CalLite Directory and Configuring the Batch File

1) Copy and paste the entire DEFAULT folder from ***CalLite_v3\Scenarios\Run_Details*** into the same "Run_Details" folder and rename it. For the purposes of this tutorial, this new folder will be renamed to "batchFileTest" and will be referred to as such from this point forward.
    a. Note: you may copy/paste another study folder, other than DEFAULT, if you wish to use that specific study as a starting point.
    b. You may elect to create a new folder within the CalLite_v3 directory to store your new studies, instead of "Run_Details". Make sure to change the pathnames appropriately in the following steps. For the purposes of this tutorial, the original "Run_Details" folder will be used.

2) Copy/paste all the SV files from ***CalLite_v3\Model_w2\DSS_Files*** to ***CalLite_v3\Scenarios\Run_Details\batchFileTest\Run\DSS*.** Alternatively, copy/paste only the one needed for that study.
3) In the CalLite_v3 directory, copy/paste and rename the "group_0" batch file.

4) Modify the newly created batch file to point to the .config file in the new directory created in step 1. (i.e. **CalLite_v3\Scenarios\Run_Details\batchFileTest\batchFileTest.config**). Use the original group_0 as a reference.

Modifying the Input Files

1) Modify the .config file
    a) Specify the SV, DV, and INIT DSS filenames, file locations, and the appropriate Level of Development.
2) Modify the Lookup tables
    a) Modify GUI_ related tables to manually set values (see details in the Step-by-Step guide below)
    b) Copy the files from the folders entitled "VariableDemand" (if using current SWP demands) or "FutureDemand" (if using SWP future or user-defined demands) and replace the corresponding lookup tables.

Running the Model

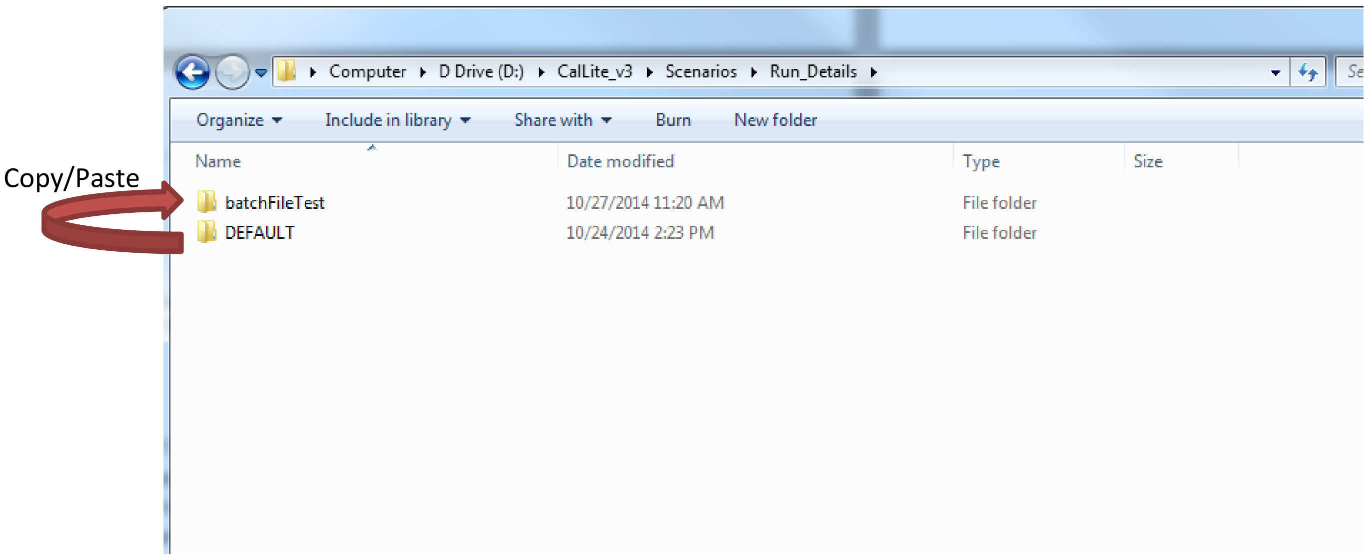
Double clicking "D:\CalLite_v3\group_batchFileTest.bat" will run the respective study. The output will be saved in the "DvarFile" path specified in the .config file.

I.3 Step by Step Guide

I.3.1 Creating the Manual CalLite Directory

Create a new directory in which to run CalLite without the GUI.

1) Copy and paste the entire DEFAULT folder from ***CalLite_v3\Scenarios\Run_Details*** into the same "Run_Details" folder and rename it.



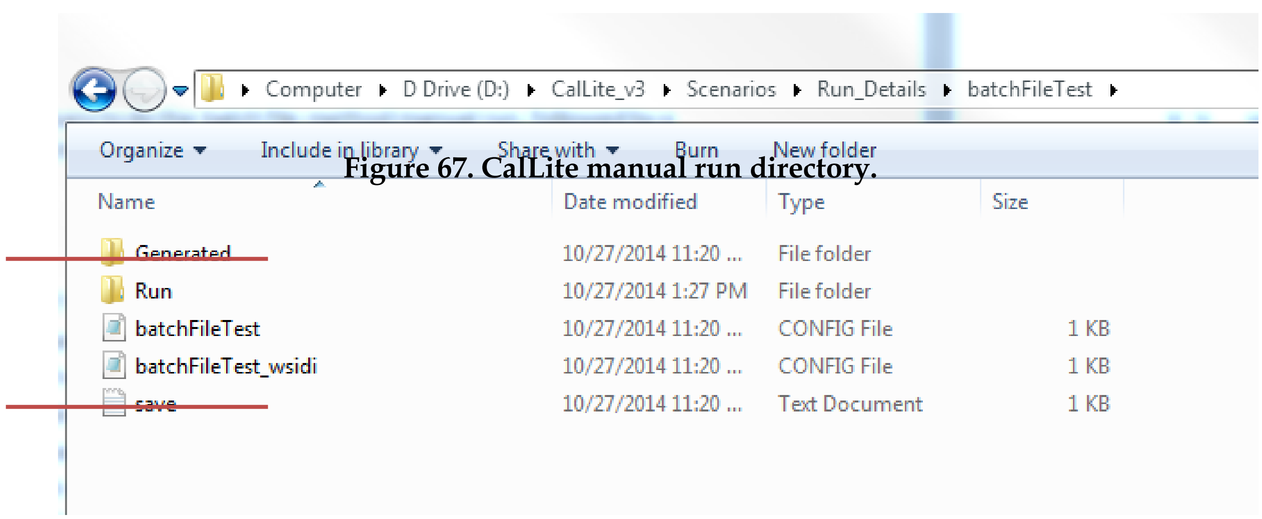
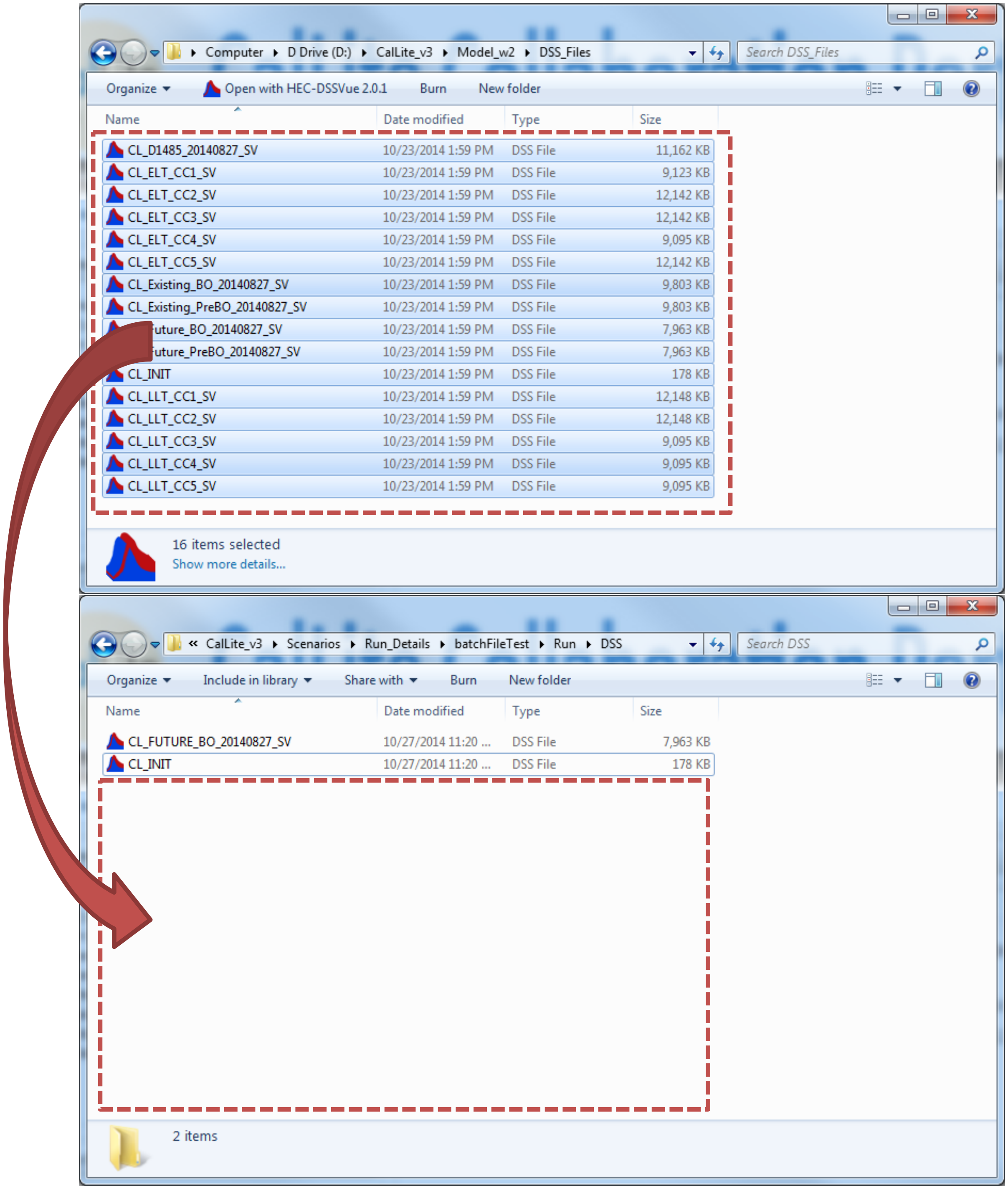


Figure 67. CalLite manual run directory.

'Generated' and 'save' are files generated by the GUI and are not necessary for a manual run; they can be deleted.

I.3.2 Copy the SV Files from Model_w2

Copy/paste the desired SV file(s) from ***CalLite_v3\Model_w2\DSS_Files*** to ***CalLite_v3\Scenarios\Run_Details\batchFileTest\Run\DSS***

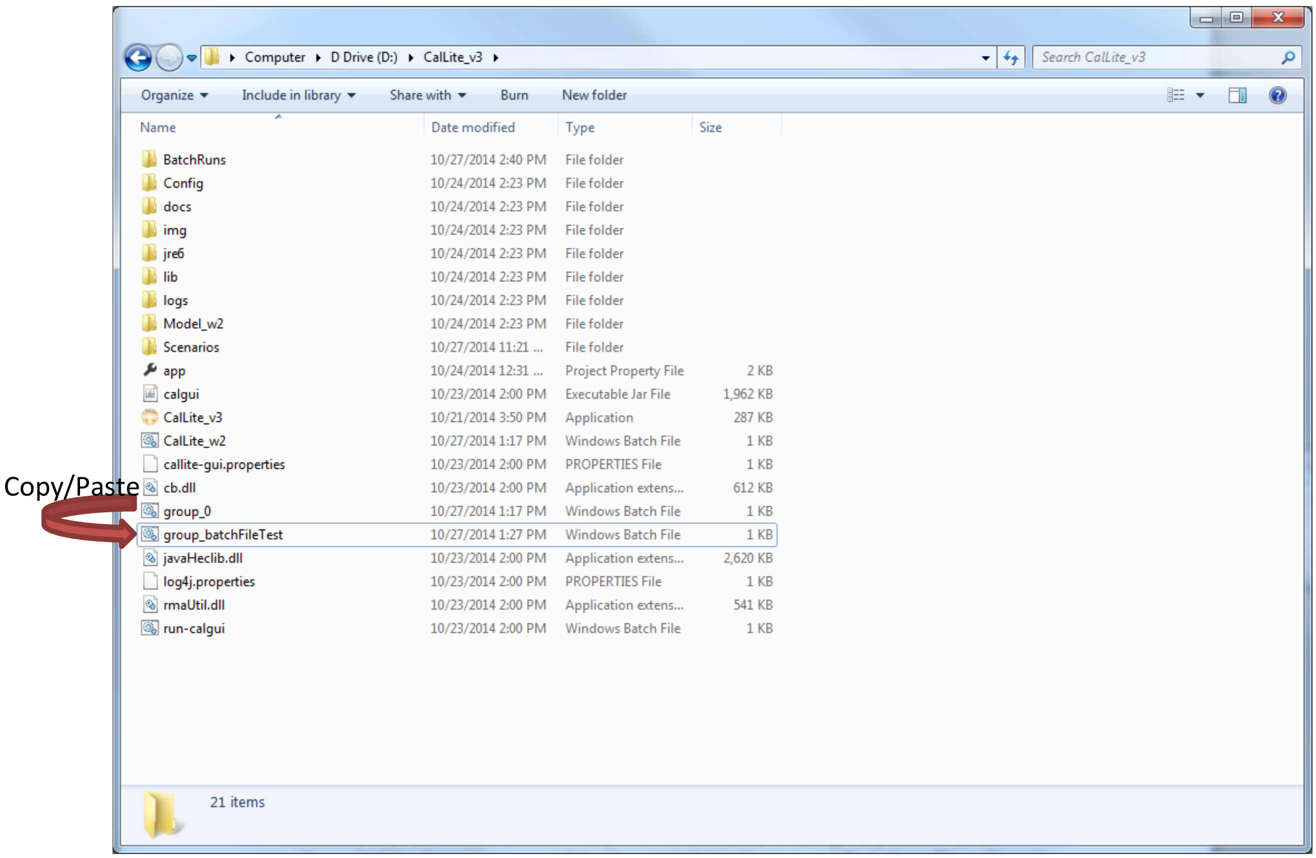


All the SV files may be copied over, but the model will only use the one specified in the .config file. See section I.3.4.1.

