Appendix A
Water Operations Analysis

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Attachments

A1 Water Operation Detailed Results
A2 Supplemental Modeling and Sensitivity Analysis

Abbreviations and Acronyms

AF	acre-foot/feet
Banks Pumping Plant	Harvey O. Banks Pumping Plant
CalSim II	California Simulation Model II
cfs	cubic feet per second
CVP	Central Valley Project
Delta	Sacramento-San Joaquin River Delta
DMC	Delta-Mendota Canal
DSM2	Delta Simulation Model II
DWR	California Department of Water Resources
EC	electrical conductivity
IPO	Interim Plan of Operations
Jones Pumping Plant	C.W. “Bill” Jones Pumping Plant
LOD	Level of Development
µmhos/cm	micromhos per centimeter
M&I	municipal and industrial
Reclamation	Bureau of Reclamation
SJR	San Joaquin River
SWP	State Water Project
VAMP	Vernalis Adaptive Management Plan

Appendix A
Water Operations Analysis

A.1 Introduction and Background

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) is evaluating the feasibility of using recirculation strategies to improve water quality and flows in the lower San Joaquin River (SJR). Specifically, Reclamation is evaluating the feasibility of the Delta-Mendota Canal (DMC) Recirculation Project, which involves recirculating water from the Sacramento-San Joaquin River Delta (Delta) through the Central Valley Project's (CVP's) pumping and conveyance facilities to the SJR, upstream from Vernalis.

The purpose of this investigation, authorized pursuant to federal and state actions, is to identify and evaluate the feasibility of alternative plans for the DMC Recirculation Project that will accomplish the planning objectives defined in the authorizing language. This study, which is part of Reclamation's overall Program to Meet Standards, will determine whether the DMC Recirculation Project will provide greater flexibility in meeting the existing water quality standards and flow objectives for which the CVP has responsibility, reduce the demand on water from New Melones Reservoir currently used to improve water quality and flow, and assist the Secretary of the Interior in meeting any obligation to CVP water contractors using New Melones Reservoir.

This report describes the planning-level water operations analysis used to evaluate recirculation alternative plans.

A.2 Analytical Methods

Two primary analytical tools were used in the analysis: Delta Simulation Model II (DSM2) and California Simulation Model II (CalSim II). CalSim II is the primary tool used to evaluate water operations for recirculation, but is supported with spreadsheet tools to process data and DSM2 to provide estimates of DMC water quality. CalSim II is used to establish systemwide conditions including flow and quality in the SJR, Stanislaus River conditions, and Delta conditions (Reclamation 2005). The need for recirculation and the ability to provide recirculation is determined using CalSim II. Effects to SJR Basin operations are produced using CalSim II based on use of recirculation.

For the purpose of this analysis, operation of Sacramento River Basin facilities and the Sacramento River inflow to the Delta are not changed. A spreadsheet was developed to assess changes in Delta operations based on changes in SJR flow and changes in Delta export at both C.W. “Bill” Jones Pumping Plant (Jones Pumping Plant) and Harvey O. Banks Pumping Plant (Banks Pumping Plant).

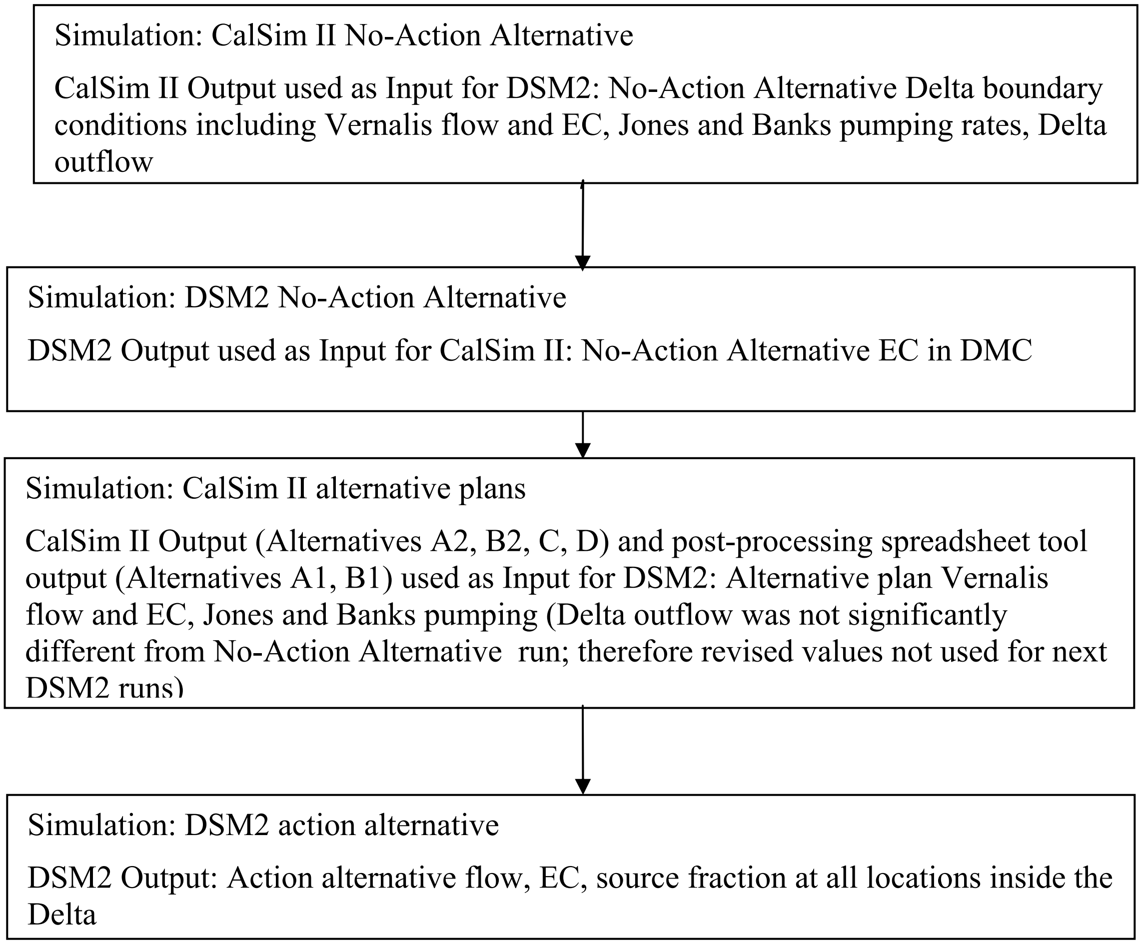
DSM2 is capable of using Delta boundary conditions from CalSim II to evaluate conditions in the Delta. For this project, DSM2 is used in conjunction with CalSim II to establish water quality conditions and electrical conductivity (EC) for the alternative plans. DSM2 is run for conditions under the No-Project/No-Action Alternatives by inputting Vernalis flow and water quality results, Jones and Banks pumping rates, and Delta outflow from CalSim II. DSM2 then provides DMC water quality conditions back to CalSim II. CalSim II is then run to evaluate water operations for the alternatives, and then revised Delta boundary conditions (Vernalis flow and water quality results, and Jones and Banks pumping rates) from CalSim II are input to DSM2 to determine effects on the Delta for the alternatives. This iterative process is shown on **Figure A-1**. DSM2 is described in **Appendix B**.

A.2.1 CalSim Modeling

CalSim II is a planning model designed to simulate the operations of the CVP and State Water Project (SWP) reservoir and water delivery systems for current and future facilities, flood control operating criteria, water delivery policies, instream flow and Delta outflow requirements, and hydroelectric power generation operations. CalSim II is the best available tool for modeling the CVP and SWP and is the only systemwide hydrologic model being used by Reclamation and California Department of Water Resources (DWR) to conduct planning and impact analyses of potential projects.

CalSim II modeling conducted for the DMC Recirculation Project is built on the Common Assumption model package developed jointly by Reclamation and DWR. Version 8D is considered the best available depiction of system facilities and operations for this evaluation. The Version 8D model simulation using the Transfer Step of the model establishes system operations for conditions under the No-Project/No-Action Alternatives. Key assumptions governing and surrounding the operation of the CVP/SWP water system are described in **Table A-1**. The SJR Basin component of CalSim II was extracted from the Common Assumptions full system model to allow the analysis to be performed more time efficiently. In effect, this approach “freezes” (leaves constant) the upstream Sacramento River Basin operation. The approach is used for this analysis under the premise that for this stage of the evaluation no changes to Sacramento River

Basin operations are to occur due to recirculation. Changes in Delta operations are addressed using DSM2 and a simplified CalSim II postprocessor.



Simulation: CalSim II No-Action Alternative

CalSim II Output used as Input for DSM2: No-Action Alternative Delta boundary conditions including Vernalis flow and EC, Jones and Banks pumping rates, Delta outflow

Simulation: DSM2 No-Action Alternative

DSM2 Output used as Input for CalSim II: No-Action Alternative EC in DMC

Simulation: CalSim II alternative plans

CalSim II Output (Alternatives A2, B2, C, D) and post-processing spreadsheet tool output (Alternatives A1, B1) used as Input for DSM2: Alternative plan Vernalis flow and EC, Jones and Banks pumping (Delta outflow was not significantly different from No-Action Alternative run; therefore revised values not used for next DSM2 runs)

Simulation: DSM2 action alternative

DSM2 Output: Action alternative flow, EC, source fraction at all locations inside the Delta

Figure A-1. CalSim II and DSM2 Iterative Modeling Process

Table A-1. Key CalSim Assumptions

CalSim II Inputs (CACMP – Version 8D)		
	No-Project Alternative Assumption	**No-Action Alternative Assumption**
Planning horizon	2004[1]	2030[1]
Demarcation date	June 1, 2004[1]	Same as No-Project Alternative assumption
Period of simulation	82 years (1922–2003)	Same as No-Project Alternative assumption
HYDROLOGY		
Level of development	2005 level[2]	2030 level[3]
Sacramento Valley (excluding American River)		
CVP	Land-use based, limited by contract amounts[4]	Same as No-Project Alternative assumption
SWP (FRSA)	Land-use based, limited by contract amounts[5]	Same as No-Project Alternative assumption
Nonproject	Land-use based	Same as No-Project Alternative assumption
Federal refuges	Recent historical Level 2 deliveries[6]	Firm Level 2 water needs[6]
American River		
Water rights	2004[7]	Sacramento Area Water Forum[7,8]
CVP	2004[7]	Sacramento Area Water Forum (PCWA modified)[7,8]
PCWA	No CVP contract water supply	35,000 AF CVP contract supply diverted at the new American River PCWA Pump Station
San Joaquin River[9]		
Friant Unit	Limited by contract amounts, based on current allocation policy	Same as No-Project Alternative assumption
Lower Basin	Land-use based, based on district-level operations and constraints	Same as No-Project Alternative assumption
Stanislaus River	Land-use based, based on New Melones Interim Plan of Operations[10]	Same as No-Project Alternative assumption
Delta export area (CVP/SWP project facilities)		
CVP	Demand based on contracts amounts[4]	Same as No-Project Alternative assumption
Contra Costa Water District	124,000 AF CVP contract supply and water rights[11]	195,000 AF CVP contract supply and water rights[11]

Table A-1. Key CalSim Assumptions

CalSim II Inputs (CACMP – Version 8D)		
	No-Project Alternative Assumption	**No-Action Alternative Assumption**
SWP	Demand varies based on pattern used for 2004 OCAP today studies; Table A transfers that occurred in 2005 and 2006 are not included	Demand based on full Table A amounts[5,12]
Article 56	Based on 2002–2006 contractor requests	Same as No-Project Alternative assumption
Article 21	MWD demand up to 100,000 AF/month from December to March, total of other demands up to 84,000 AF/month in all months[5,12]	MWD demand unlimited but subject to capacity to convey and deliver; KCWA demand of up to 2,555 cfs; others same as existing
Federal refuges	Recent historical Level 2 deliveries[6]	Firm Level 2 water needs[6]
FACILITIES		
Systemwide	Existing facilities[1]	Same as No-Project Alternative assumption
Sacramento Valley		
Shasta Lake	Existing, 4,552,000 AF capacity	Same as No-Project Alternative assumption
Colusa Basin	Existing conveyance and storage facilities	Same as No-Project Alternative assumption
Upper American River	PCWA American River pump station not included[13]	PCWA American River pump station included
Lower Sacramento River	FRWP not included	FRWP included
Delta Region		
SWP Banks Pumping Plant	6,680 cfs capacity[1]	Same as No-Project Alternative assumption
CVP Jones Pumping Plant	4,200 cfs plus diversions upstream of DMC constriction	4,600 cfs capacity in all months (allowed for by the DMC–California Aqueduct Intertie)
Los Vaqueros Reservoir	Existing storage capacity, 100,000 AF (Alternative Intake Project not included)	Existing storage capacity, 100,000 AF; Alternate Intake Project included[14]
San Joaquin River		
Millerton Lake (Friant Dam)	Existing, 520,000 AF capacity	Same as No-Project Alternative assumption

Table A-1. Key CalSim Assumptions

CalSim II Inputs (CACMP – Version 8D)		
	No-Project Alternative Assumption	**No-Action Alternative Assumption**
Delta export area (CVP/SWP project facilities)		
South Bay Aqueduct Enlargement	None	430 cfs capacity from junction with California Aqueduct to Alameda County FC&WSD Zone 7 diversion point
California Aqueduct East Branch Enlargement	None	None
WATER MANAGEMENT ACTIONS (CALFED)		
Water Transfer Supplies (available long-term program)		
Phase 8[15]	None	Supplies up to 185,000 AF/year from new groundwater substitution, with 60% going to SWP and 40% to CVP[16]
Lower Yuba River Accord	Not included	Not included
REGULATORY STANDARDS		
Trinity River		
Minimum flow below Lewiston Dam	Trinity EIS Preferred Alternative (369,000–815,000 AF/year)	Same as No-Project Alternative assumption
Trinity Reservoir end-of-September minimum storage	Trinity EIS Preferred Alternative (600,000 AF as able)	Same as No-Project Alternative assumption
Clear Creek		
Minimum flow below Whiskeytown Dam	Downstream water rights, 1963 Reclamation Proposal to the Service and National Park Service, and the Service's discretionary use of CVPIA 3406(b)(2)	Same as No-Project Alternative assumption
Upper Sacramento River		
Shasta Lake end-of-September minimum storage	D-1993 winter run biological opinion (1,900,000 AF)	Same as No-Project Alternative assumption
Minimum flow below Keswick Dam	Flows for D-90-5 and the Service's discretionary use of CVPIA 3406(b)(2)	Same as No-Project Alternative assumption
Feather River		
Minimum flow below Thermalito Diversion Dam	1983 DWR–DFG Agreement (600 cfs)	Same as No-Project Alternative assumption

Table A-1. Key CalSim Assumptions

CalSim II Inputs (CACMP – Version 8D)		
	No-Project Alternative Assumption	**No-Action Alternative Assumption**
Minimum flow below Thermalito Afterbay outlet	1983 DWR–DFG Agreement (750–1,700 cfs)	Same as No-Project Alternative assumption
Yuba River		
Minimum flow below Daguerre Point Dam	Interim D-1644 Operations[17]	Same as No-Project Alternative assumption
American River		
Minimum flow below Nimbus Dam	D-893[18] (see accompanying Operations Criteria), and the Service's discretionary use of CVPIA 3406(b)(2)	Same as No-Project Alternative assumption
Minimum Flow at H Street Bridge	D-893	Same as No-Project Alternative assumption
Lower Sacramento River		
Minimum flow near Rio Vista	D-1641	Same as No-Project Alternative assumption
Mokelumne River		
Minimum flow below Comanche Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (100-325 cfs)	Same as No-Project Alternative assumption
Minimum flow below Woodbridge Diversion Dam	FERC 2916-029, 1996 (Joint Settlement Agreement) (25-300 cfs)	Same as No-Project Alternative assumption
Stanislaus River		
Minimum flow below Goodwin Dam	1987 Reclamation–DFG agreement, and Service discretionary use of CVPIA 3406(b)(2)	Same as No-Project Alternative assumption
Minimum dissolved oxygen	D-1422	Same as No-Project Alternative assumption
Merced River		
Minimum flow below Crocker-Huffman Diversion Dam	Davis-Grunsky (180-220 cfs, Nov-Mar), Cowell Agreement, and FERC 2179 (25–100 cfs)	Same as No-Project Alternative assumption
Tuolumne River		
Minimum flow at Lagrange Bridge	FERC 2299-024, 1995 (Settlement Agreement) (94,000-301,000 AF/year)	Same as No-Project Alternative assumption

Table A-1. Key CalSim Assumptions

CalSim II Inputs (CACMP – Version 8D)		
	No-Project Alternative Assumption	**No-Action Alternative Assumption**
San Joaquin River		
San Joaquin River below Friant Dam/Mendota Pool	None	None
Maximum salinity near Vernalis	D-1641	Same as No-Project Alternative assumption
Minimum flow near Vernalis	D-1641, and VAMP per SJRA	Same as No-Project Alternative assumption[19]
Sacramento–San Joaquin River Delta		
Delta Outflow Index (Flow and Salinity)	D-1641	Same as No-Project Alternative assumption
Delta Cross Channel gate operation	D-1641	Same as No-Project Alternative assumption
Delta exports	D-1641, the Service's discretionary use of CVPIA 3406(b)(2)	Same as No-Project Alternative assumption
OPERATIONS CRITERIA: RIVER-SPECIFIC		
Upper Sacramento River		
Flow objective for navigation (Wilkins Slough)	3,500–5,000 cfs based on CVP water supply condition	Same as No-Project Alternative assumption
American River		
Folsom Dam flood control	Variable 400/670 flood control diagram (without outlet modifications)	Same as No-Project Alternative assumption
Flow below Nimbus Dam	Discretionary operations criteria corresponding to D-893 required minimum flow	Same as No-Project Alternative assumption
Sacramento Area Water Forum Mitigation Water	None	Up to 47,000 AF in dry years
Feather River		
Flow at Mouth of Feather River (above Verona)	Maintain DFG/DWR flow target of 2,800 cfs for Apr-Sep dependent on Oroville inflow and FRSA allocation	Same as No-Project Alternative assumption
Stanislaus River		
Flow below Goodwin Dam	1997 New Melones Interim Plan of Operations	Same as No-Project Alternative assumption
San Joaquin River		
Salinity at Vernalis	D-1641	SJR Salinity Management Plan[20]

Table A-1. Key CalSim Assumptions

CalSim II Inputs (CACMP – Version 8D)		
	No-Project Alternative Assumption	**No-Action Alternative Assumption**
OPERATIONS CRITERIA: SYSTEMWIDE		
CVP water allocation		
CVP Settlement and Exchange	100%(75% in Shasta critical years)	Same as No-Project Alternative assumption
CVP refuges	100% (75% in Shasta critical years)	Same as No-Project Alternative assumption
CVP agriculture	100-0% based on supply (Delta export delivery area allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same as No-Project Alternative assumption
CVP M&I	100-50% based on supply (Delta export delivery area allocations are reduced due to D-1641 and 3406(b)(2) allocation-related export restrictions)	Same as No-Project Alternative assumption
SWP water allocation		
North of Delta (FRSA)	Contract-specific	Same as No-Project Alternative assumption
South of Delta (including North Bay Aqueduct)	Based on supply; equal prioritization between agriculture and M&I based on Monterey Agreement	Same as No-Project Alternative assumption
CVP-SWP coordinated operations		
Sharing of responsibility for in-basin use	1986 COA (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)	1986 COA (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)
Sharing of surplus flows	1986 COA	Same as No-Project Alternative assumption
Sharing of restricted export capacity for project-specific priority pumping	Equal sharing of export capacity under D-1641; use of CVPIA 3406(b)(2) restricts only CVP exports	Same as No-Project Alternative assumption
Dedicated CVP conveyance at Banks Pumping Plant	None	SWP to convey 50,000 AF/year of Level 2 refuge water supplies at Banks Pumping Plant (July and August)

Table A-1. Key CalSim Assumptions

CalSim II Inputs (CACMP – Version 8D)		
	No-Project Alternative Assumption	**No-Action Alternative Assumption**
North-of-Delta accounting adjustments	None	CVP to provide the SWP a maximum of 375,000 AF/year of water to meet in-basin requirements through adjustments in 1986 COA accounting (released from Shasta)
Sharing of export capacity for lesser priority and wheeling-related pumping	Cross Valley Canal wheeling (maximum of 128,000 AF/year), CALFED ROD defined Joint Point of Diversion	Same as No-Project Alternative assumption
San Luis Low Point	SLR is allowed to operate to a minimum storage of 100,000 AF.	Same as No-Project Alternative assumption
CVPIA 3406(b)(2)		
Policy Decision	Per May 2003 U.S. Dept. of Interior Decision	Same as No-Project Alternative assumption
Allocation	800,000 AF, 700,000 AF in 40-30-30 dry years, and 600,000 AF in 40-30-30 critical years	Same as No-Project Alternative assumption
Actions	1995 Basin Plan, upstream fish flow objectives (Oct-Jan), VAMP (Apr 15-May 15) CVP export restriction, 3,000 cfs CVP export limit in May and June (D-1485 striped bass cont.), post-VAMP (May 16-31) CVP export restriction, ramping of CVP export (June), upstream releases (Feb-Sep)	Same as No-Project Alternative assumption
Accounting adjustments	Per May 2003 Interior decision, no limit on responsibility for nondiscretionary D-1641 requirements with 500,000 AF target, no reset with the storage metric and no offset with the release and export metrics, 200,000 AF target on costs from Oct-Jan	Same as No-Project Alternative assumption

Notes:

[1] A detailed description of the assumptions selection criteria and policy basis used will be included in the policy section of the CACMP report**.**

[2] The Sacramento Valley hydrology used in the No-Project Alternative CalSim II model reflects nominal 2005 land-use assumptions. The nominal 2005 land use was determined by interpolation between the 1995 and projected 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects 2005 land-use assumptions developed by Reclamation to support its studies.

[3] The Sacramento Valley hydrology used in the No-Action Alternative CalSim II model reflects 2020 land-use assumptions associated with Bulletin 160-98. The San Joaquin Valley hydrology reflects draft 2030 land-use assumptions developed by Reclamation to support Reclamation studies.

[4] CVP contract amounts have been reviewed and updated according to existing and amended contracts as appropriate. Assumptions regarding CVP agricultural and M&I service contracts and Settlement Contract amounts are documented in Tables 4 (North of Delta) and 6 (South of Delta) of Appendix B: CACMP Delivery Specifications.

[5] SWP contract amounts have been reviewed and updated as appropriate. Assumptions regarding SWP agricultural and M&I contract amounts are documented in Table 2 (North of Delta) and Table 3 (South of Delta) of Appendix B: CACMP Delivery Specifications.

[6] Water needs for federal refuges have been reviewed and updated as appropriate. Assumptions regarding firm Level 2 refuge water needs are documented in Table 4 (North of Delta) and 6 (South of Delta) of Appendix B: CACMP Delivery Specifications. As part of the Water Transfers technical memorandum (Appendix A: Characterization and Quantification), incremental Level 4 refuge water needs have been documented as part of the assumptions of future water transfers.

[7] Assumptions regarding American River water rights and CVP contracts are documented in Table 5 of Appendix B: CACMP Delivery Specifications.

[8] Sacramento Area Water Forum 2025 assumptions are defined in Sacramento Water Forum’s Environmental Impact Report. PCWA CVP contract supply is modified to be diverted at the PCWA pump station. Assumptions regarding American River water rights and CVP contracts are documented in Table 4 of Appendix B: CACMP Delivery Specifications.

[9] The new CalSim II representation of the SJR has been included in this model package (*CalSim II San Joaquin River Model* [Reclamation 2005]). Updates to the SJR have been included since the preliminary model release in August 2005. In addition, a dynamic groundwater simulation is currently being developed for SJR valley, but is not yet implemented. Groundwater extraction/recharge and stream-groundwater interaction are static assumptions and may not accurately reflect a response to simulated actions. These limitations should be considered in the analysis of results.

[10] The CACMP CalSim II model representation for the Stanislaus River does not necessarily represent Reclamation’s current or future operational policies.

[11] The Existing CVP contract is 140,000 AF. The actual amount diverted is reduced due to supplies from the Los Vaqueros project. The existing Los Vaqueros storage capacity is 100,000 AF. Associated water rights for Delta excess flows are included.

[12] Table A and Article 21 deliveries into the San Francisco Bay Area Region–South and South Coast Region in the CACMP are a result of interaction between CalSim II and LCPSIM. More information regarding LCPSIM is included in the following subsection of this document and the CalSim-LCPSIM Integration technical memorandum (see Appendix C: Analytical Framework).

[13] PCWA American River pumping facility upstream of Folsom Lake is under construction. A Sacramento River diversion for PCWA is not included in the PFCMP. This assumption will be revisited as part of the development of the Feasibility Study Common Models Package.

[14] The Contra Costa Water District Alternate Intake Project is a new intake at Victoria Canal to operate as an alternate intake for Los Vaqueros Reservoir. This assumption is consistent with the future no-project condition defined by the Los Vaqueros Enlargement study team.

[15] Mokelumne River flows reflect EBMUD supplies associated with the Freeport Regional Water Project.

[16] This Phase 8 requirement is assumed to be met through Sacramento Valley Water Management Agreement Implementation.

[17] Interim D-1644 is assumed to be implemented

[18] Sacramento Area Water Forum Lower American River Flow Management Standard is not included in the CACMP. Reclamation has agreed in principle to the Flow Management Standard, but flow specifications are not yet available for modeling purposes.

[19] It is assumed that either VAMP, a functional equivalent, or D-1641 requirements would be in place in 2030.