I.3.3 Configuring the Batch File

The batch file “group_0.bat” calls the WRIMS2 engine to run the specified study.

The original batch file “group_0” reflects last study run from the GUI, so do not simply modify it, as any changes will be overwritten when a new study is run through the GUI. A new batch file will need to be created to initiate the manual run for the newly created study – make a copy of “group_0” and rename it to reflect the name of the new study.



Within the newly created batch file (group_batchFileTest.bat), rename the directories to point to the .config file of the new study.

```
@title = "%~dp0\Model_w2\runConfig_calgui
D:\CalLite_v3\Scenarios\Run_Details\batchFileTest\batchFileTest.config
batchFileTest"

%~dp0\Model_w2\runConfig_calgui
D:\CalLite_v3\Scenarios\Run_Details\batchFileTest\batchFileTest.config
batchFileTest
```

Before the new study can be run, the study parameters need to be changed. This is the subject of the next section.

I.3.4 Modifying the Input Files

To run a CalLite scenario, there are two set of modifications that need to be made to files in the manual run directory regarding the .config file and lookup tables.

I.3.4.1 Modifying the .config File

The .config file contains the SV file F-part and directories for model inputs/outputs: these parameters need to be changed to reflect those of the new study.

Specifying the SV file: Specify the path for the correct SV file from ***batchFileTest\Run\DSS.*** The SV files were added to the study folder in step 1.3.2. Remember to change the SV file F-part (SvarFPart) accordingly.

Specifying the DV file: Specify the path for the output DV file. This file will be created when a run is started.

Specifying the INIT file: There is only one INIT file, but make sure the directory points to the INIT file inside the newly created study.

*All pathnames should be checked to ensure they are not still referring to files in the DEFAULT study (or the original study that was copied)

```
# This config file and run folder must be placed in the same directory

Begin Config

WreslPlus              yes
MainFile               run\main.wresl
Solver                 XA
DvarFile               D:\CalLite_v3\Scenarios\batchFileTest_DV.dss
SvarFile               D:\CalLite_v3\Scenarios\Run_Details\batchFileTest\Run\DSS\CL_FUTURE_BO_20140827_SV.DSS
SvarAPart              CalLite
SvarFPart              2020D09E
InitFile               D:\CalLite_v3\Scenarios\Run_Details\batchFileTest\Run\DSS\CL_INIT.dss
InitFPart              INITIAL
TimeStep               1MON
StartYear              1921
StartMonth             10
StopYear               2003
StopMonth              9
#GroundwaterDir         .
ShowWreslLog               Yes
PrefixInitToDvarFile   Yes

IlpLog   no
IlpLogFormat   CplexLp
IlpLogVarValue no

End Config
```

Figure 68. The .config file for the manually run study.

I.3.4.2 Lookup Tables

This subsection describes changes to table files in the "Run\Lookup" folder. When running CalLite using the GUI, the GUI writes the appropriate values into these files. When doing a manual run, the values in these files need to be edited manually. The following six files are the basic tables that need to be edited to setup a manual CalLite run: GUI_HydroClimate.table; GUI_Operations.table; GUI_Regs.table; GUI_RPAsOtherRegs.table; GUI_RunBasis.table; and GUI_SODDemand.table; (Figure 69).In addition, for changes made to south-of-Delta demands, some additional files need to be copied.

The following sections describe how to change each table file, which files to copy, and how changes in each file correspond to options in the GUI.

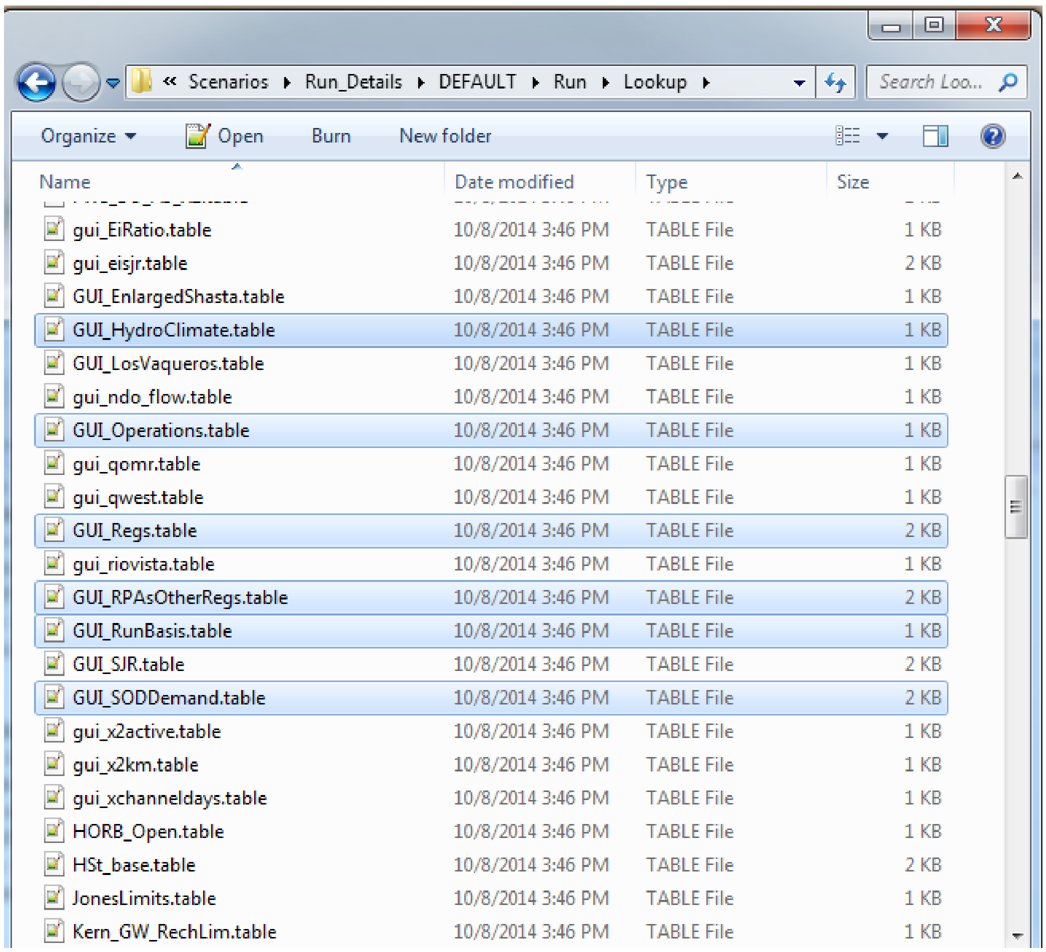


Figure 69. GUI lookup tables.

Hydroclimate Lookup Table

The Hydroclimate dashboard in the GUI has 3 active main frames, and each frame corresponds to an Index number in the gui_HydroClimate.table file (Figure 70). Change the option number in the table file to assign a value for each index.

Index #	Description	Value
1	Current Level of Development	0
	Future Level of Development	1
	Early Long Term Climate Change Hydrology	2
	Late Long Term Climate Change Hydrology	3
2	X2 Method (KM Equation) *Advanced User Only. Not available on GUI, must be changed manually.	0
	X2 Method (ANN) [DEFAULT]	1
3	Base (Current Sea Level)	0
	Sea Level Rise of 15 cm	1
	Sea Level Rise of 45 cm	2
4	No Climate Change	0
	Climate Change Scenario Q1	1
	Climate Change Scenario Q2	2
	Climate Change Scenario Q3	3
	Climate Change Scenario Q4	4
	Climate Change Scenario Q5	5

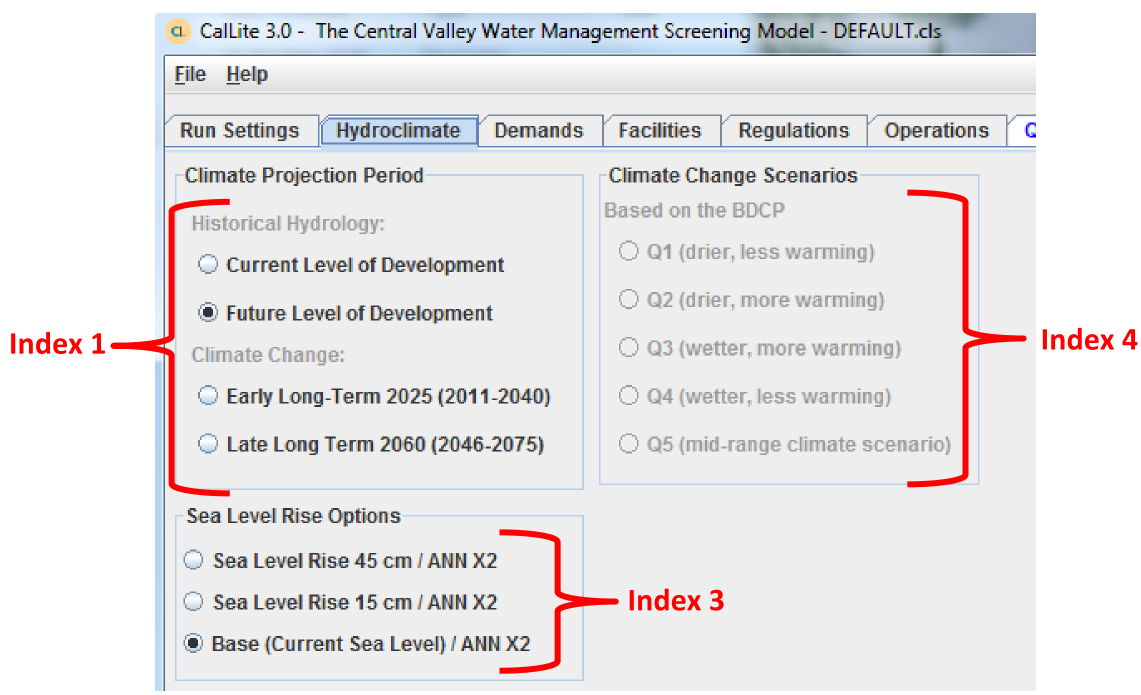


Figure 70. Hydroclimate dashboard and map of lookup table indices.

Operations Lookup Table

The Operation dashboard in the GUI has one main frame which has three settings which are saved in the GUI_Operations.table file (Indices 1-5), see Figure 71.

For Index 1-4 (Wheeling, JPOD, Intertie, and Payback Wheeling), there are only 2 options, on and off:

Option 0 – The operations is off and will not be included
Option 1 – The operation is on

Index 5 controls the CVP/SWP Allocation Method:

Option 0 – WSI-DI Allocation
Option 1 – User-Specified Fixed Allocation (currently not active in the WRESL code)
Option 2 – FAM Allocation

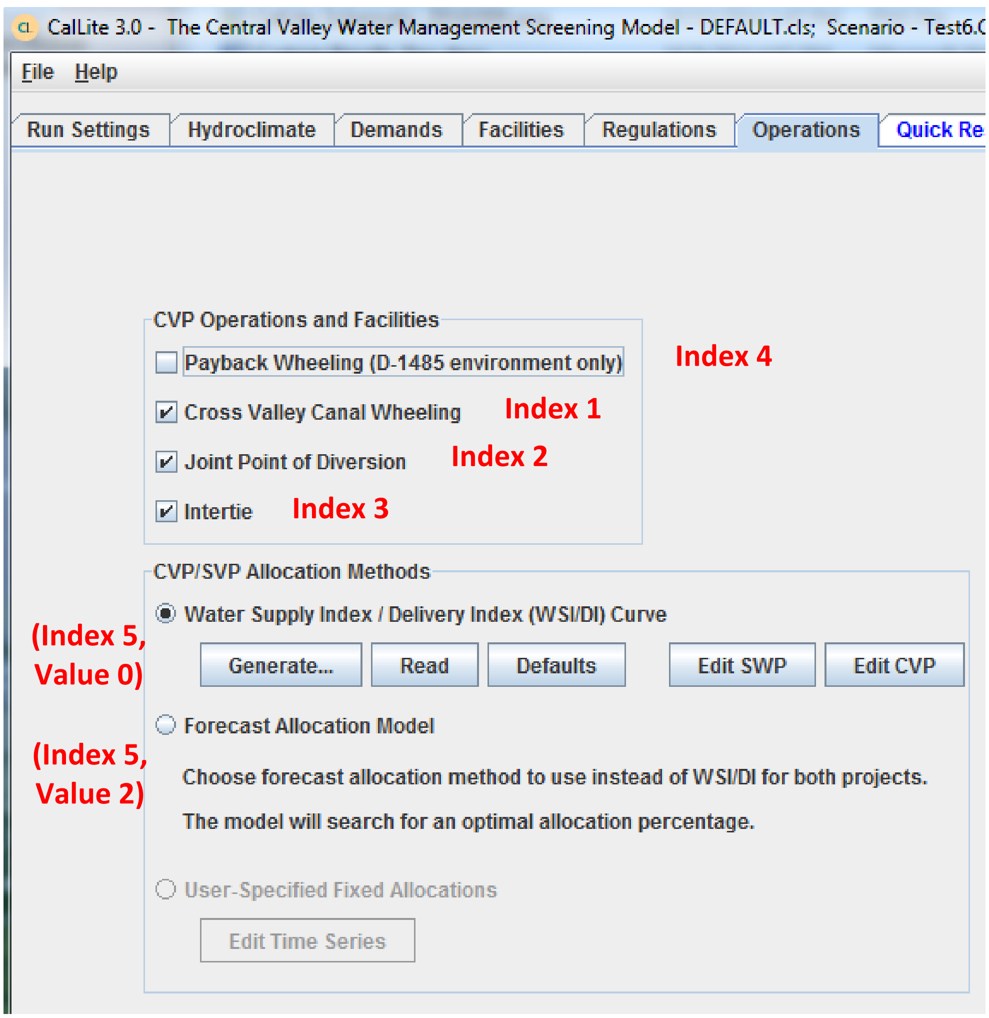


Figure 71. Operations dashboard and map of lookup table indices.