[20] The CACMP CalSim II model representation for the SJR does not explicitly implement the CALFED Salinity Management Plan

Key:

AF = acre-feet
cfs = cubic feet per second
CACMP = Common Assumptions Common Models Package
CALFED = California-Federal Bay Delta Program
CDFG = California Department of Fish and Game
COA = Coordinated Operations Agreement
CVP = Central Valley Project
CVPIA = Central Valley Project Improvement Act
D-xxxx = State Water Resources Control Board Water Right Decision
DMC = Delta-Mendota Canal
DWR = California Department of Water Resources
EBMUD = East Bay Municipal Utility District
EIS = Environmental Impact Statement
FC&WSD = Flood Control and Water Supply District
FERC = Federal Energy Regulatory Commission
FRSA = Feather River Service Area
FRWP = Freeport Regional Water Project
KCWA = Kern County Water Authority
LCPSIM = Least Cost Pricing Simulation Model
M&I = municipal and industrial
MWD = Metropolitan Water District of Southern California
OCAP = Operations Criteria and Plan
PCWA = Placer County Water Authority
PFCMP = Plan Formulation Report Common Models Package
ROD = Record of Decision
SJR = San Joaquin River
SJRA = San Joaquin River Agreement
SLR = San Luis Reservoir
SWP = State Water Project
Service = U.S. Fish and Wildlife Service
VAMP = Vernalis Adaptive Management Plan

Level of Development

CalSim II simulations at a projected Level of Development (LOD) are used to depict how the modeled water system might operate with an assumed physical and institutional configuration imposed on a long-term sequential hydrologic series. An existing LOD study assumes that current land use, facilities, and operational objectives are in place for each year of simulation (1922–2003). The results are a depiction of the existing conditions, which provides a basis for comparison of project effects for the California Environmental Quality Act analysis. A 2030 future LOD study is needed to explore how the system may perform under an assumed future set of physical and institutional circumstances. This future setting is developed by assuming 2030 future LOD land use, facilities, and operational objectives and is used for conditions under the No-Project/No-Action Alternatives and applied to all alternative plans modeled using future LOD for the National Environmental Policy Act analysis.

Existing Level of Development

Parameters used to describe existing LOD hydrologic conditions and operating rules for the SJR Basin water system were developed using recent historical data and current established operational objectives and requirements. These criteria are described in the *CalSim II San Joaquin River Model* (Reclamation 2005). The results provide a CalSim simulation of the system depicting existing operations.

Future (2030) Level of Development

Projecting the availability of facilities, institutional and regulatory requirements, and the practices that will affect the management of future water supplies is the subject of ongoing discussion by the Common Assumptions workgroup (http://www.storage.water.ca.gov/common_assumptions/index.cfm). However, assumptions must be made regarding these items to provide a projection of 2030 future LOD for the National Environmental Policy Act analysis.

The SJR Basin has experienced numerous physical and institutional changes over the decades, and is continuing to experience change. The several changes addressed in this version of the 2030 future LOD that lead to substantive change in hydrologic outcome as compared to the existing LOD simulation include:

- Land-use conversion from agricultural use to urban use
- The source of water to meet the change in land use
- Changes in drainage to the SJR from land-use changes and changes in agricultural practices.

Several operational assumptions that remain constant between the existing and 2030 future LOD include:

- All current tributary and SJR mainstem flow requirements and other regulatory requirements remain in place for the 2030 future LOD.
- All current water exchanges, transfers, and sales explicitly or implicitly modeled in the current LOD remain in place for the 2030 future LOD.
- Water-use efficiency remains the same between the existing and 2030 future LOD.
- Tributary inflow (rim flows) remains the same.

Drainage to the San Joaquin River

Drainage and return flows to the SJR for the existing LOD are described in the *CalSim II San Joaquin River Model* (Reclamation 2005), particularly in the discussion of the water quality module. Several of the salinity (EC) characteristics of the drainage and return flow components are explicitly modeled in CalSim II. One such explicit component is the discharge of the Grassland Bypass Project. This project, now incorporated into the Westside Regional Drainage Plan, continues to reduce selenium and salt discharges to the SJR.

Current efforts and plans to eliminate selenium from discharges to the SJR will also result in a reduction of salt discharges to the SJR. Prior to 2030 this program anticipates the total removal of currently modeled discharge to the SJR. To incorporate this anticipated change in the future LOD, the CalSim II input parameters for the Grassland Bypass Project have been reduced to zero discharge (from an existing LOD discharge of approximately 30,000 acre-feet ([AF] per year).

A.2.2 Suitability of Models

Both the frequency and magnitude of demand for DMC Recirculation are dependent on SJR and DMC water quality and flow conditions, making paramount the use of models that reasonably depict the flow and quality within the DMC and the SJR.

Representation of SJR within CalSim II has undergone extensive review and testing (CALFED 2006; Reclamation and DWR 2007). The water quality depiction of the SJR upstream of the Stanislaus River confluence, a location of concern because of the SJR's influence on New Melones Project operation, received extensive critique.

Figure A-2 is a plot of average monthly SJR EC as depicted by CalSim II and as recorded for the period of October 1995 through September 2003. This graphic is representative of the accuracy of CalSim II in depicting water quality conditions in the SJR upstream of the Stanislaus River confluence, a location typically referred to as the “Maze” Boulevard crossing of the SJR. A flow and quality recorder is in place at this location, and provided information for the calibration of CalSim II. As addressed in the Peer Review (CALFED 2006; Reclamation and DWR 2007), CalSim II provides an adequate simulation of SJR flow and water quality conditions and is the best available tool for such a depiction.

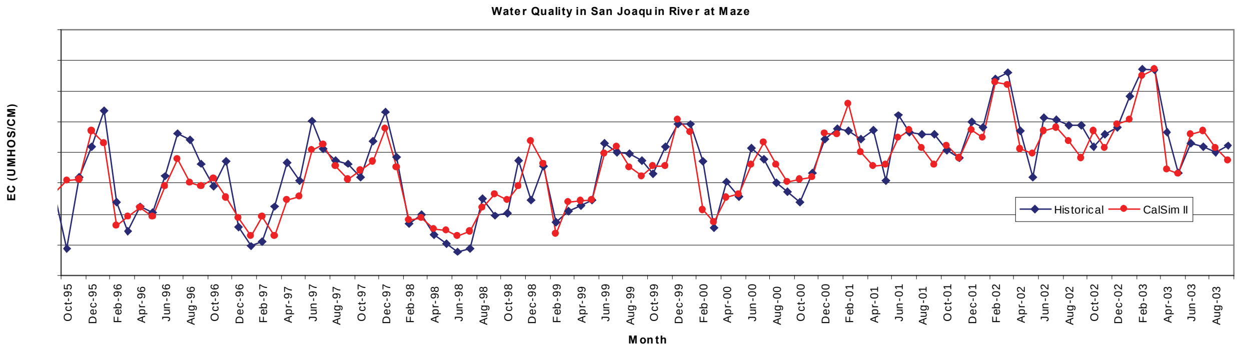


Figure A-2. Comparison Between Average Monthly Measured EC in the San Joaquin River at Maze and Predicted EC from the CalSim II Model

CalSim II, and explicitly the component of CalSim II that depicts the SJR Basin, are currently being used by the ongoing planning efforts of Reclamation and DWR, including the Upper San Joaquin River Basin Investigation, Los Vaqueros investigation, North of Delta Off-Stream Storage Investigation, and others. Use of CalSim II for this analysis provides consistency among the several planning initiatives. CalSim II is also an appropriate tool to provide analysis of the interaction between SJR flow and quality conditions as affected by recirculation and the operation of the New Melones Project.

The opportunity for recirculation is dependant on the water quality in the DMC. As described in **Section A3**, the use of recirculation as a means to augment SJR’s flow or improve its quality can be constrained by the water quality that occurs in the DMC. The depiction of water quality in the DMC (the source of water for recirculation) is based on output from DSM2. **Figure A-3** is a plot of simulated DMC water quality compared to the recent history of recorded data. Although differences occur that can be explained by many factors that differ between the simulation and recorded events (e.g., differences in barrier, flow, and export operations), the simulated results provide an adequate basis for analysis, providing general trends of results that vary by month, season, and year.

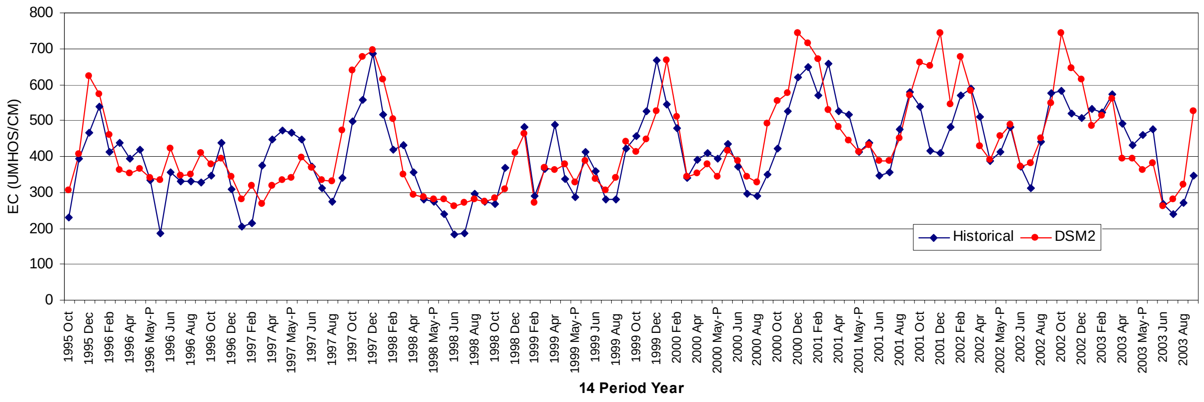


Figure A-3. Comparison Between Measured EC in the Delta-Mendota Canal and EC Predicted by the DSM2 Model

A.3 Demand for Recirculation

Recirculation is used for two purposes: (1) to assist in meeting flow objectives at Vernalis and (2) to assist in meeting water quality objectives at Vernalis. This analysis also conditions the operation of recirculation on two objectives: (1) supplement releases from New Melones or (2) use prior to operating New Melones for the Vernalis objectives.

The amount of recirculation needed for Vernalis water quality purposes is influenced by the quality of flow in the upper DMC. The use of recirculation for the purpose of water quality control at Vernalis is a function of blending SJR water with better quality DMC water. As the levels of EC in the DMC increase in relation to the SJR's quality, more recirculation flow is required to improve Vernalis water quality. At a point where DMC's water quality is near or equal to the SJR's water quality, recirculation becomes ineffective for water quality improvement.

The amount of recirculation needed for Vernalis flow purposes is simply a flow calculation, comparing the need for flow at Vernalis and the availability of recirculation flow. DMC's water quality can also be a consideration during periods of recirculation for flow purposes.

A.3.1 Electrical Conductivity

EC in both the SJR and DMC varies depending on hydrologic conditions and operations. **Figure A-4** illustrates the general trend of EC in the SJR at Maze (upstream of the confluence with the Stanislaus River) by month and year type as depicted by CalSim II under the existing LOD. The water quality objective is also shown on the figure to provide a general indication of the potential need for recirculation from the DMC.

Similar information is shown on **Figure A-5** for the average monthly EC in the DMC based on DSM2 modeling of existing conditions.

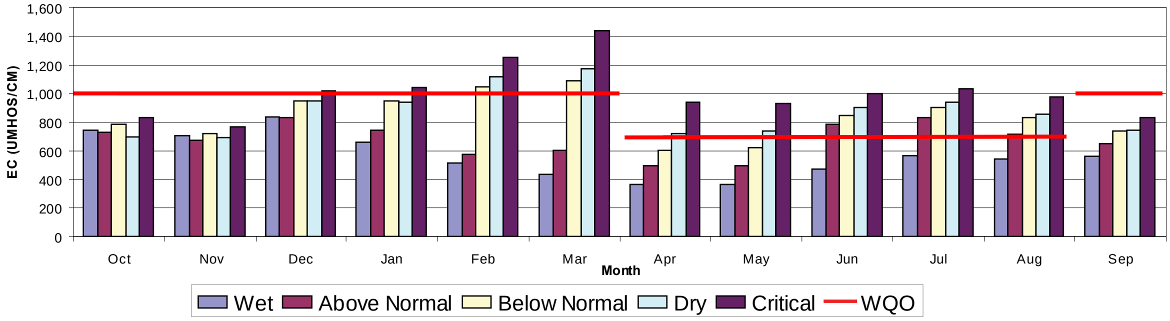


Figure A-4. Average Value of EC in the San Joaquin River at Maze by Month and Year Type from the CalSim II Model (values above the water quality objective indicate when DMC Recirculation may be used)

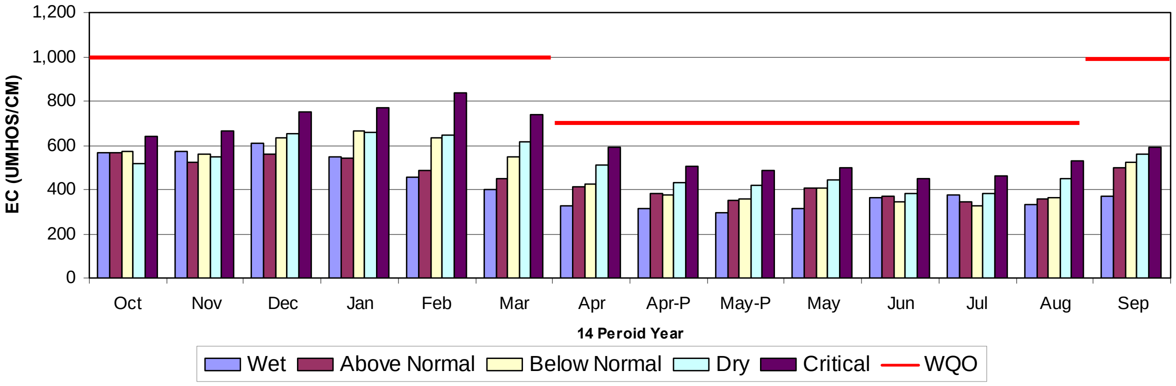


Figure A-5. Average EC Value in the DMC as Predicted by the DSM2 Model by Month and Year Type

Figures A-6 and A-7 contain plots of SJR EC at Vernalis and DMC EC for periods when the Vernalis standard is 1,000 μmhos/cm and 700 μmhos/cm. EC values for Vernalis are from the CalSim II simulation of the SJR Basin and EC values for the DMC are from the DSM2 simulation of Delta salinity. SJR EC at Vernalis in these plots is developed assuming no releases from New Melones to meet water quality objectives.

During many periods EC in the DMC is higher (poorer quality) than the SJR; represented by the data points falling above the diagonal line on the charts denoted by the light blue color. Under the Condition 1 assumption recirculation will not occur during these periods to avoid degrading quality in the SJR. The sensitivity of the results to this assumption on the water demand and water supply available for recirculation is assessed in **Appendix A2**.

At times EC in the DMC is higher than the water quality standard at Vernalis, noted by the light green shading. For purpose of this analysis recirculation is also precluded when DMC EC is above the Vernalis objective.

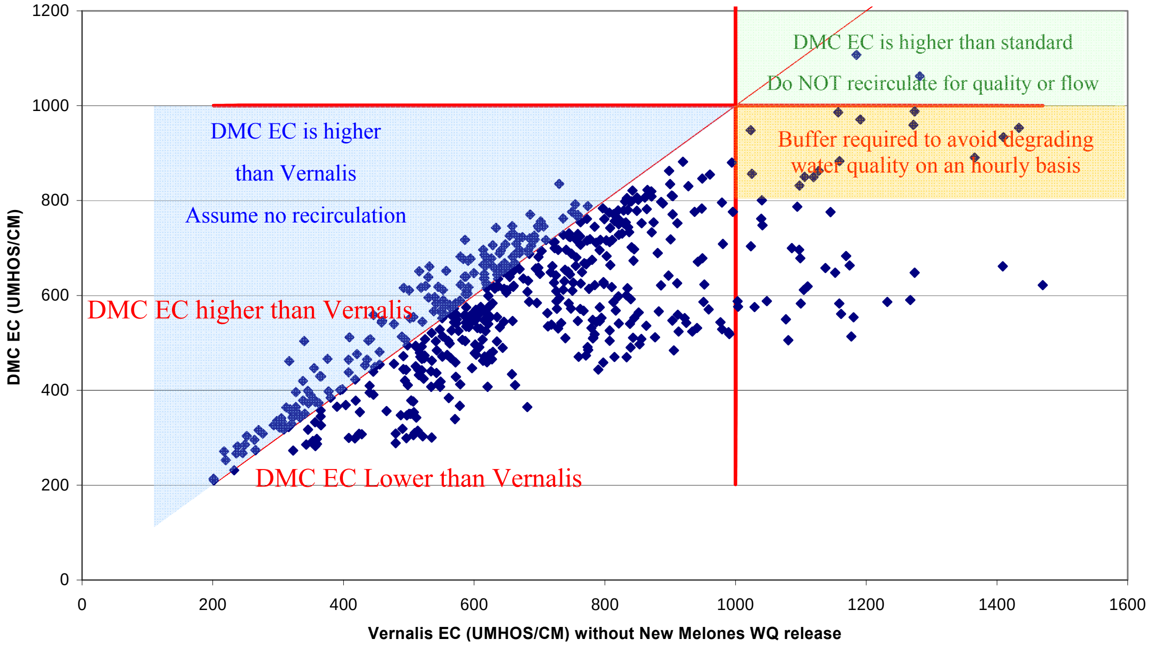


Figure A-6. Predicted EC at Vernalis and in the DMC when EC Standard is 1,000 µmhos/cm

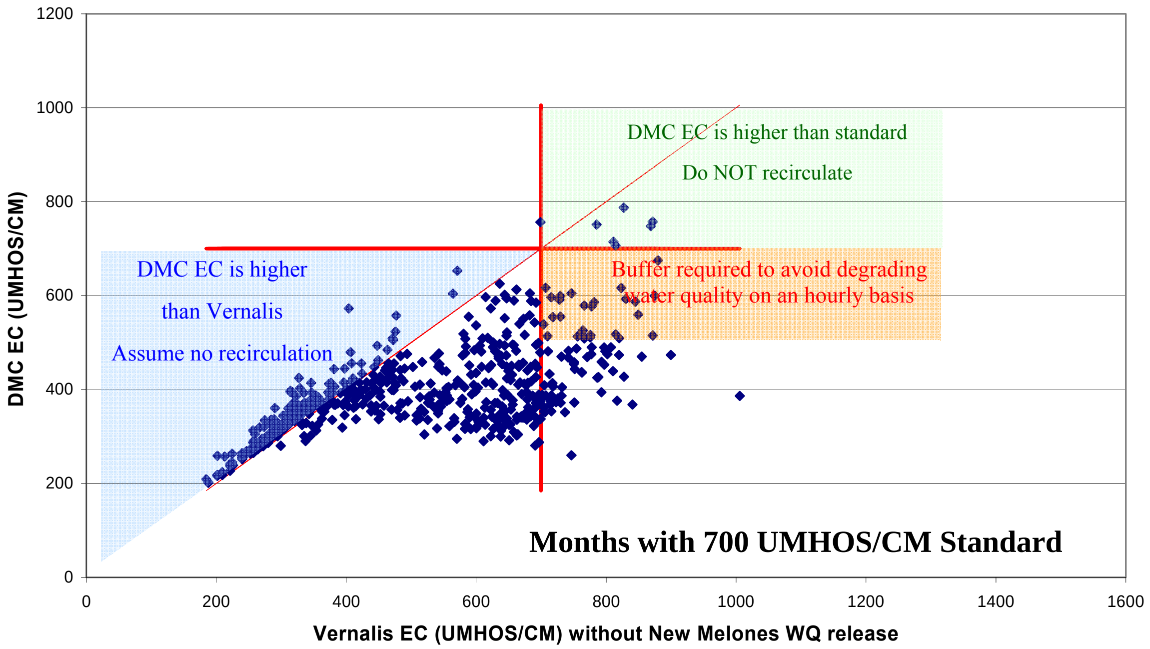


Figure A-7. Predicted EC at Vernalis and in the DMC when EC Standard is 700 µmhos/cm

EC in the DMC can vary significantly on both a daily and monthly basis. **Figure A-8** shows hourly EC measurements in the DMC for the period of January 2007 through mid-June 2007 at the DMC headworks. At times EC can vary by more than 200 µmhos/cm above the mean. The Condition 1 assumption further includes a restriction on the use of recirculation when DMC EC is within 200 µmhos/cm of the EC standard at Vernalis. The shaded orange color on **Figures A-6 and A-7** denote the times when use of Condition 1 would preclude the use of recirculation. The sensitivity of the results of this assumption on the water supply available for recirculation is assessed in **Section A7 (under development)**.

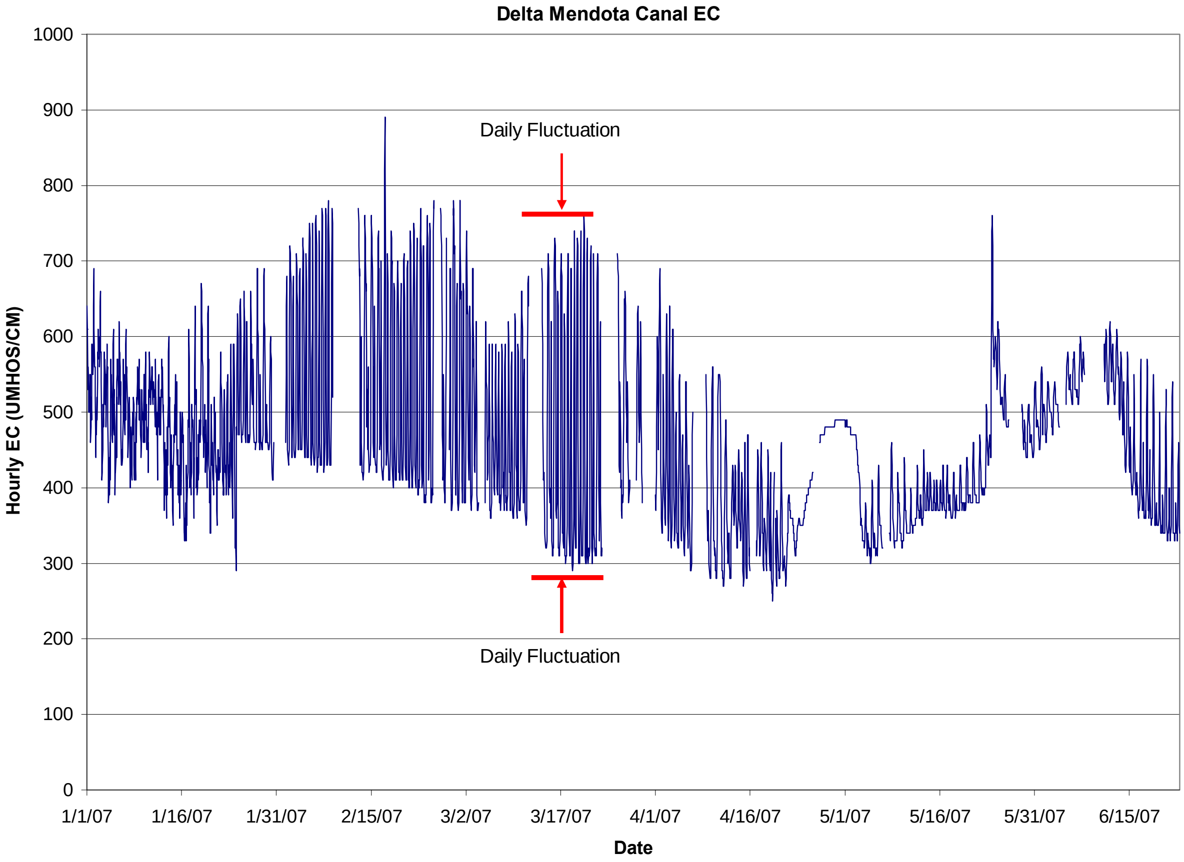


Figure A-8. Observed Hourly DMC EC

The flow objectives at Vernalis have not been achieved under various historical conditions. Under current modeling of the existing environment with strict application of the New Melones Interim Plan of Operations (IPO) the flow objectives would not be met in many years. **Table A-2** illustrates the need for additional flow to meet the Vernalis flow objective. The first block of data shows the amount of supplemental flow required at Vernalis if no release is made from New Melones, the second block shows the amount of releases from New Melones for the flow objective (based on CalSim II predictions), and the last block shows the amount of flow needed from additional releases (e.g., recirculation) even after New Melones has made releases under the IPO.

Table A-2. Amount of Flow Releases Required to Meet Vernalis Flow Objectives with and without Releases from New Melones (Goodwin Release)

Vernalis Flow Objective Shortage w/o Goodwin Release
- 1,000 acre-feet
Ranked Ordered by SJR Index

1997 IPO Allocations w/ Revised October 2005 CALSIM Boundary

WY	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Mar-Feb
W Avg	0	0	0	0	3	1	4	8	7	0	0	0	23	21
AN Avg	0	0	0	0	6	15	11	16	55	0	0	0	103	99
BN Avg	0	0	0	0	10	12	16	11	11	0	0	0	61	61
D Avg	0	0	0	0	11	16	17	5	15	0	0	0	63	62
C Avg	0	0	0	0	0	1	6	1	3	0	0	0	12	16
All Avg	0	0	0	0	5	8	10	8	17	0	0	0	48	48

Goodwin Release for Vernalis Flow Objective
- 1,000 Acre-feet
Ranked Ordered by SJR Index

1997 IPO Allocations w/ Revised October 2005 CALSIM Boundary

W Avg	0	0	0	0	0	0	0	0	1	0	0	0	1	1
AN Avg	0	0	0	0	0	2	0	0	9	0	0	0	11	11
BN Avg	0	0	0	0	0	1	0	0	0	0	0	0	2	3
D Avg	0	0	0	0	1	0	0	0	0	0	0	0	1	0
C Avg	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Avg	0	0	0	0	0	1	0	0	2	0	0	0	3	3

Remaining Vernalis Flow Objective Violation
- 1,000 Acre-feet
Ranked Ordered by SJR Index

1997 IPO Allocations w/ Revised October 2005 CALSIM Boundary

W Avg	0	0	0	0	2	1	2	2	1	0	0	0	9	7
AN Avg	0	0	0	0	5	9	2	2	16	0	0	0	34	29
BN Avg	0	0	0	0	3	3	4	4	1	0	0	0	14	15
D Avg	0	0	0	0	2	6	6	0	3	0	0	0	17	19
C Avg	0	0	0	0	0	0	0	0	0	0	0	0	1	4
All Avg	0	0	0	0	2	3	3	2	4	0	0	0	14	14

Key:

A = above normal
Avg = average
BN = below normal
C = critical
CalSim = California Simulation Model
D = dry
IPO = Interim Plan of Operations
SJR = San Joaquin River
W = wet
WY = water year

A.3.2 Existing Level of Development

Figure A-9 shows the unconstrained annual recirculation demand under existing conditions, assuming the existing LOD, where demands are considered supplemental to the New Melones release under the IPO. The annual average demand is 29,000 AF.