Regulations Lookup Table

The Regulations dashboard in the GUI has two main frames that hold settings for D-1641 and D-1485 regulations (the "D-1641/D-1485" tab and the right-hand-side table showing some regulation values) (Figure 72). Values for the settings on this tab are saved in the GUI_Regs.table file (Indices 1-15). Each index corresponds to a different regulation. Below are the different options for each Index.

Option 0 – The regulation is off and will not be included
Option 1 – Default D-1641 regulation values will be used
Option 2 – User defined regulation values will be used (selected regulations)
Option 3 – Default D-1485 regulation values will be used

The regulations that can be user-defined are shown in Figure 72 with the table name shown next to them in red. When the index value is set = 2, the corresponding table or tables must also be edited to specify the desired user-defined values.

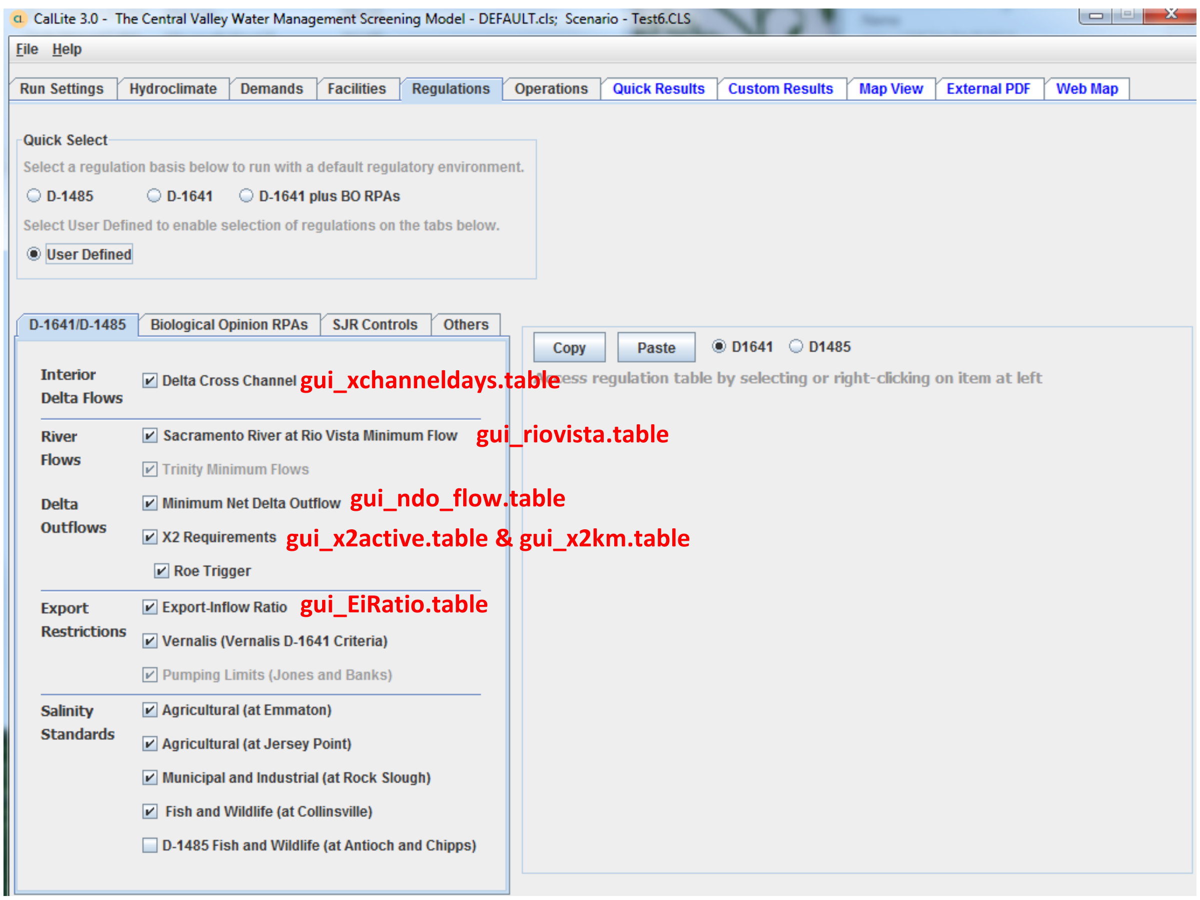


Figure 72. D-1641 Regulations dashboard and locations of user-defined tables.

Biological Opinion Regulations Lookup Tables

The Regulations dashboard in the GUI has one main frame that holds settings for RPA regulations (the RPA tab), and values for these settings are saved in the GUI_RPAsOtherRegs.table file (Indices 1-5). For each index, there are only 2 options, on and off. See Figure 73.

Option 0 – The regulation is off and will not be included
Option 1 – The regulation is on

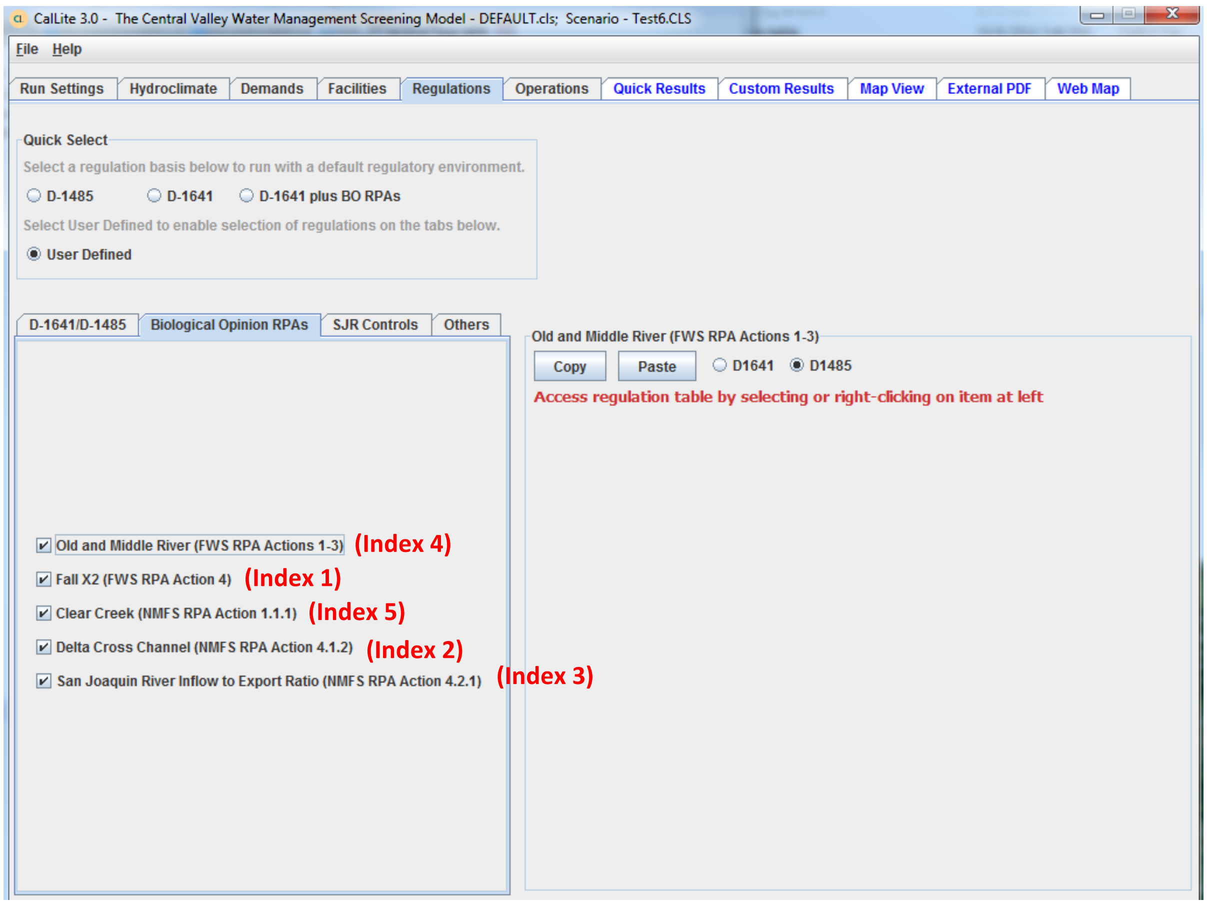


Figure 73. Biological Opinion RPA's dashboard and map of lookup table indices.

Other Regulations Lookup Table

The Regulations dashboard in the GUI has two main frames that hold settings for other regulations (the Others tab and the table to the right showing regulation values) (Figure 74). Values for the Other Regulation settings on the Others tab are saved in the GUI_RPAsOtherRegs.table file in Indices 6-8. This is the same file used for changing the Biological Opinions Regulations. B2 Actions are saved to Indices 9-15.

For each index, there are only 2 options, on and off. To change the value, change the Option number in the table file (Figure 74).

Option 0 – The regulation is off and will not be included
Option 1 – User defined regulation is on

For the user-defined option, the user-defined values can be entered in the tables whose names are in red in Figure 74.

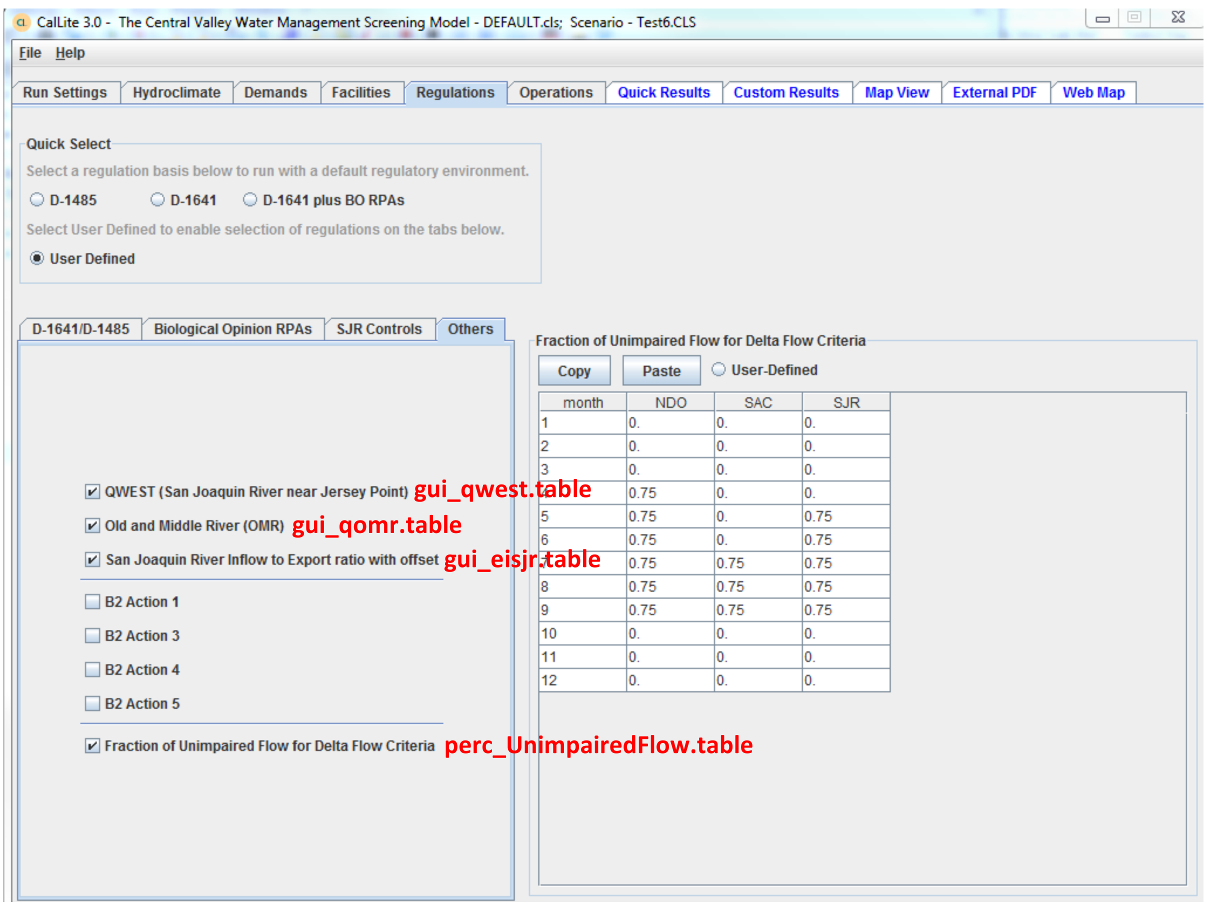


Figure 74. Other Regulations dashboard and map of lookup table indices.