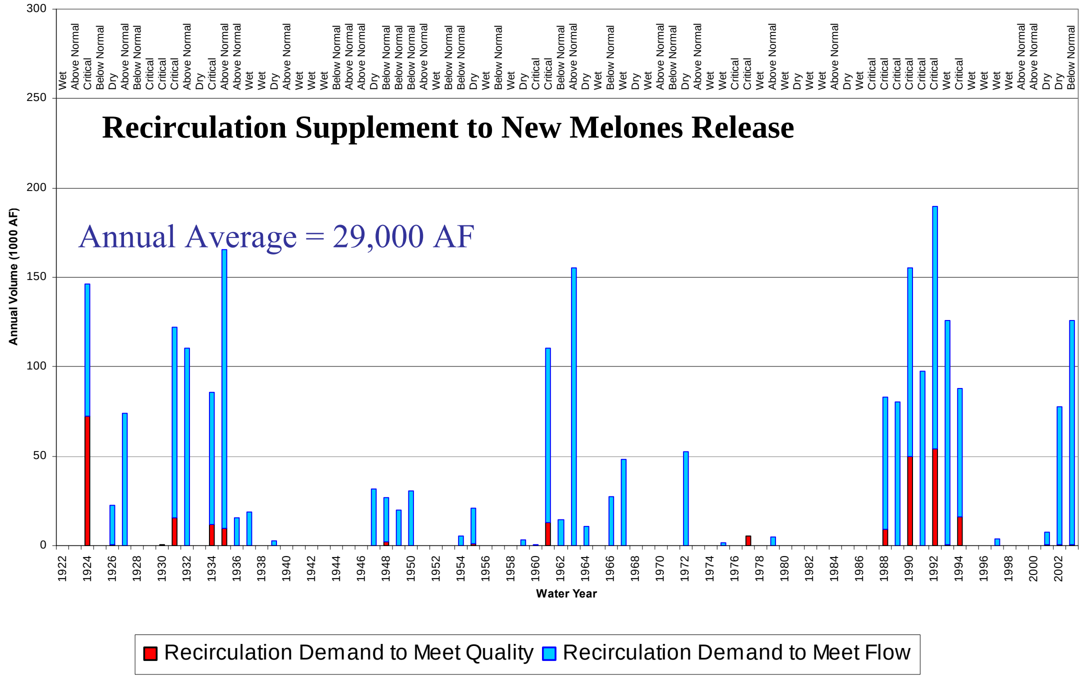


Figure A-9. Existing Level of Development Annual Unconstrained Demand for Recirculation

Figure A-10 shows the annual recirculation demand for existing conditions after applying the Condition 1 filter and where demands are considered supplemental to the New Melones release under the IPO. The annual average demand is 27,000 AF. **Figure A-11** illustrates this demand on an average monthly basis by water year type. **Figure A-11** also displays the frequency of monthly demand for recirculation by year type and the average monthly demand when demand exists.

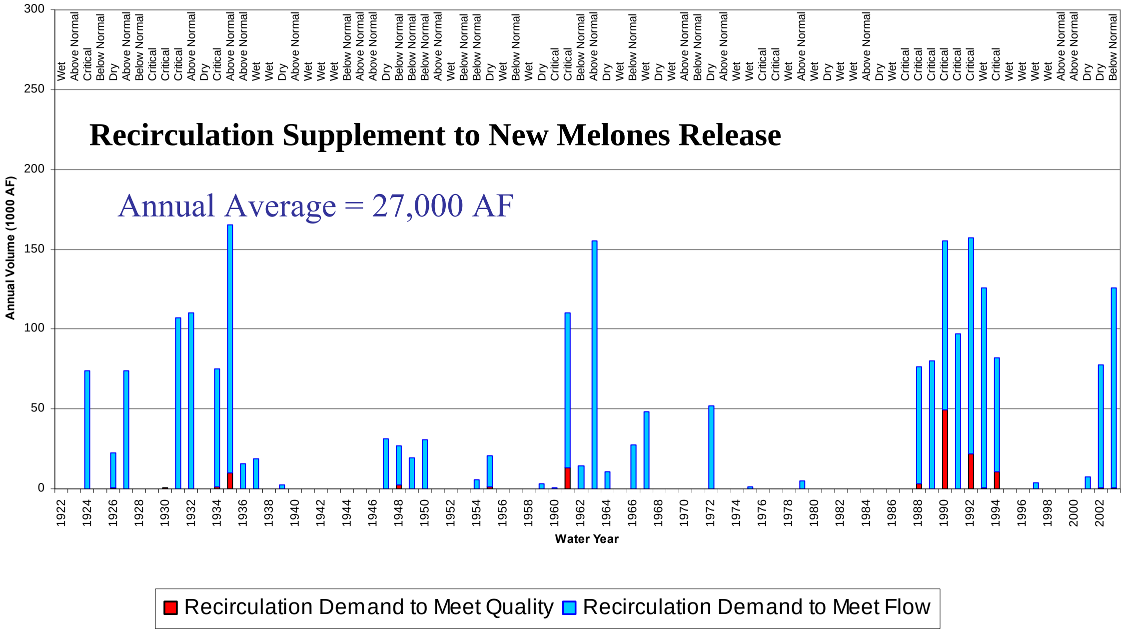


Figure A-10. Annual Demand for Recirculation under Existing Level of Development Condition 1

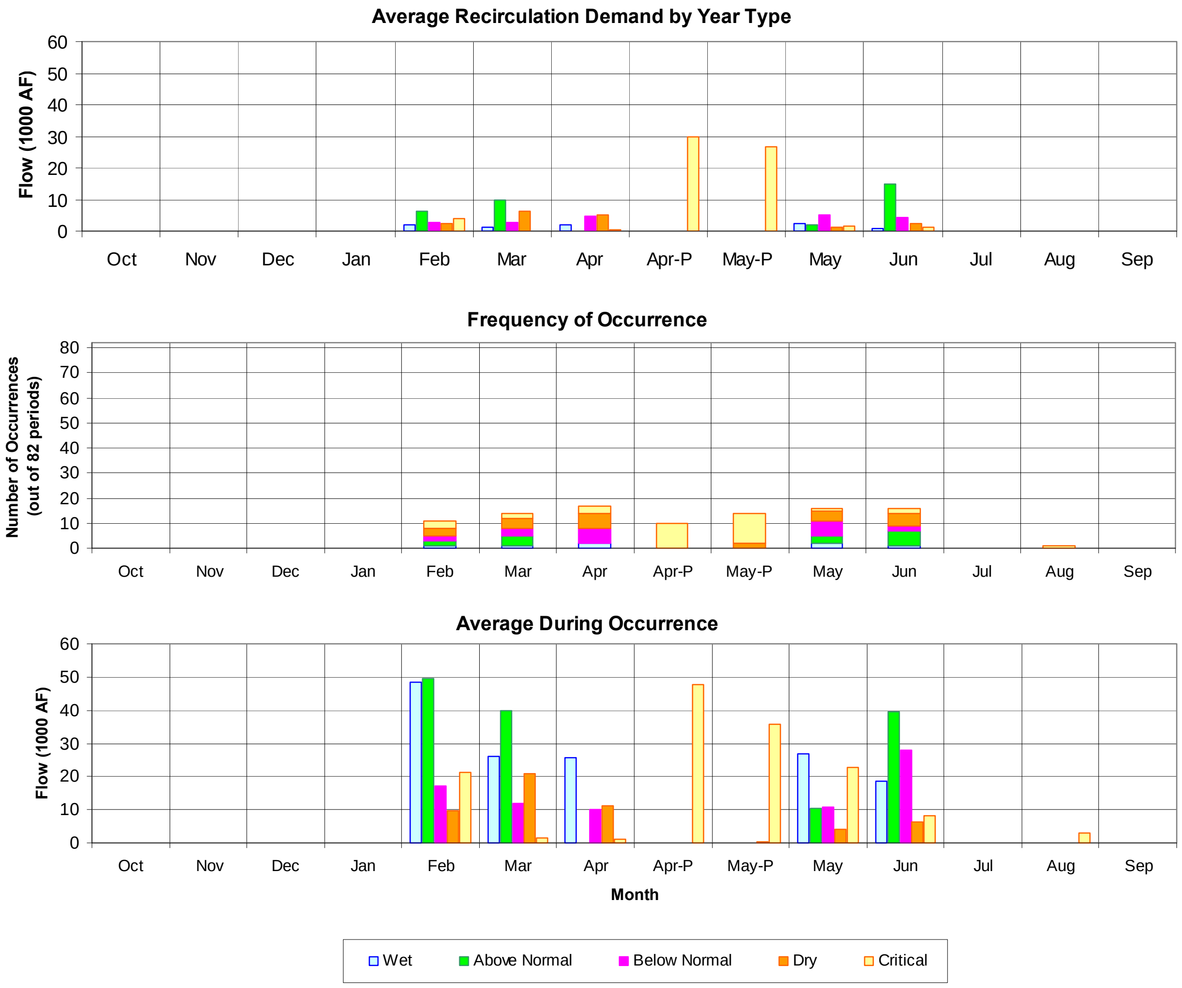


Figure A-11. Existing Level of Development Monthly Demand for Recirculation Condition 1

Figure A-12 shows the unconstrained annual recirculation demand for existing conditions, under the existing LOD, where use of recirculation towards meeting Vernalis flow and quality objectives is operated prior to New Melones releases under Alternative A2. The annual average demand of this circumstance is 132,000 AF. As shown on the figure, large amounts of recirculation are required to meet water quality objectives during certain conditions (e.g., Water Year 1924). These demands are due to DMC water quality being only slightly below the Vernalis water quality objective. To meet the water quality standard, water from the DMC would need to essentially equal the SJR's entire flow at Maze. Condition 1 was developed to address this unreasonable use of water.

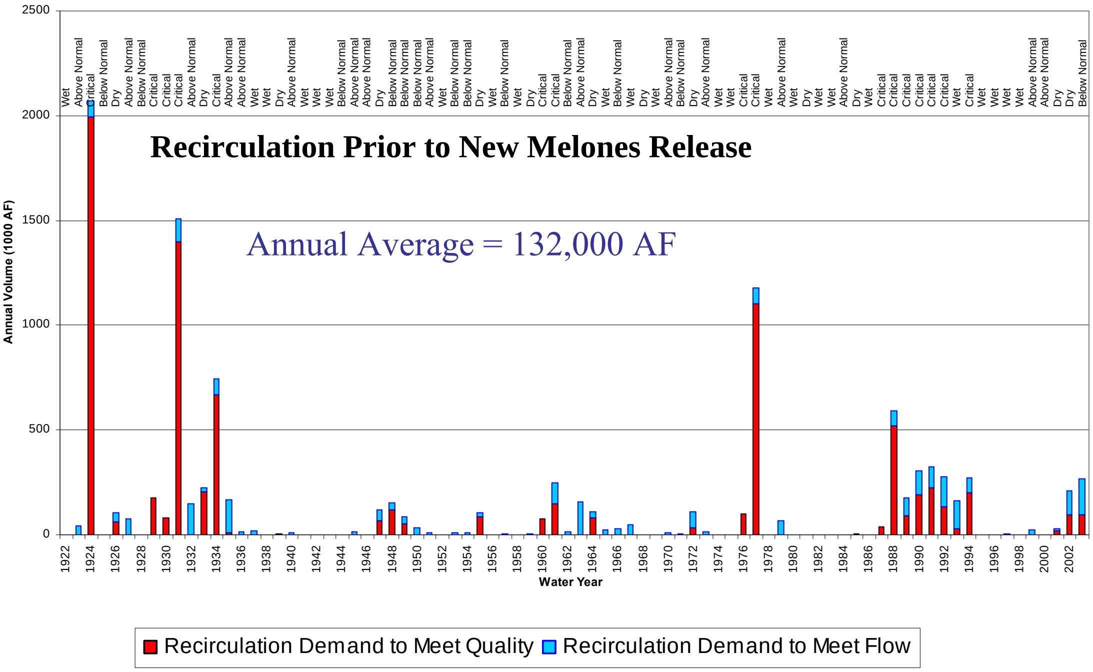


Figure A-12. Unconstrained Demand for Recirculation under Existing Level of Development

Figure A-13 shows the annual recirculation demand after applying the Condition 1 filter and where use of recirculation towards meeting Vernalis flow and quality objectives is operated prior to New Melones releases. The annual average demand of this circumstance is 52,000 AF. **Figure A-14** presents this demand on an average monthly basis by water year type. **Figure A-14** also displays the frequency of monthly demand for recirculation by year type and the average monthly demand when demand exists.