Run Basis Lookup Table

The Run Basis Lookup table (GUI_RunBasis.table) stores the Run Basis decision made by the user on the Run Settings dashboard (see Figure 75). There is only one index in this table, Index 1:

Value = 0 – D-1485 Run Basis

Value = 1 – Pre-BO Run Basis

Value = 2 – BO Run Basis

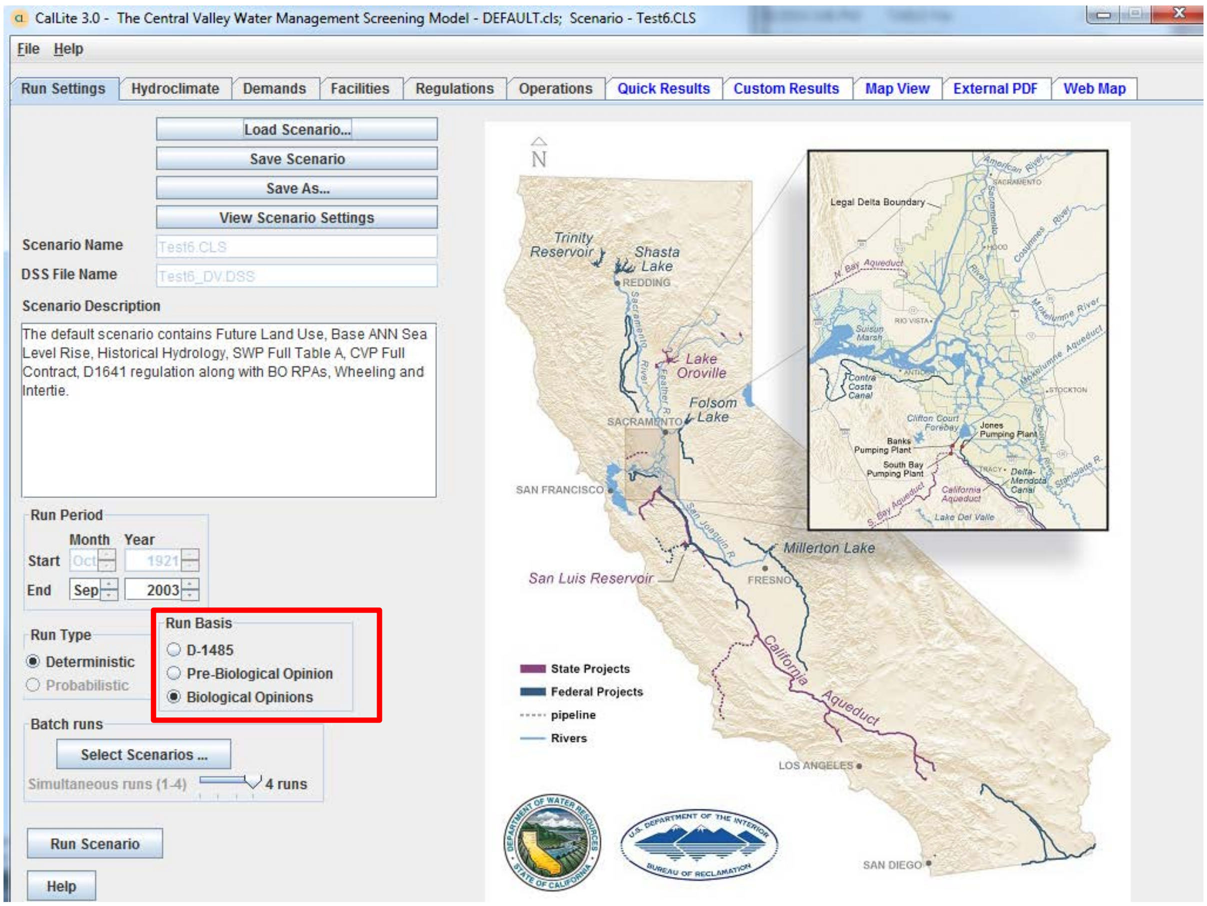


Figure 75. Run Basis location on the Run Settings dashboard.

South of Delta Demand Lookup Table

The Demands dashboard in the GUI has 2 main frames (for SWP and CVP demands), whose settings are saved in the GUI_SODdemand.table file using Indices 0-8 (Figure 76). To change the value for each Index, change the option numbers and other values in the table file.

Index #	Description	Value
0	Variable or Fixed SWP Demand	1
	User-Defined SWP Demand	2
1 - 4	User-Defined Values for SWP	-
5	Full Contract CVP Demand	1
	User-Defined CVP Demand	2
6 - 8	User-Defined Values for CVP	-

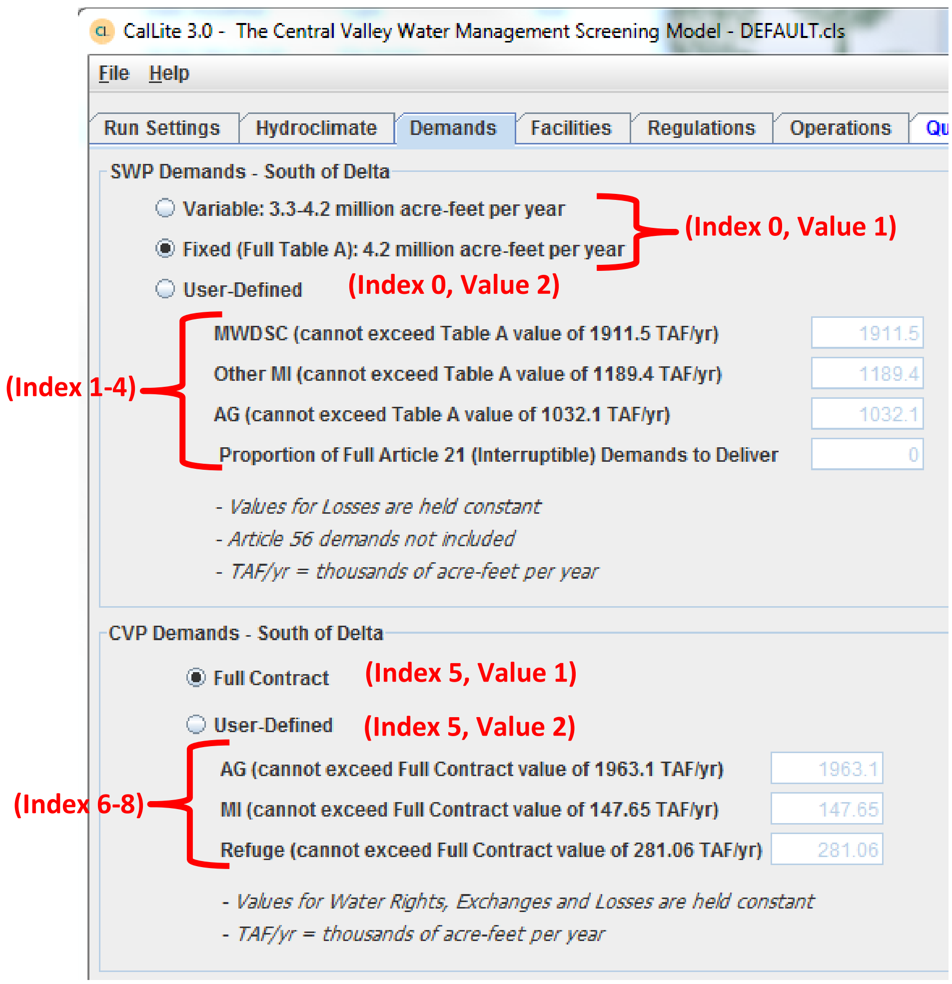


Figure 76. Demands dashboard and map of lookup table indices.

For SWP demands, there are additional tables that need to be copied into the "Lookup" folder. These tables can be found in the "VariableDemand" and "FutureDemand" subfolders (Figure 77). For Variable demands, copy the files from the "VariableDemand" folder to the "Lookup" folder in the manual run directory, replacing any existing files. For Future (Full Table A) demands, copy the files from the "FutureDemand" folder to the "Lookup" folder.

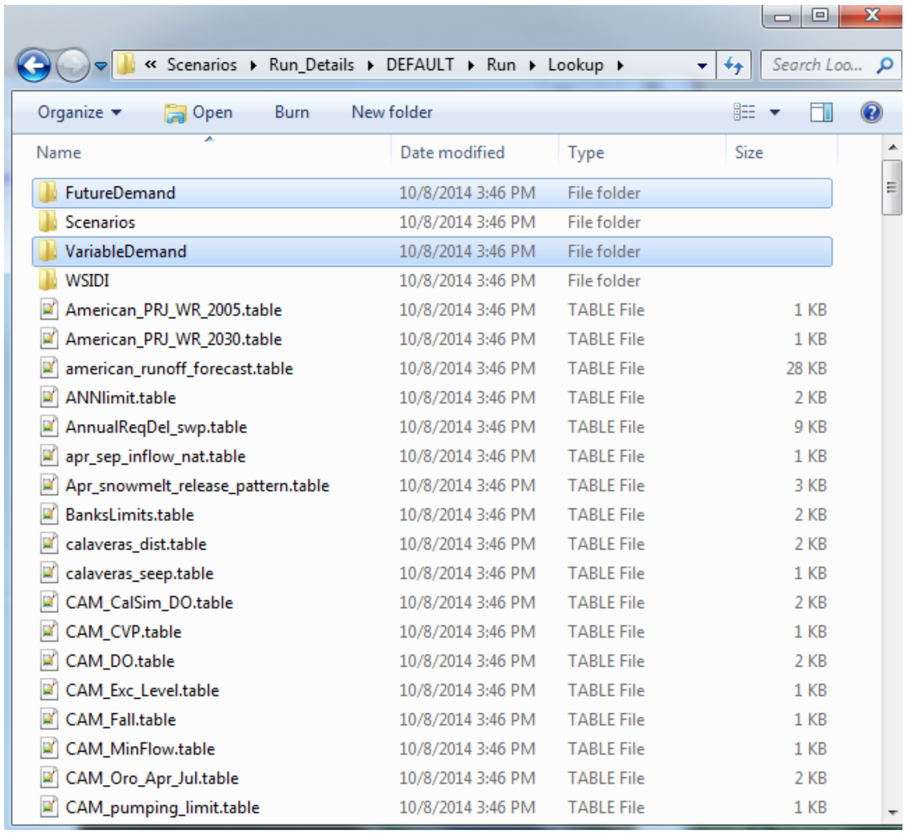


Figure 77. Lookup table directory.

I.3.5 Running the Model

Once the .config file and lookup files have been modified and replaced, you are set to run the model. To run the model, simply double click on the newly created “group_” batch file. The output DV file will be created in the location specified in the .config file.

Appendix J CalLite Report Tool

The report tool is located under the External PDF dashboard (Figure 78). This dashboard can be broken down into 5 elements: (1) Report template file, (2) DSS results files to compare, (3) Report output file, (4) General information, and (5) Generate Report.