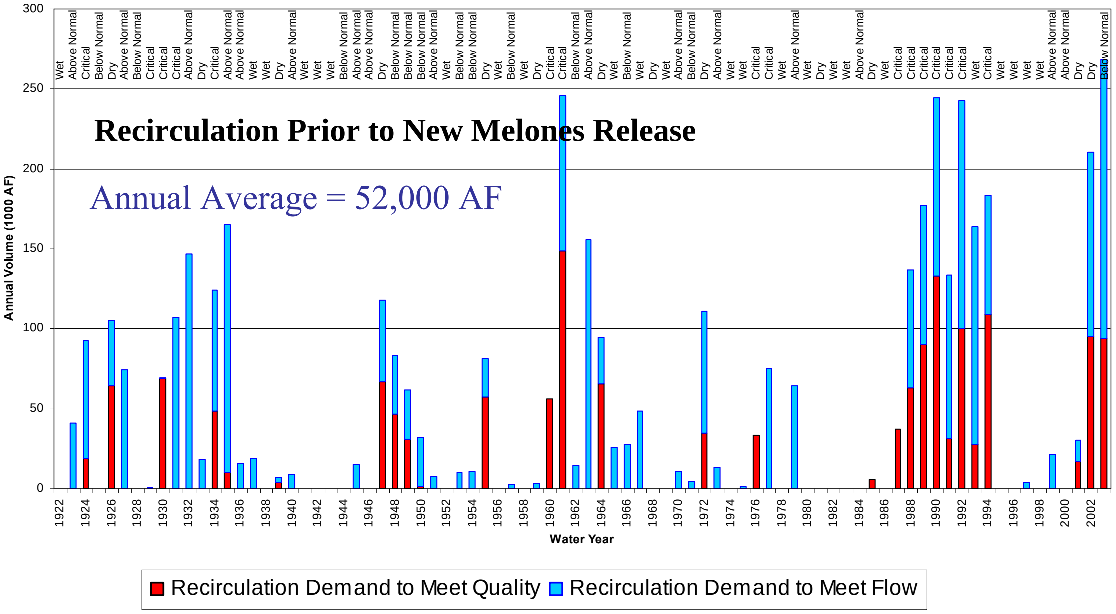


Figure A-13. Annual Demand for Recirculation under Existing Level of Development for Recirculation Prior to New Melones Release Condition 1

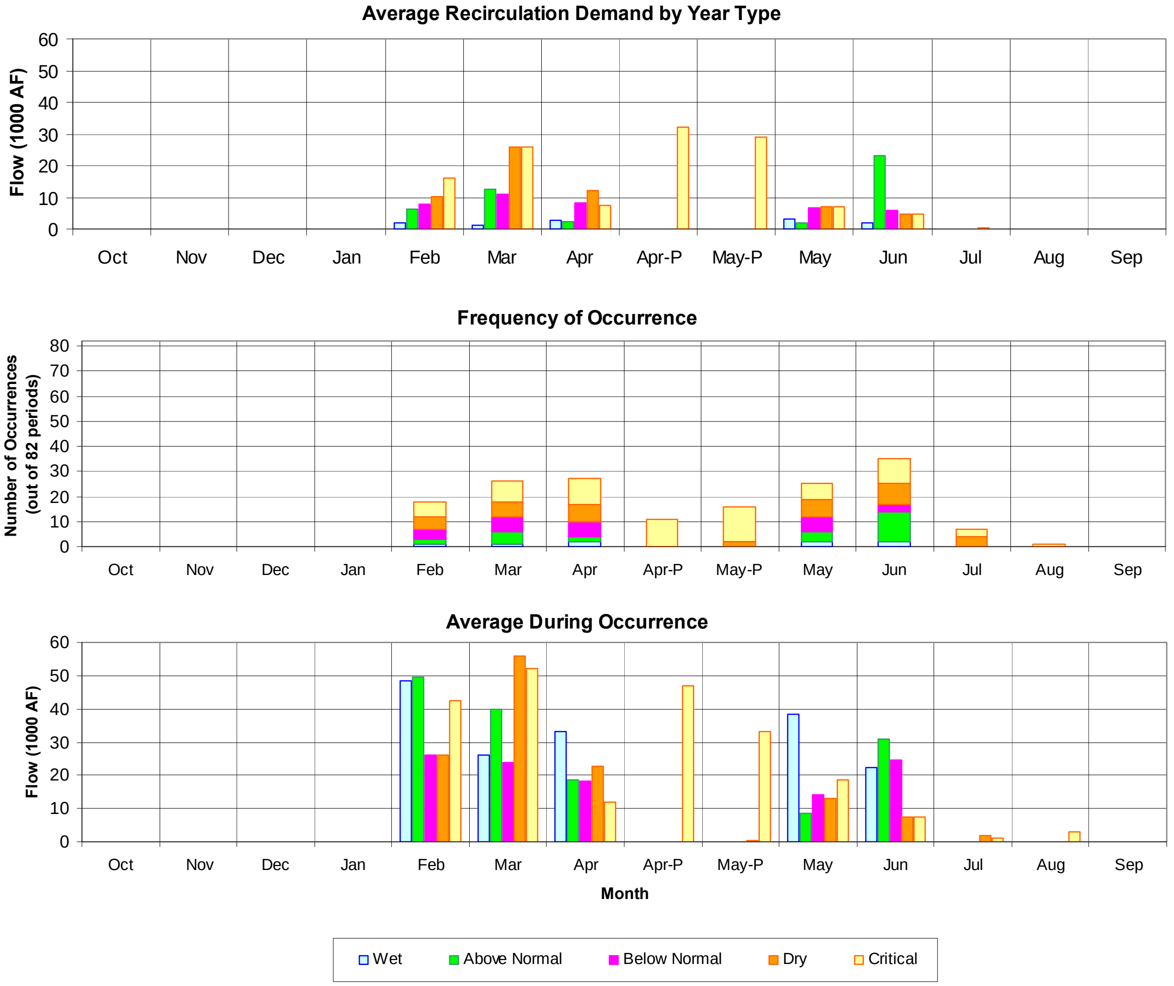


Figure A-14. Monthly Demand for Recirculation under Existing Level of Development for Recirculation Prior to New Melones Release Condition 1

Currently, releases from New Melones Reservoir are explicitly made towards meeting water quality and flow objectives in the SJR at Vernalis. As demonstrated by the comparison of results shown above for the two calculations of Condition 1 constrained recirculation demand, use of recirculation towards meeting objectives at Vernalis could lead to a reduction in release requirements from New Melones for Vernalis purposes. This reduction in releases from New Melones could increase Stanislaus River water supply allocations under the IPO, including additional allocations to CVP Stanislaus River contractors and allocations to streamflow purposes. **Figure A-15** displays the maximum possible decrease in Stanislaus River release for water quality purposes, assuming recirculation can replace all the existing Stanislaus River releases. **Figure A-16** contains the same form of information for the maximum possible decrease in Stanislaus River release for Vernalis flow purposes.

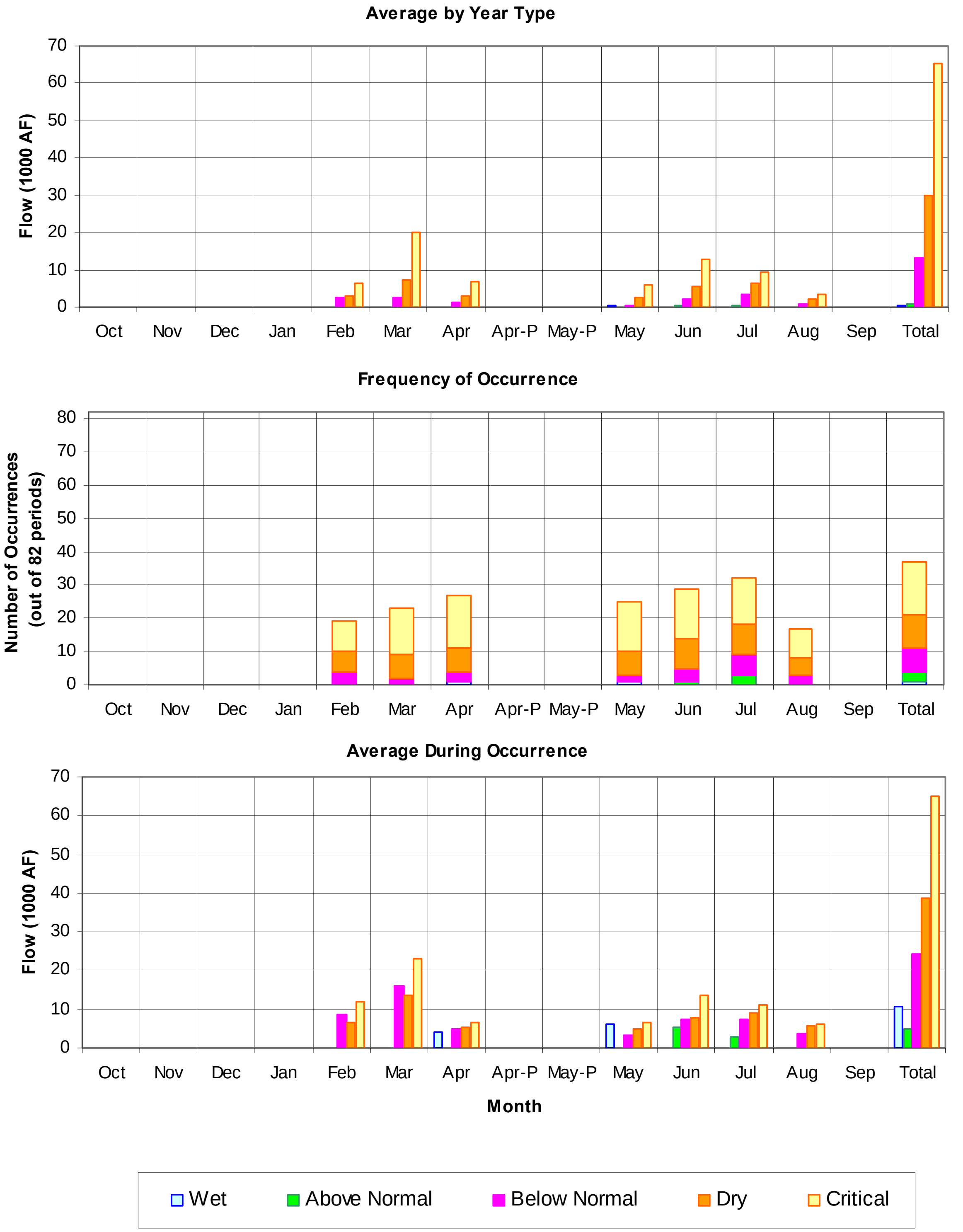


Figure A-15. New Melones Release for Vernalis Water Quality under Existing Level of Development Condition 1

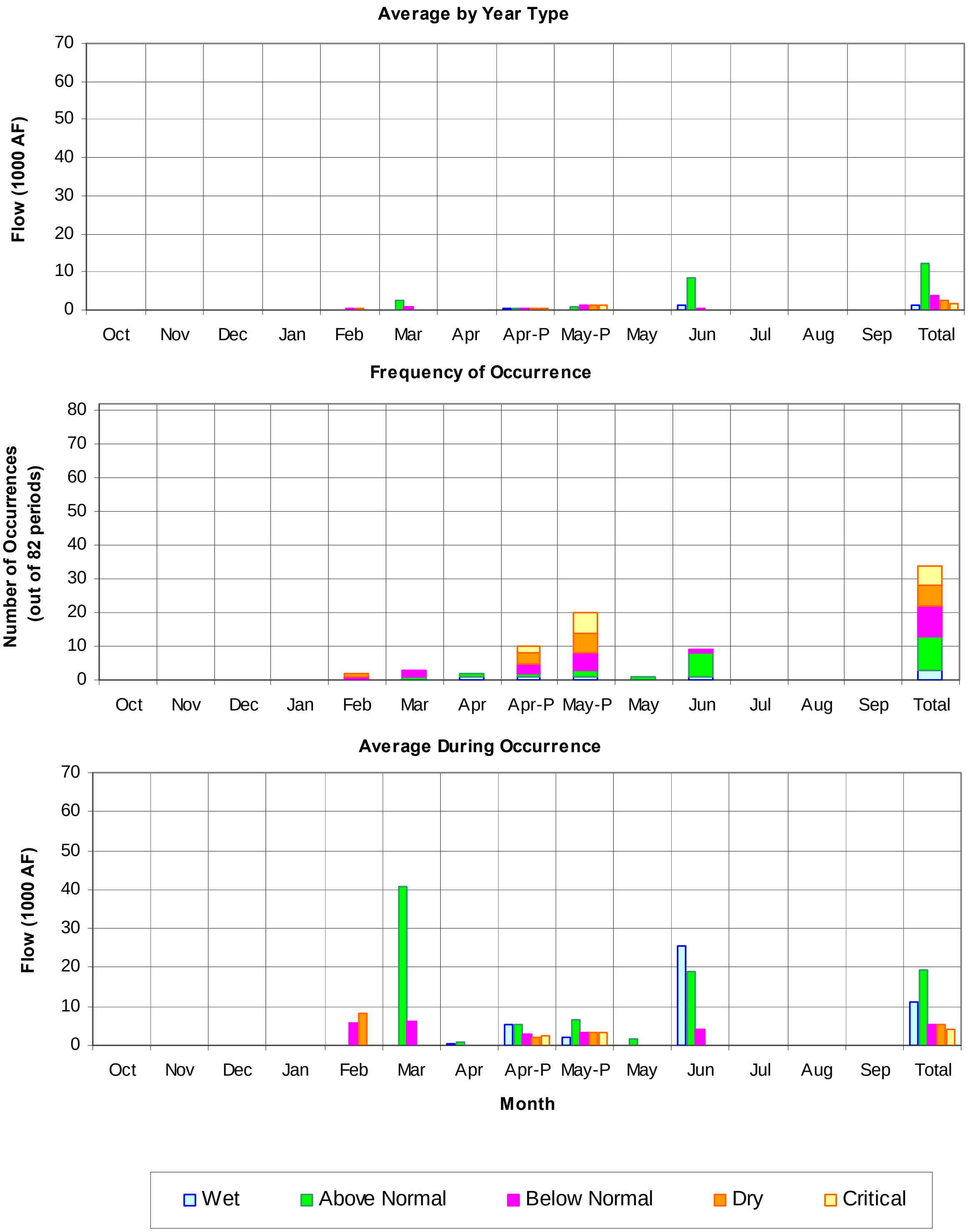


Figure A-16. New Melones Release for Vernalis Flow under Existing Level of Development Condition 1

A.3.3 Future Level of Development

Figure A-17 shows the unrestrained annual recirculation demand for the No-Action Alternative conditions, under the 2030 future LOD, where demands are considered supplemental to New Melones releases under the IPO. The annual average demand is 31,000 AF.

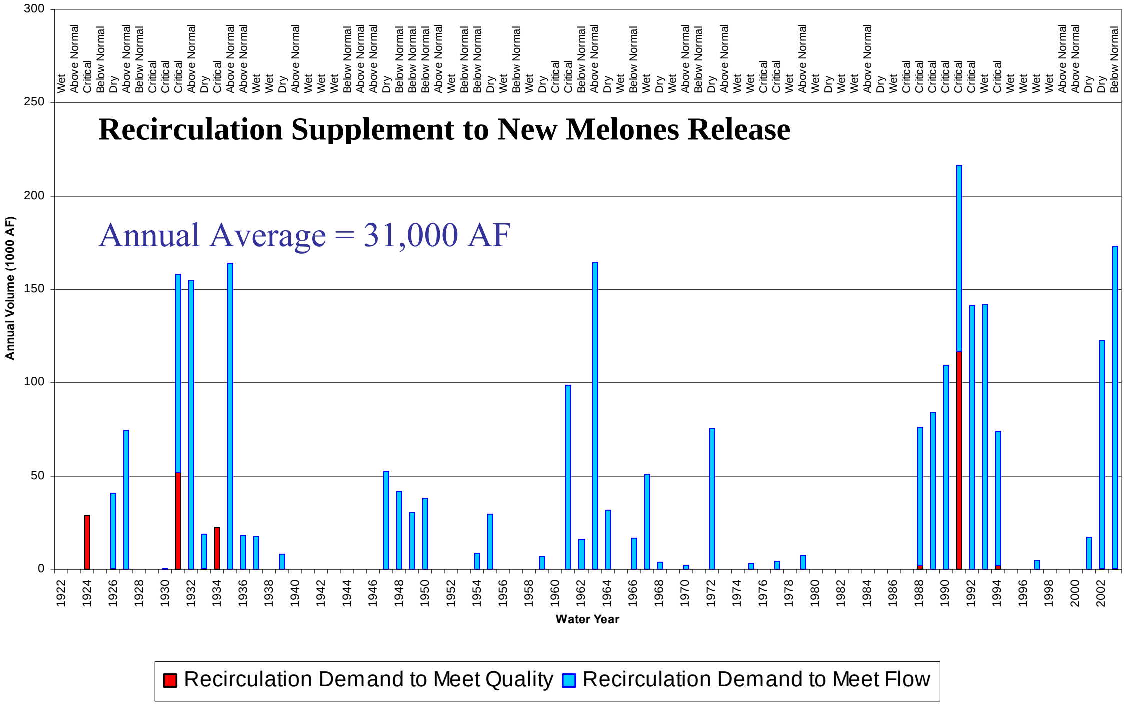


Figure A-17. Unconstrained Annual Demand for Recirculation under Future Level of Development

Figure A-18 shows the annual recirculation demand for the No-Action Alternative conditions after applying the Condition 1 filter and where demands are considered supplemental to New Melones releases under the IPO. The annual average demand is 28,000 AF. **Figure A-19** represents this demand on an average monthly basis by water year type. **Figure A-19** also displays the frequency of monthly demand for recirculation by year type and the average monthly demand when demand exists. The Condition 1 filter allows for a conservative buffer. **Section A7 (under development)** provides an analysis of the sensitivity of this analysis to the Condition 1 assumptions

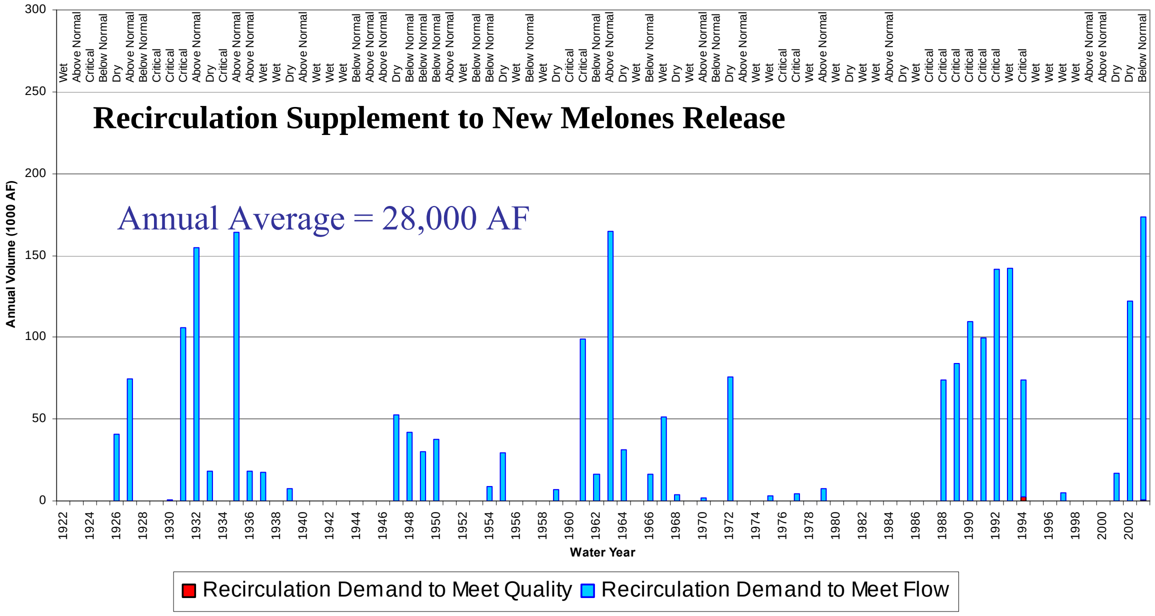


Figure A-18. Annual Demand for Recirculation under Future Level of Development Condition 1

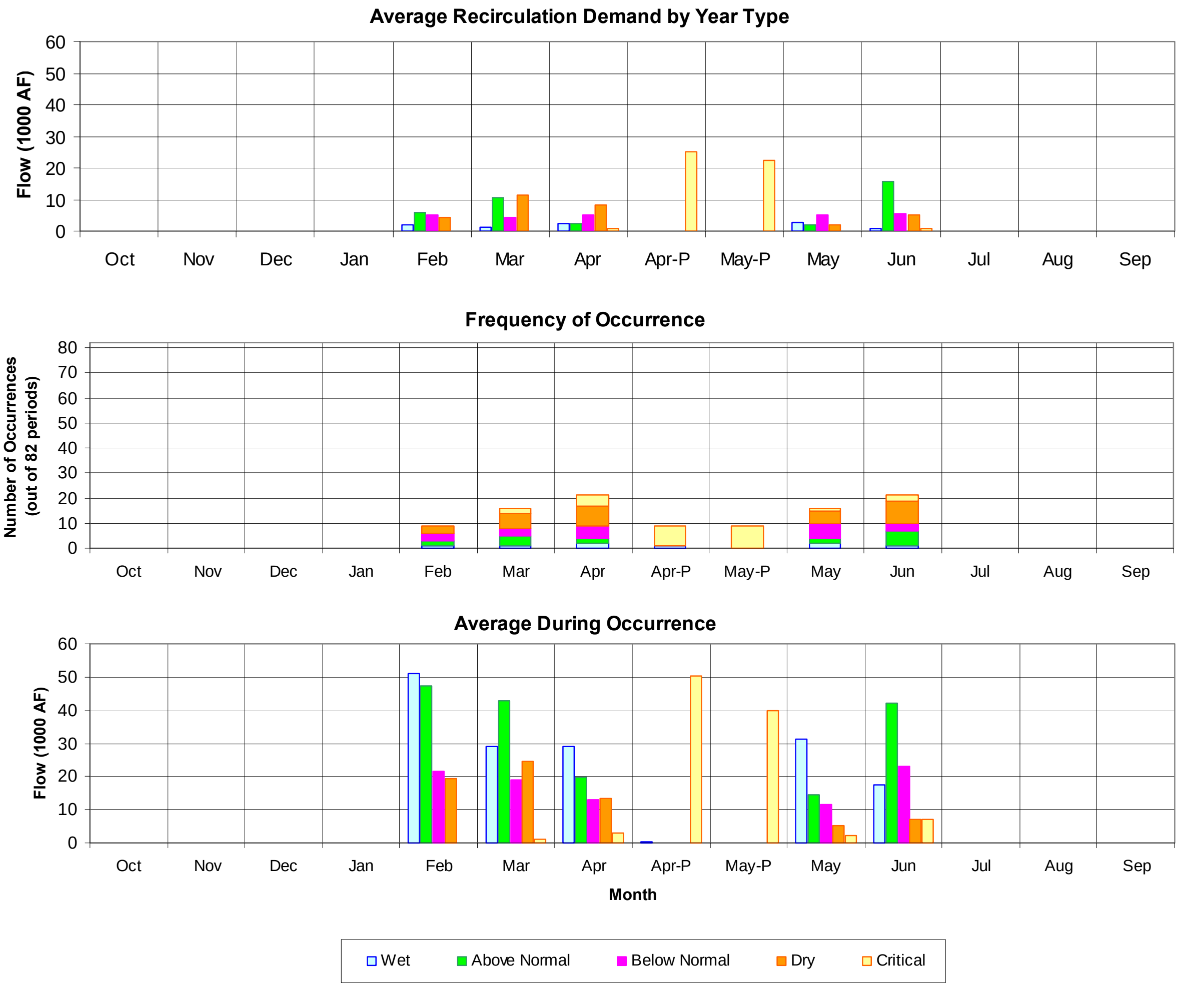


Figure A-19. Monthly Demand for Recirculation under Future Level of Development Condition 1

Similarly, **Figure A-20** shows the unconstrained annual recirculation demand for the No-Action Alternative conditions, under the 2030 future LOD, where use of recirculation toward meeting Vernalis objectives is operated prior to New Melones releases. The annual average demand is 68,000 AF.

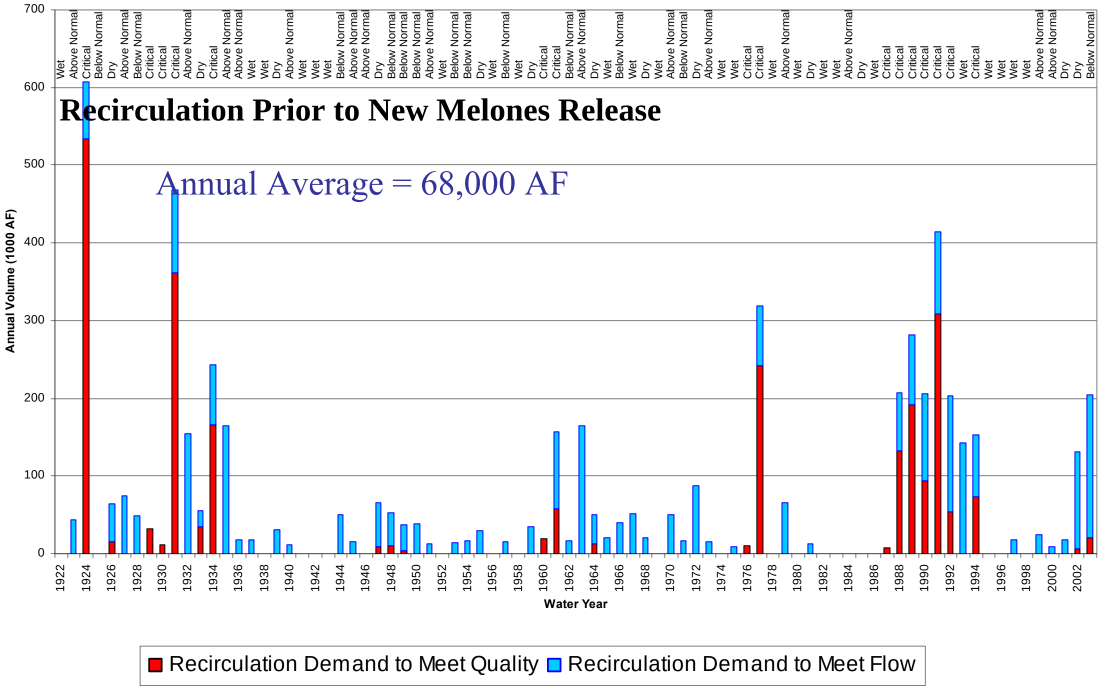


Figure A-20. Future Level of Development Unconstrained Annual Demand for Recirculation

Figure A-21 shows the annual recirculation demand for the No-Action Alternative conditions after applying the Condition 1 filter, where use of recirculation toward meeting Vernalis objectives is operated prior to New Melones releases. The annual average demand is 45,000 AF. **Figure A-22** illustrates this demand on an average monthly basis by water year type. **Figure A-22** also displays the frequency of monthly demand for recirculation by year type and the average monthly demand when demand exists.