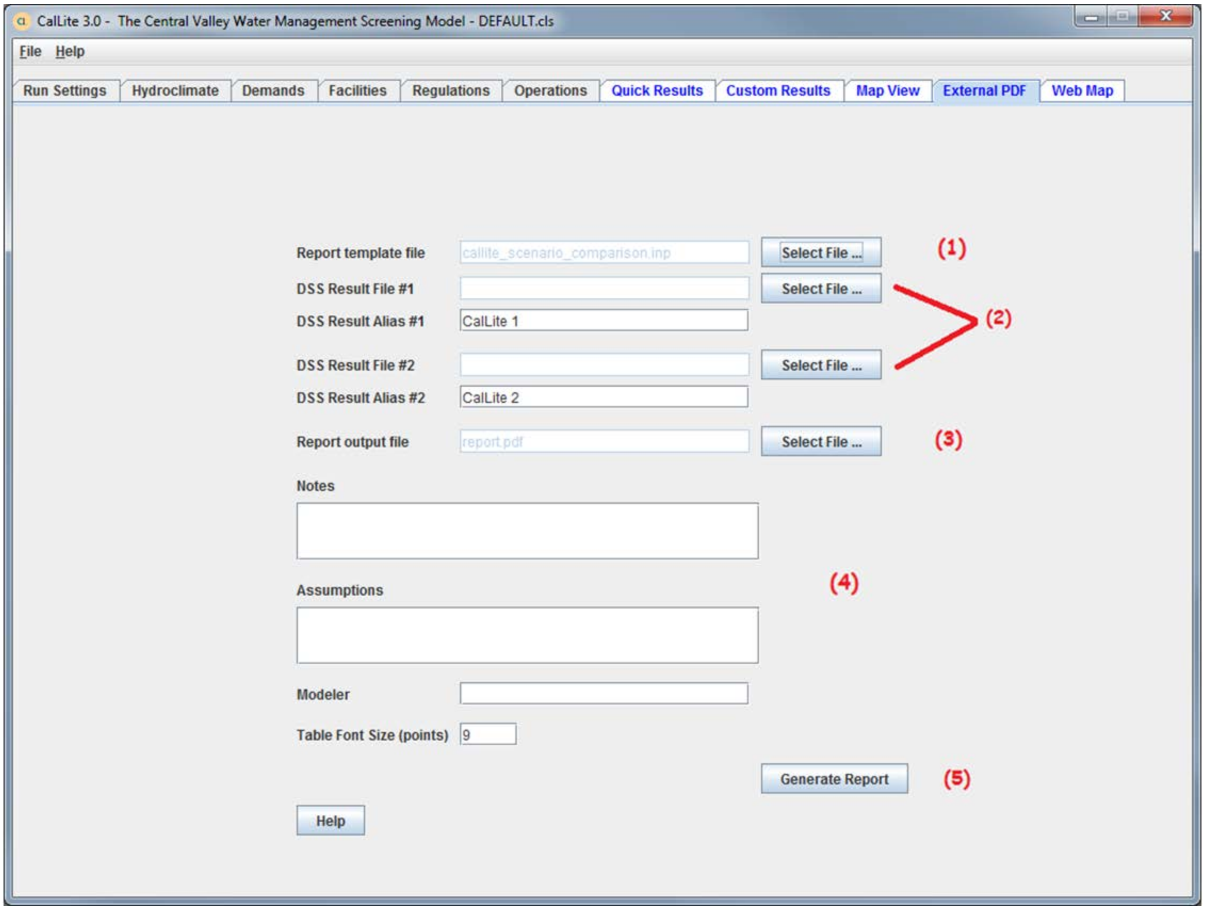


Figure 78. Elements of External PDF dashboard.

The following sections describe these different elements in more detail, show a sample report, and describe how to edit the report template file.

J.1 Elements of the External PDF Dashboard

J.1.1 Report Template File

The report template file controls which variables from each DSS file will be compared, and in what form. Clicking on the select file button opens a dialogue box for the user to choose which template file to use (Figure 79).

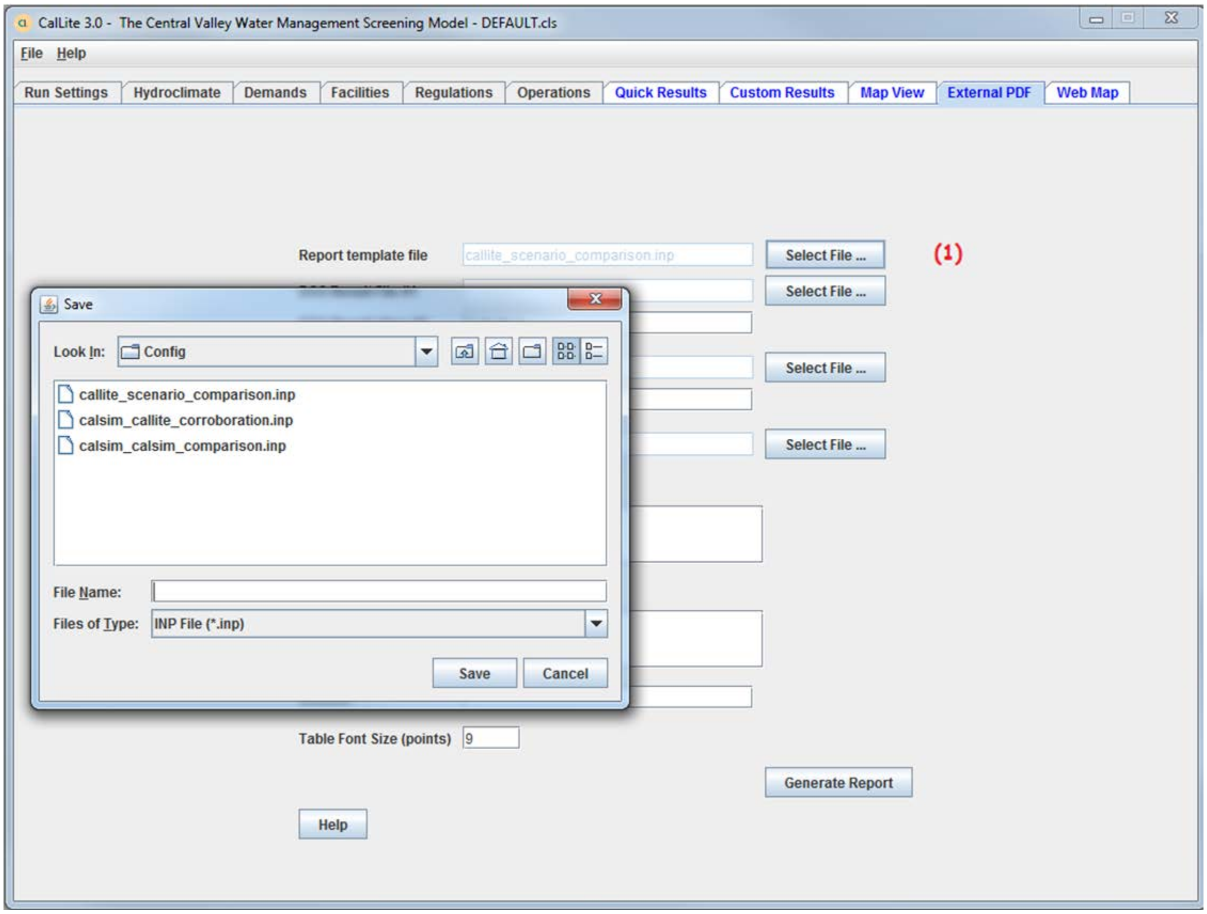


Figure 79. Report template file.

CalLite-CalLite comparison (callite_scenario_comparison.inp):

The default report template file will compare two CalLite studies.

CalSim-CalLite corroboration (calsim_callite_corroboration.inp):

The report tool can also be used to compare CalLite results to CalSim results. To do this, the DSS Result File #1 must be set to the output DSS from a CalSim simulation, the DSS Result File #2 must be set to the output DSS from a CalLite simulation.

CalSim-CalSim comparison (calsim_calsim_corroboration.inp):

Use the report template file to compare two CalSim studies.

J.1.2 Studies to Compare

The user must specify the output DSS files from the two studies that will be compared. It is possible to compare CalLite studies, CalSim studies, or corroborate between a CalLite and a CalSim study. Click on the two buttons shown in Figure 80 to choose DSS files from each study. The study names entered will be printed on the report for reference purpose.

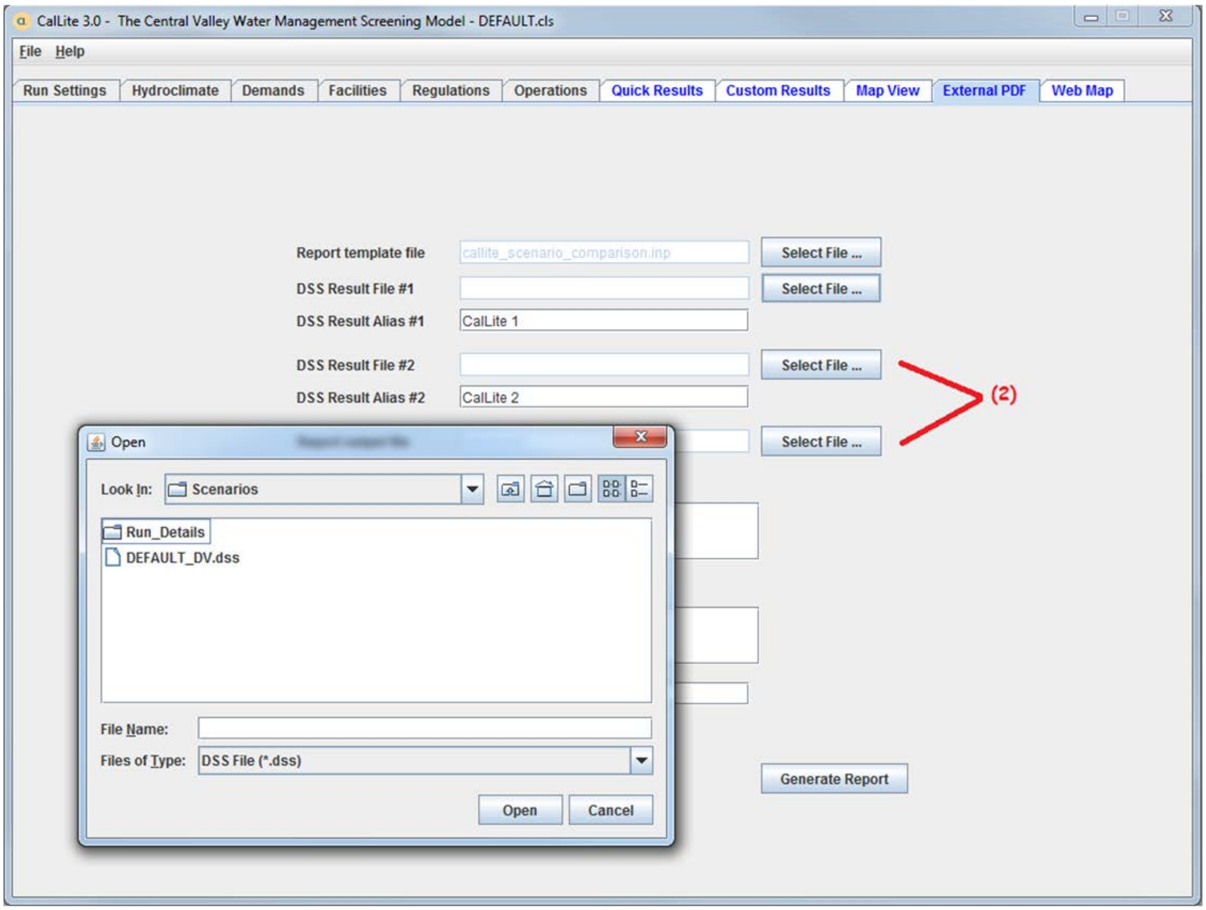


Figure 80. Studies to compare.

J.1.3 Report Output File

Click on the select file button to choose where to save and to rename the report (Figure 81). The report will be in .pdf format.

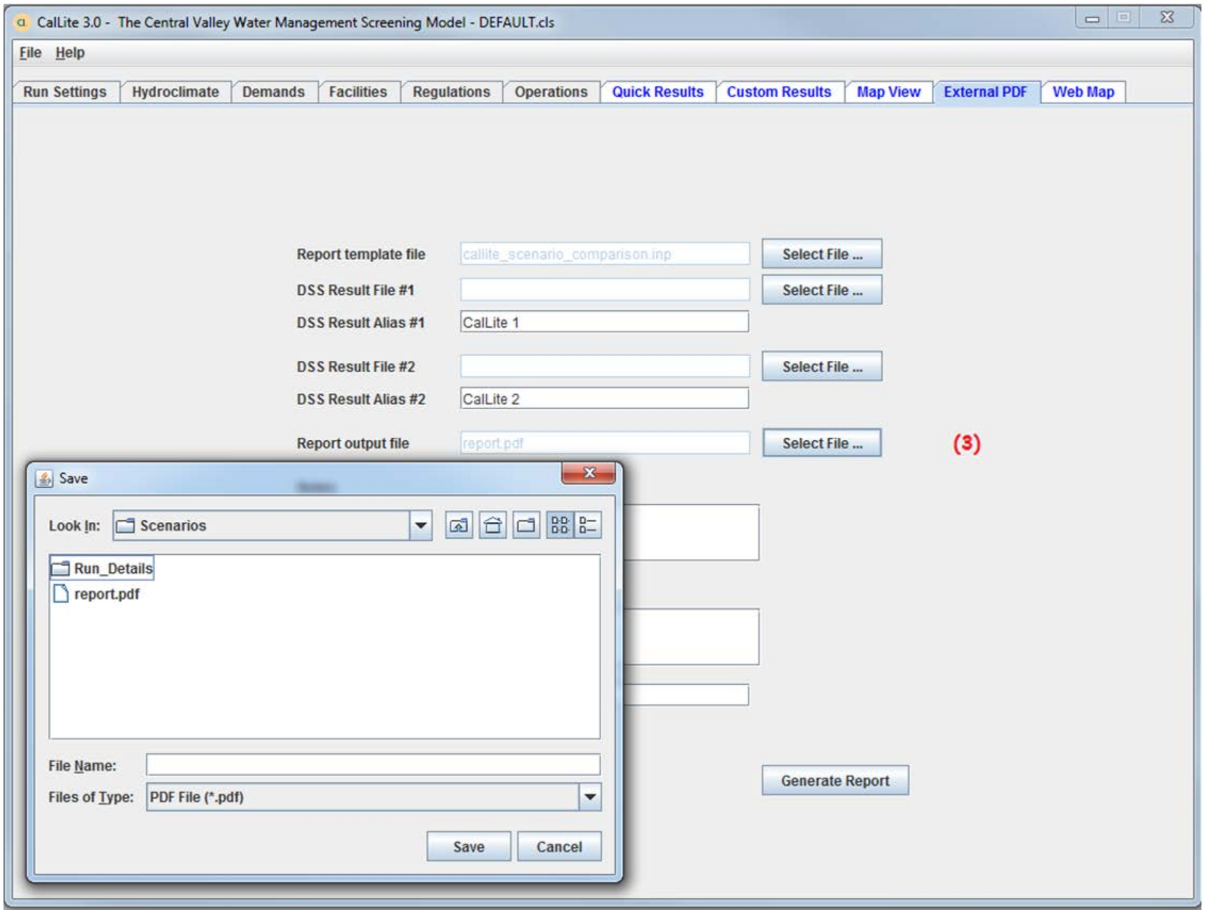


Figure 81. Report output file.

J.1.4 General Information

This area is for the user to input any general information regarding the report being generated (Figure 82). The notes, assumptions, modeler, and table font size text boxes can be edited for this purpose.

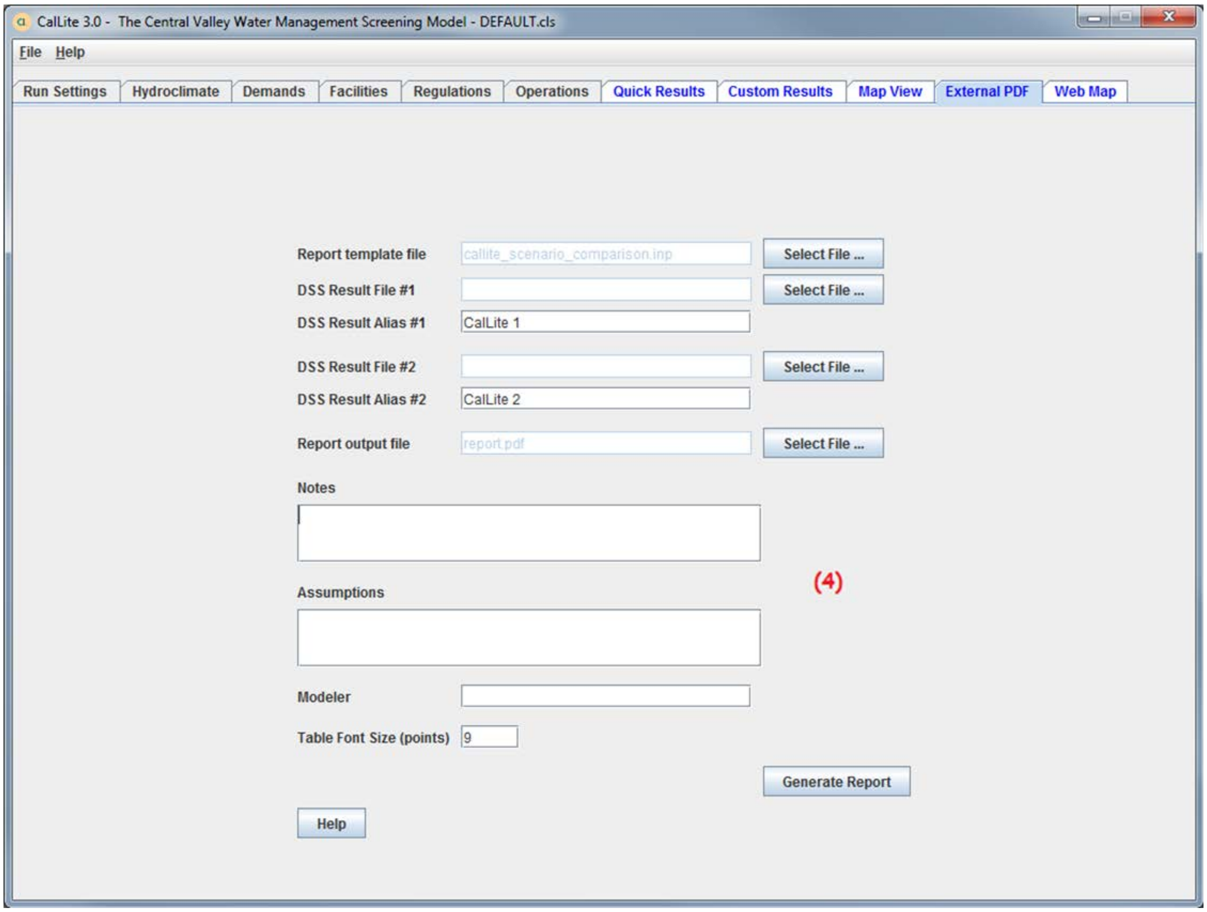


Figure 82. General information.

J.1.5 Generate Report

Finally, click the generate report button to create the pdf report and launch it using Adobe Acrobat (Figure 83).

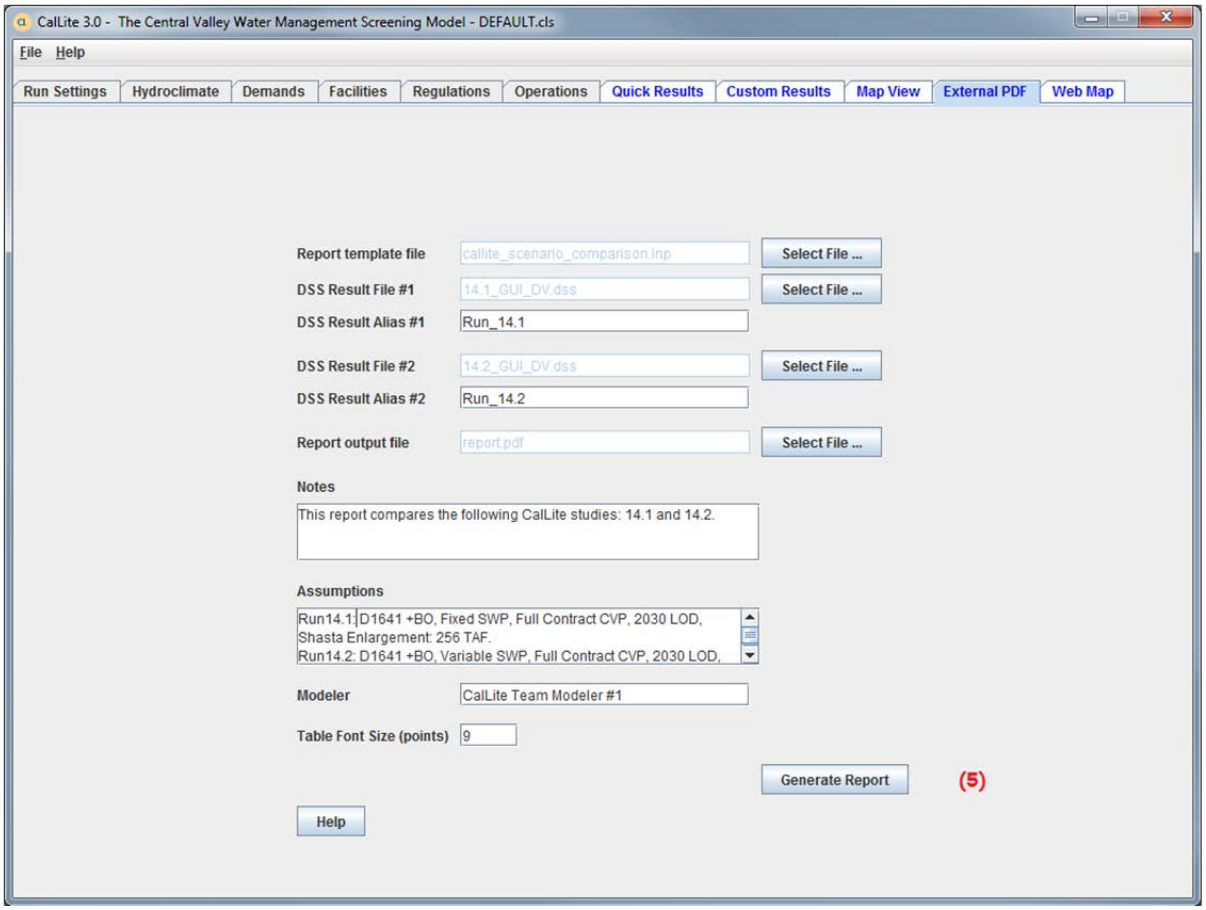
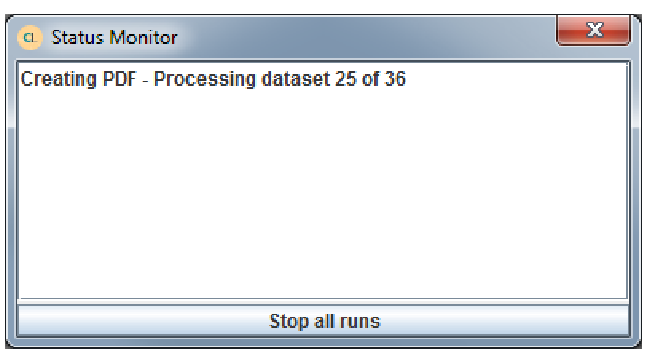
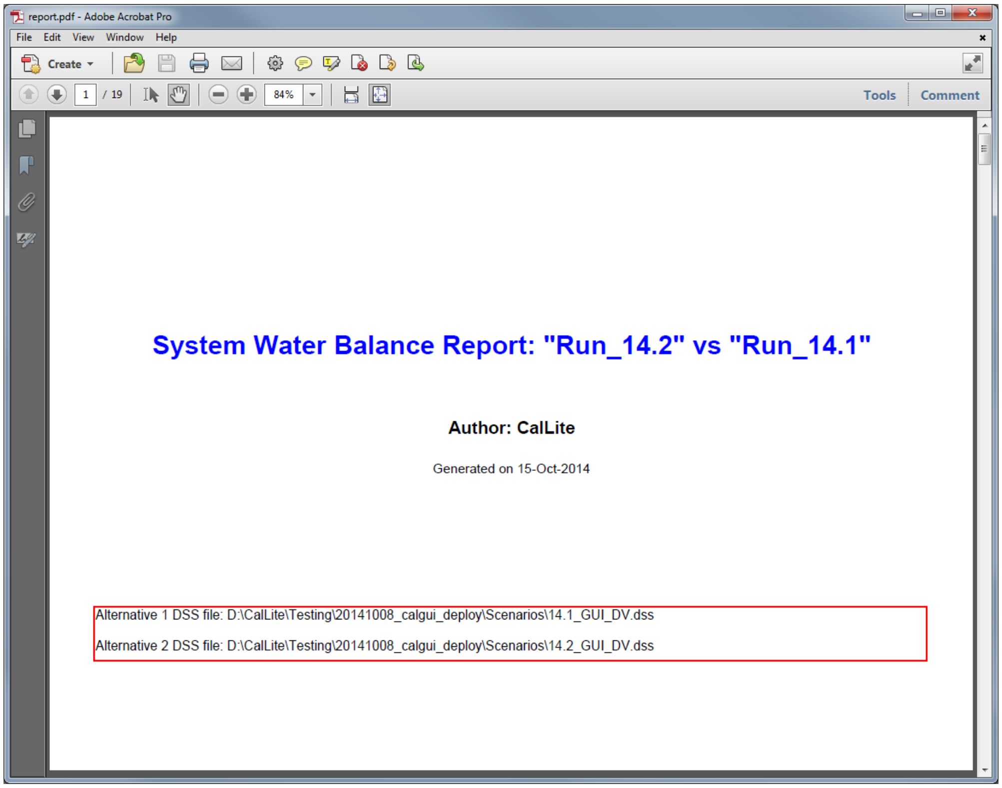


Figure 83. Generate report.

Once the button has been clicked and all the input information has been filled out, the CalLite GUI will show a screen as below:



The report should look similar to the sample report shown below:



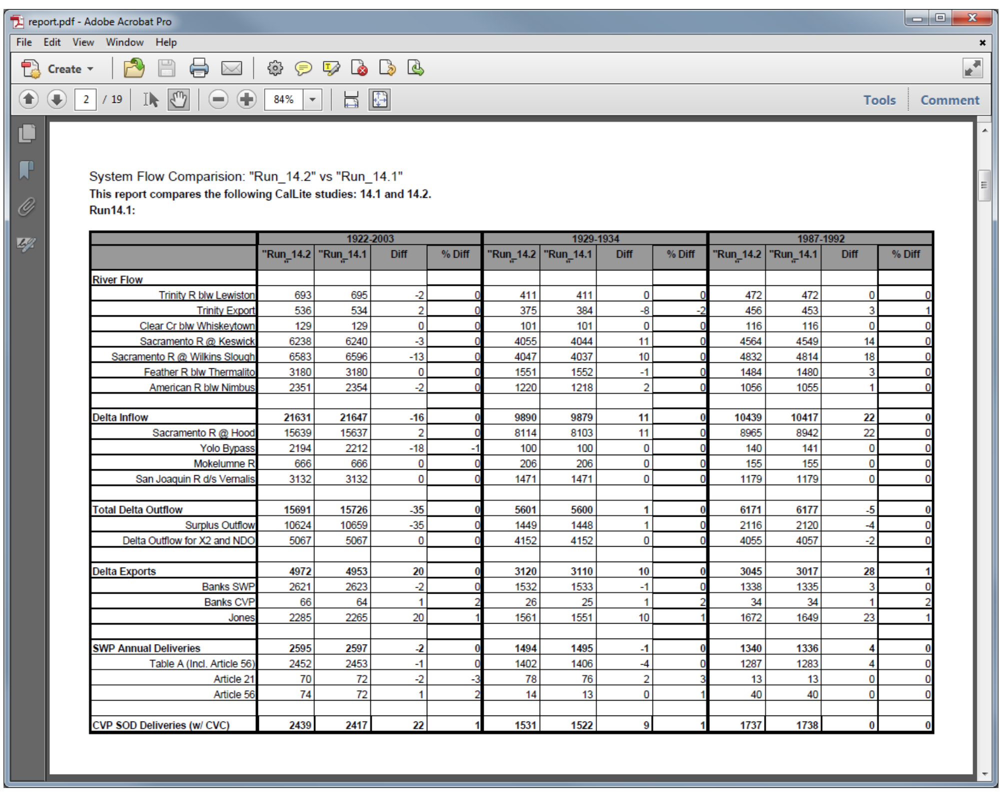
System Water Balance Report: "Run_14.2" vs "Run_14.1"

Author: CalLite

Generated on 15-Oct-2014

Alternative 1 DSS file: D:\CalLite\Testing\20141008_calgui_deploy\Scenarios\14.1_GUI_DV.dss

Alternative 2 DSS file: D:\CalLite\Testing\20141008_calgui_deploy\Scenarios\14.2_GUI_DV.dss

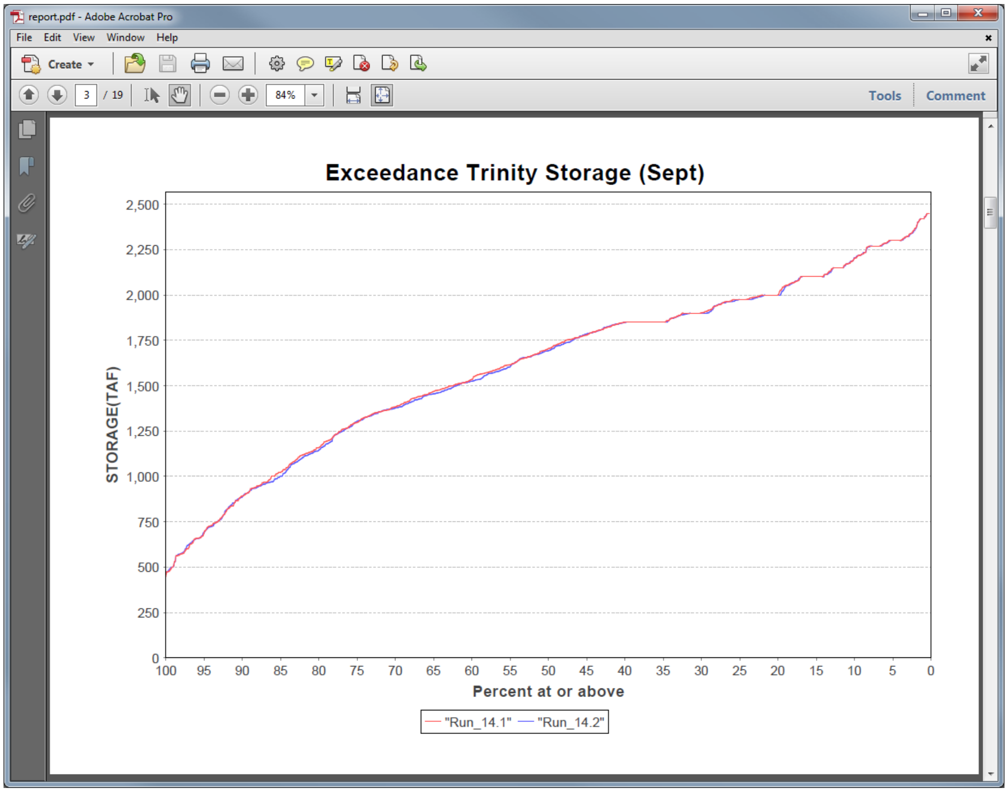


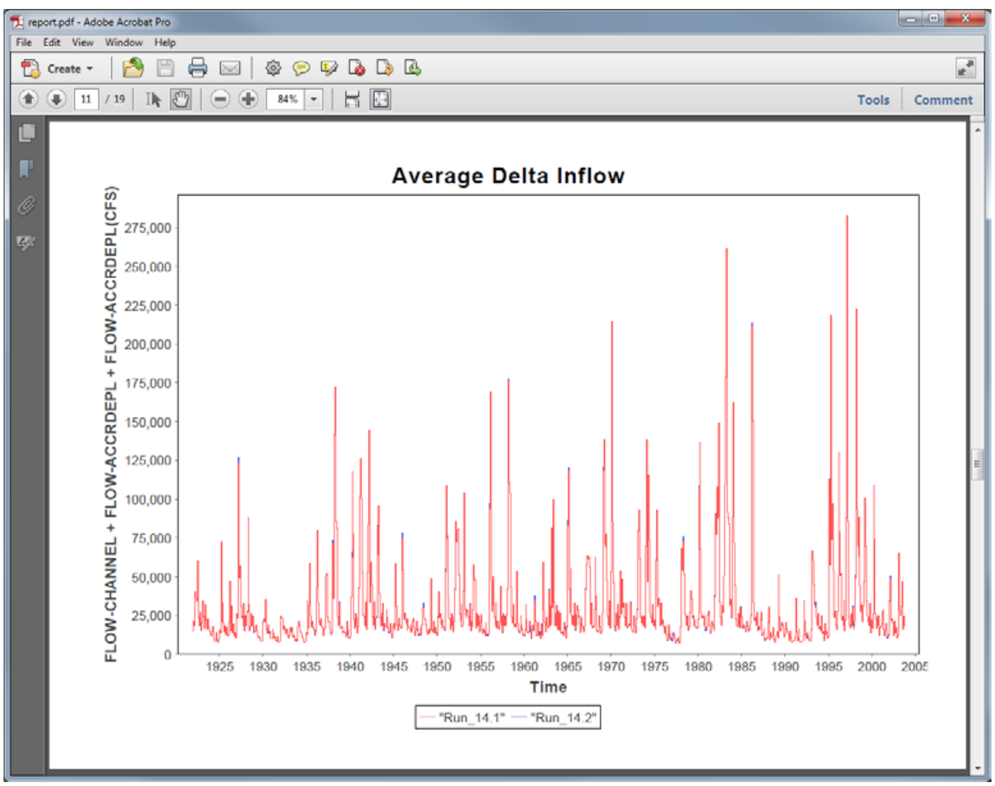
System Flow Comparision: "Run_14.2" vs "Run_14.1"

This report compares the following CalLite studies: 14.1 and 14.2.

Run14.1:

	1922-2003				1929-1934				1987-1992			
	"Run_14.2"	"Run_14.1"	Diff	% Diff	"Run_14.2"	"Run_14.1"	Diff	% Diff	"Run_14.2"	"Run_14.1"	Diff	% Diff
River Flow												
Trinity R blw Lewiston	693	695	-2	0	411	411	0	0	472	472	0	0
Trinity Export	536	534	2	0	375	384	-8	-2	456	453	3	1
Clear Cr blw Whiskeytown	129	129	0	0	101	101	0	0	116	116	0	0
Sacramento R @ Keswick	6238	6240	-3	0	4055	4044	11	0	4564	4549	14	0
Sacramento R @ Wilkins Slough	6583	6596	-13	0	4047	4037	10	0	4832	4814	18	0
Feather R blw Thermalito	3180	3180	0	0	1551	1552	-1	0	1484	1480	3	0
American R blw Nimbus	2351	2354	-2	0	1220	1218	2	0	1056	1055	1	0
Delta Inflow	**21631**	**21647**	**-16**	0	**9890**	**9879**	**11**	0	**10439**	**10417**	**22**	0
Sacramento R @ Hood	15639	15637	2	0	8114	8103	11	0	8965	8942	22	0
Yolo Bypass	2194	2212	-18	-1	100	100	0	0	140	141	0	0
Mokelumne R	666	666	0	0	206	206	0	0	155	155	0	0
San Joaquin R d/s Vernalis	3132	3132	0	0	1471	1471	0	0	1179	1179	0	0
Total Delta Outflow	**15691**	**15726**	-35	0	**5601**	**5600**	**1**	0	**6171**	**6177**	-5	0
Surplus Outflow	10624	10659	-35	0	1449	1448	1	0	2116	2120	-4	0
Delta Outflow for X2 and NDO	5067	5067	0	0	4152	4152	0	0	4055	4057	-2	0
Delta Exports	**4972**	**4953**	**20**	0	**3120**	**3110**	**10**	0	**3045**	**3017**	**28**	1
Banks SWP	2621	2623	-2	0	1532	1533	-1	0	1338	1335	3	0
Banks CVP	66	64	1	2	26	25	1	2	34	34	1	2
Jones	2285	2265	20	1	1561	1551	10	1	1672	1649	23	1
SWP Annual Deliveries	**2595**	**2597**	**-2**	0	**1494**	**1495**	-1	0	**1340**	**1336**	**4**	0
Table A (Incl. Article 56)	2452	2453	-1	0	1402	1406	-4	0	1287	1283	4	0
Article 21	70	72	-2	-3	78	76	2	3	13	13	0	0
Article 56	74	72	1	2	14	13	0	1	40	40	0	0
CVP SOD Deliveries (w/ CVC)	**2439**	**2417**	**22**	1	**1531**	**1522**	**9**	1	**1737**	**1738**	0	0


report.pdf - Adobe Acrobat Pro
File Edit View Window Help
Create
3 / 19
84%
Tools
Comment
Exceedance Trinity Storage (Sept)
STORAGE(TAF)
2,500
2,250
2,000
1,750
1,500
1,250
1,000
750
500
250
0
100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
Percent at or above
"Run_14.1" "Run_14.2"


report.pdf - Adobe Acrobat Pro
File Edit View Window Help
Create
11 / 19
84%
Tools
Comment
Average Delta Inflow
FLOW-CHANNEL + FLOW-ACCRDEPL + FLOW-ACCRDEPL(CFS)
275,000
250,000
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005
Time
"Run_14.1" "Run_14.2"

J.2 Modifying the Report Template File

Under the “Config” folder in the directory where CalLite was installed, there are report format files with the .inp extension (Figure 84). By default CalLite comes with two of these files, one for comparing two CalLite studies and one for comparing a CalSim study to a CalLite study.

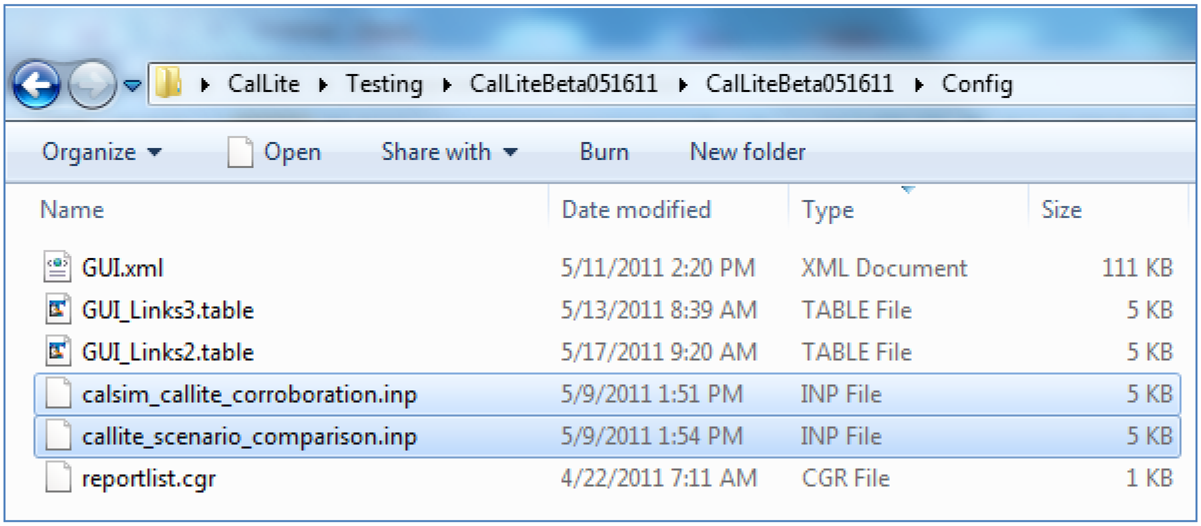
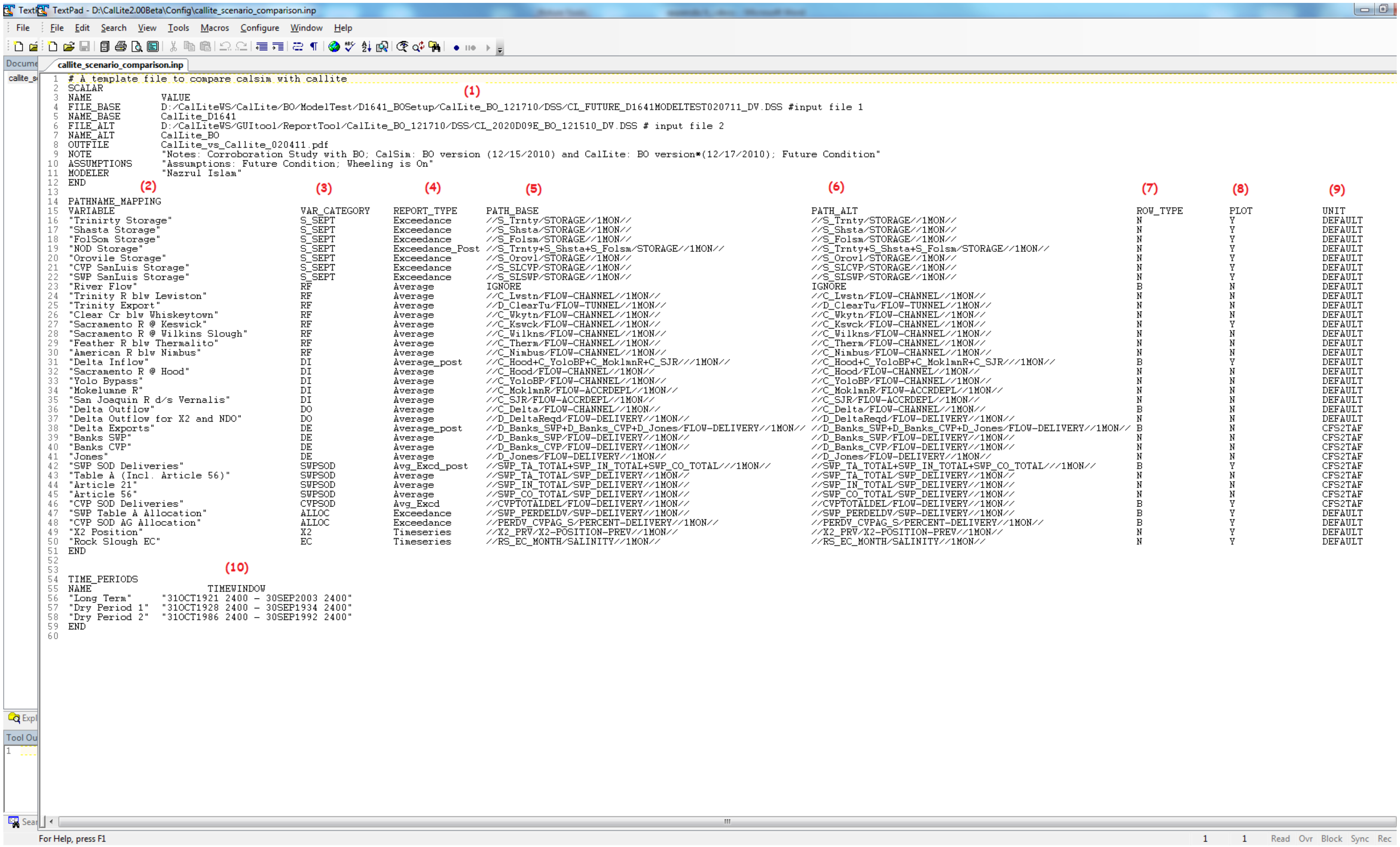


Figure 84. Configuration folder.

These files can be opened using text editor software such as TextPad. The file can be broken down into 9 different parts:

1) General Information: This portion displays the general information as compiled from the DSS results files and the user input from the GUI. This does not need to be edited since the report tool generates this information by default.
2) Display Name (VARIABLE): These are the names that will be displayed in the report for each variable.
3) Category Type (VAR_CATEGORY): This denotes the category of the variable being reported
    - S – Storage
    - RF – River Flow
    - DI – Delta Inflow
    - DO – Delta outflow
    - DE – Delta Exports
    - SWPSOD – State Water Project South of Delta
    - CVPSOD – Central Valley Project South of Delta
    - ALLOC – Allocation
    - X2 – Salinity (X2) position
    - EC – Electrical Conductivity

4) Data Type (REPORT_TYPE): This denotes the statistical category or the source of the variable being reported. A "_Post" means the data has been post processed and may be a combination of multiple variable results.
    - Average – Averaged data
    - Exceedance – Storage vs Percent at or Above
    - Avg_Excd – Average vs Percent at or above
    - Timeseries – results data that are not averaged or exceedance
5) DSS Pathname for First Study (PATH_BASE): These are the results DSS pathnames for the first study that are used to retrieve the data. Multiple paths can be manipulated by using the + or – operators. All paths begin and end with //
6) DSS Pathname for Second Study (PATH_ALT): These are the results DSS pathnames for the second study that are used to retrieve the data. Multiple paths can be manipulated by using the + or – operators. All paths begin and end with //
7) Font and Formatting (ROW_TYPE): This denotes the font and formatting of the variable to be displayed.
    - N – Normal and indented, usually for subtopics
    - B – Bold, usually for main topics header
8) Plot (PLOT): A yes (Y)/no (N) to determine if a graph is to be included.
9) Unit: this defines the units of the graphs to be displayed. Default leaves the units in cfs whereas cfs2taf converts the units to TAF.
10) General Information Part II: This portion displays the general information as compiled from the DSS results file and the user input from the GUI. This does not need to be edited since the report tool generates this information by default.



```
# A template file to compare calsim with callite
SCALAR
NAME            VALUE
FILE_BASE       D:/CalLiteWS/CalLite/BO/ModelTest/D1641_BOSetup/CalLite_BO_121710/DSS/CL_FUTURE_D1641MODELTEST020711_DV.DSS #input file 1
NAME_BASE       CalLite_D1641
FILE_ALT        D:/CalLiteWS/GUItool/ReportTool/CalLite_BO_121710/DSS/CL_2020D09E_BO_121510_DV.DSS # input file 2
NAME_ALT        CalLite_BO
OUTFILE         CalLite_vs_Callite_020411.pdf
NOTE            "Notes: Corroboration Study with BO; CalSim: BO version (12/15/2010) and CalLite: BO version*(12/17/2010); Future Condition"
ASSUMPTIONS     "Assumptions: Future Condition; Wheeling is On"
MODELER         "Nazrul Islam"
END

PATHNAME_MAPPING
VARIABLE                              VAR_CATEGORY    REPORT_TYPE      PATH_BASE                                                   PATH_ALT                                                    ROW_TYPE    PLOT    UNIT
"Trinirty Storage"                    S_SEPT          Exceedance       //S_Trnty/STORAGE//1MON//                                   //S_Trnty/STORAGE//1MON//                                   N           Y       DEFAULT
"Shasta Storage"                      S_SEPT          Exceedance       //S_Shsta/STORAGE//1MON//                                   //S_Shsta/STORAGE//1MON//                                   N           Y       DEFAULT
"FolSom Storage"                      S_SEPT          Exceedance       //S_Folsm/STORAGE//1MON//                                   //S_Folsm/STORAGE//1MON//                                   N           Y       DEFAULT
"NOD Storage"                         S_SEPT          Exceedance_Post  //S_Trnty+S_Shsta+S_Folsm/STORAGE//1MON//                   //S_Trnty+S_Shsta+S_Folsm/STORAGE//1MON//                   N           Y       DEFAULT
"Orovile Storage"                     S_SEPT          Exceedance       //S_Orovl/STORAGE//1MON//                                   //S_Orovl/STORAGE//1MON//                                   N           Y       DEFAULT
"CVP SanLuis Storage"                 S_SEPT          Exceedance       //S_SLCVP/STORAGE//1MON//                                   //S_SLCVP/STORAGE//1MON//                                   N           Y       DEFAULT
"SWP SanLuis Storage"                 S_SEPT          Exceedance       //S_SLSWP/STORAGE//1MON//                                   //S_SLSWP/STORAGE//1MON//                                   N           Y       DEFAULT
"River Flow"                          RF              Average          IGNORE                                                      IGNORE                                                      B           N       DEFAULT
"Trinity R blw Lewiston"              RF              Average          //C_Lwstn/FLOW-CHANNEL//1MON//                              //C_Lwstn/FLOW-CHANNEL//1MON//                              N           N       DEFAULT
"Trinity Export"                      RF              Average          //D_ClearTu/FLOW-TUNNEL//1MON//                             //D_ClearTu/FLOW-TUNNEL//1MON//                             N           N       DEFAULT
"Clear Cr blw Whiskeytown"            RF              Average          //C_Wkytn/FLOW-CHANNEL//1MON//                              //C_Wkytn/FLOW-CHANNEL//1MON//                              N           N       DEFAULT
"Sacramento R @ Keswick"              RF              Average          //C_Kswck/FLOW-CHANNEL//1MON//                              //C_Kswck/FLOW-CHANNEL//1MON//                              N           Y       DEFAULT
"Sacramento R @ Wilkins Slough"       RF              Average          //C_Wilkns/FLOW-CHANNEL//1MON//                             //C_Wilkns/FLOW-CHANNEL//1MON//                             N           N       DEFAULT
"Feather R blw Thermalito"            RF              Average          //C_Therm/FLOW-CHANNEL//1MON//                              //C_Therm/FLOW-CHANNEL//1MON//                              N           N       DEFAULT
"American R blw Nimbus"               RF              Average          //C_Nimbus/FLOW-CHANNEL//1MON//                             //C_Nimbus/FLOW-CHANNEL//1MON//                             N           N       DEFAULT
"Delta Inflow"                        DI              Average_post     //C_Hood+C_YoloBP+C_MoklmnR+C_SJR///1MON//                  //C_Hood+C_YoloBP+C_MoklmnR+C_SJR///1MON//                  B           Y       DEFAULT
"Sacramento R @ Hood"                 DI              Average          //C_Hood/FLOW-CHANNEL//1MON//                               //C_Hood/FLOW-CHANNEL//1MON//                               N           N       DEFAULT
"Yolo Bypass"                         DI              Average          //C_YoloBP/FLOW-CHANNEL//1MON//                             //C_YoloBP/FLOW-CHANNEL//1MON//                             N           N       DEFAULT
"Mokelumne R"                         DI              Average          //C_MoklmnR/FLOW-ACCRDEPL//1MON//                           //C_MoklmnR/FLOW-ACCRDEPL//1MON//                           N           N       DEFAULT
"San Joaquin R d/s Vernalis"          DI              Average          //C_SJR/FLOW-ACCRDEPL//1MON//                               //C_SJR/FLOW-ACCRDEPL//1MON//                               N           N       DEFAULT
"Delta Outflow"                       DO              Average          //C_Delta/FLOW-CHANNEL//1MON//                              //C_Delta/FLOW-CHANNEL//1MON//                              B           N       DEFAULT
"Delta Outflow for X2 and NDO"        DO              Average          //D_DeltaReqd/FLOW-DELIVERY//1MON//                         //D_DeltaReqd/FLOW-DELIVERY//1MON//                         N           N       DEFAULT
"Delta Exports"                       DE              Average_post     //D_Banks_SWP+D_Banks_CVP+D_Jones/FLOW-DELIVERY//1MON//     //D_Banks_SWP+D_Banks_CVP+D_Jones/FLOW-DELIVERY//1MON//     B           N       CFS2TAF
"Banks SWP"                           DE              Average          //D_Banks_SWP/FLOW-DELIVERY//1MON//                         //D_Banks_SWP/FLOW-DELIVERY//1MON//                         N           N       CFS2TAF
"Banks CVP"                           DE              Average          //D_Banks_CVP/FLOW-DELIVERY//1MON//                         //D_Banks_CVP/FLOW-DELIVERY//1MON//                         N           N       CFS2TAF
"Jones"                               DE              Average          //D_Jones/FLOW-DELIVERY//1MON//                             //D_Jones/FLOW-DELIVERY//1MON//                             N           N       CFS2TAF
"SWP SOD Deliveries"                  SWPSOD          Avg_Excd_post    //SWP_TA_TOTAL+SWP_IN_TOTAL+SWP_CO_TOTAL///1MON//           //SWP_TA_TOTAL+SWP_IN_TOTAL+SWP_CO_TOTAL///1MON//           B           Y       CFS2TAF
"Table A (Incl. Article 56)"          SWPSOD          Average          //SWP_TA_TOTAL/SWP_DELIVERY//1MON//                         //SWP_TA_TOTAL/SWP_DELIVERY//1MON//                         N           N       CFS2TAF
"Article 21"                          SWPSOD          Average          //SWP_IN_TOTAL/SWP_DELIVERY//1MON//                         //SWP_IN_TOTAL/SWP_DELIVERY//1MON//                         N           N       CFS2TAF
"Article 56"                          SWPSOD          Average          //SWP_CO_TOTAL/SWP_DELIVERY//1MON//                         //SWP_CO_TOTAL/SWP_DELIVERY//1MON//                         N           N       CFS2TAF
"CVP SOD Deliveries"                  CVPSOD          Avg_Excd         //CVPTOTALDEL/FLOW-DELIVERY//1MON//                         //CVPTOTALDEL/FLOW-DELIVERY//1MON//                         B           Y       CFS2TAF
"SWP Table A Allocation"              ALLOC           Exceedance       //SWP_PERDELDV/SWP-DELIVERY//1MON//                         //SWP_PERDELDV/SWP-DELIVERY//1MON//                         B           Y       DEFAULT
"CVP SOD AG Allocation"               ALLOC           Exceedance       //PERDV_CVPAG_S/PERCENT-DELIVERY//1MON//                    //PERDV_CVPAG_S/PERCENT-DELIVERY//1MON//                    B           Y       DEFAULT
"X2 Position"                         X2              Timeseries       //X2_PRV/X2-POSITION-PREV//1MON//                           //X2_PRV/X2-POSITION-PREV//1MON//                           N           Y       DEFAULT
"Rock Slough EC"                      EC              Timeseries       //RS_EC_MONTH/SALINITY//1MON//                              //RS_EC_MONTH/SALINITY//1MON//                              N           Y       DEFAULT
END


TIME_PERIODS
NAME                 TIMEWINDOW
"Long Term"      "31OCT1921 2400 - 30SEP2003 2400"
"Dry Period 1"   "31OCT1928 2400 - 30SEP1934 2400"
"Dry Period 2"   "31OCT1986 2400 - 30SEP1992 2400"
END
```


Figure 85. Report Template File.