In comparison to the current environmental setting, demand is reduced for the need for recirculation towards meeting the Vernalis water quality standard and a slight increase in demand for the flow objective. This change is due to removal of Grassland Bypass Project discharges. The removal of Grassland Bypass Project discharges improves the underlying water quality in the SJR; however, at the same time reduces flow in the SJR.

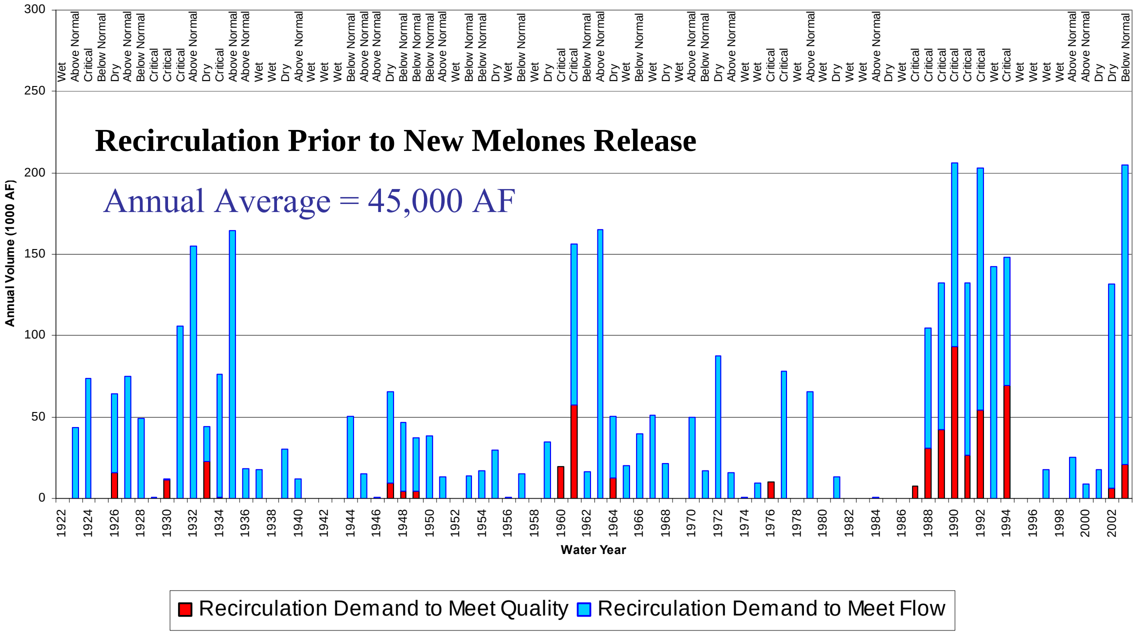


Figure A-21. Future Level of Development Annual Demand for Recirculation Condition 1

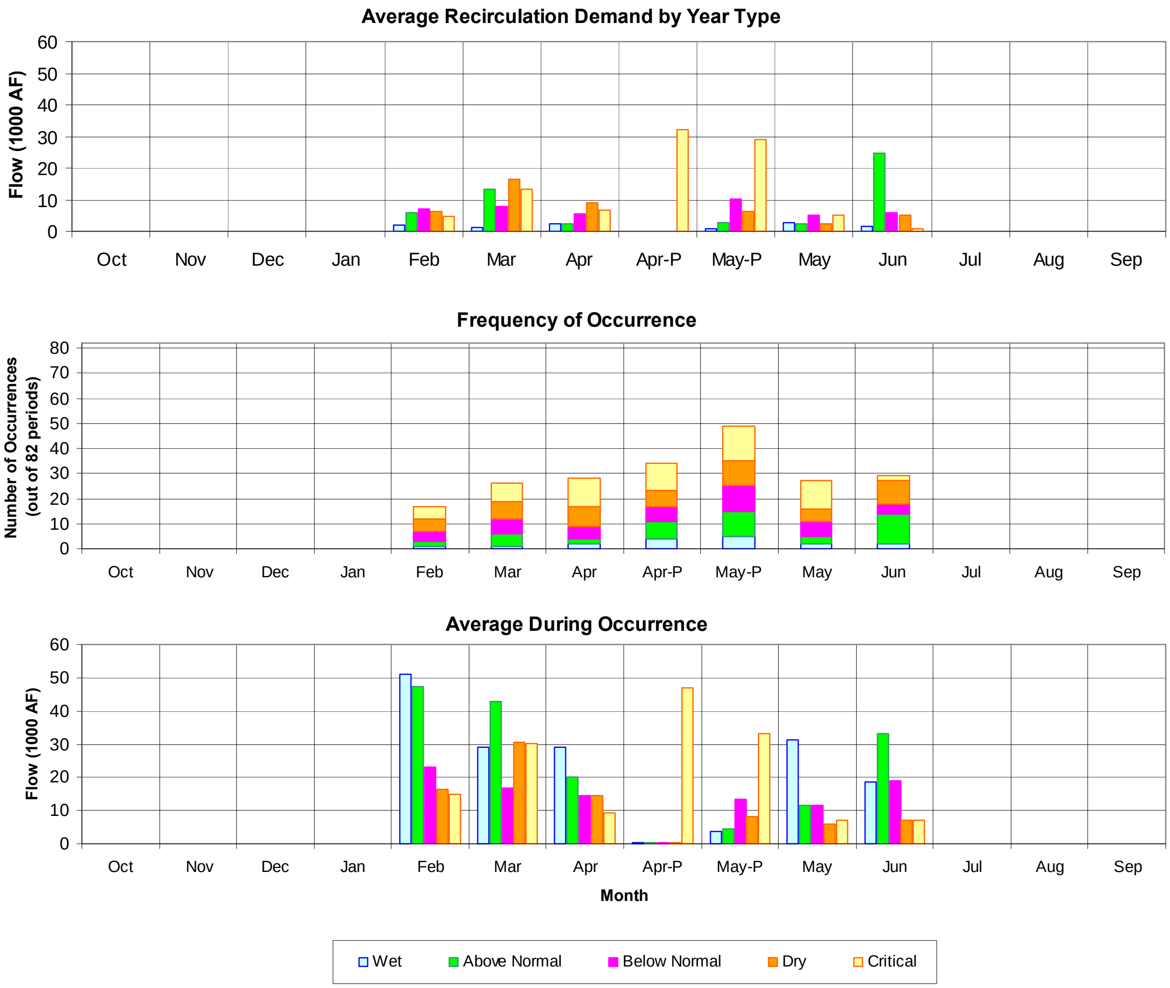


Figure A-22. Future Level of Development Monthly Demand for Recirculation Prior to New Melones Release Condition 1

A.4 Available Water Supply for Recirculation

Section A3 described the underlying demand for recirculation to meet flow and water quality objectives including constraint by water quality filtering. The amount of water supply available for recirculation is also constrained by additional factors such as the availability of capacity to provide water from the CVP/SWP export facilities. Water can be made available for recirculation by: (1) using excess capacity at Jones Pumping Plant, (2) using available water stored in CVP San Luis Reservoir, (3) using excess capacity at Banks Pumping Plant, and (4) placing demand for recirculation above CVP Delta export agricultural and municipal and industrial (M&I) contract deliveries. The extent of the use of these various means to meet recirculation demands distinguishes each alternative plan.

A.4.1 Excess Jones Pumping Plant Pumping

Jones Pumping Plant consists of an inlet channel, pumping plant, and discharge pipes. Water in the Delta is lifted 197 feet into the DMC. Each of the pumps is powered by a 25,000-horsepower motor. Power is supplied by CVP power plants to operate the pumps. The water is pumped through three 15-foot-diameter discharge pipes and carried about 1 mile up to the DMC.

The six pumps have capacities ranging from 800 to 990 cubic feet per second (cfs). Jones Pumping Plant has the physical capacity to pump 4,880 cfs, the nominal capacity of the DMC at the pumping plant. **Table A-3** shows various pumping rates based on the number of pumps operating and whether the siphons are opened or closed. Jones Pumping Plant capacity would be reduced if one or more of the pumps are in forced or planned outage or are reduced for Endangered Species Act concerns; such events are not incorporated into this analysis.

Table A-3. Capacity Ratings of Jones Pumping Plant Pumps

<table>
<tr><th rowspan="3">Siphons</th><th colspan="6">Pumping Capacity Under Available Pump Combinations (cfs)</th><th rowspan="3">No. of Units Running</th></tr>
<tr><th colspan="2">West Tube</th><th colspan="2">Center Tube</th><th colspan="2">East Tube</th></tr>
<tr><th>One</th><th>Two</th><th>Three</th><th>Four</th><th>Five</th><th>Six</th></tr>
<tr><td>Open</td><td>800</td><td>940</td><td>940</td><td>800</td><td>900</td><td>750</td><td rowspan="2">one</td></tr>
<tr><td>Closed</td><td>850</td><td>990</td><td>990</td><td>850</td><td>950</td><td>800</td></tr>
<tr><td>Open</td><td colspan="2">1,650</td><td colspan="2">1,650</td><td colspan="2">1,600</td><td rowspan="2">two</td></tr>
<tr><td>Closed</td><td colspan="2">1,790</td><td colspan="2">1,790</td><td colspan="2">1,600</td></tr>
<tr><td>Open</td><td colspan="3">2,580</td><td colspan="3">2,350</td><td rowspan="2">three</td></tr>
<tr><td>Closed</td><td colspan="3">2,680</td><td colspan="3">2,500</td></tr>
<tr><td>Open</td><td colspan="4">3,330</td><td colspan="2" rowspan="2">▨</td><td rowspan="2">four</td></tr>
<tr><td>Closed</td><td colspan="4">3,530</td></tr>
<tr><td>Open</td><td colspan="2" rowspan="2">▨</td><td colspan="4">3,240</td><td rowspan="2">four</td></tr>
<tr><td>Closed</td><td colspan="4">3,440</td></tr>
<tr><td>Open</td><td rowspan="2">▨</td><td colspan="5">4,130</td><td rowspan="2">five</td></tr>
<tr><td>Closed</td><td colspan="5">4,380</td></tr>
<tr><td>Open</td><td rowspan="2"></td><td rowspan="2">▨</td><td colspan="4">4,000</td><td rowspan="2">five</td></tr>
<tr><td>Closed</td><td colspan="4">4,240</td></tr>
<tr><td>Open</td><td colspan="6">4,680</td><td rowspan="2">six</td></tr>
<tr><td>Closed</td><td colspan="6">4,880</td></tr>
</table>

Key:

cfs= cubic feet per second
no.= number

Delta Mendota Canal Capacity

DMC capacity at Checks 3 and 6, with capacities of about 4,300 and 4,200 cfs, respectively, often restrict pumping at Jones Pumping Plant. The pumping rate at the plant is determined by the water-surface elevation in the DMC and the rate at which Jones Pumping Plant pumping occurs is generally limited to the downstream flow capacity plus the amount of canal-side deliveries occurring in the reaches above the constrictions. Full continuous operation of the 6 units at Jones Pumping Plant is not possible unless canal-side demands exceed 400 cfs upstream of Check 6. When canal-side demands downstream from Check 6 result in a decrease in water-surface elevation at Check 6, pumping at Jones Pumping Plant can be increased. The locations of the wasteways used for recirculation are in the upper DMC and, when canal-side demands are low, excess capacity, up to 400 cfs, is available for recirculation.

For “excess capacity” to exist at Jones Pumping Plant the facility must have unused physical capacity, unused capacity must be available based on regulatory standards, and the use of Jones Pumping Plant for recirculation must not increase the risk of reduction in CVP deliveries. Regulatory standards considered when determining excess capacity at Jones Pumping Plant are SWRCB D-1641 and implementation of Public Law 102-575 Section 3406(b)(2). **Figure A-23** illustrates exceedance probability plots of available Jones Pumping Plant capacity for periods when recirculation demands exist.

A.4.2 Use of Available Water in CVP San Luis Reservoir

San Luis Reservoir is located in the eastern part of the Diablo Range, approximately 12 miles west of the city of Los Banos. SWP and CVP jointly operate the 2,039,000-AF reservoir and associated facilities. The total available storage within San Luis Reservoir for CVP operations is 971,000 AF.

In this analysis, for water to be available in San Luis Reservoir for recirculation without impact to water deliveries water supply allocation to CVP contractors must be 100 percent and the San Luis Reservoir low point must be above the acceptable level (369 feet). If either of these two conditions does not exist, use of stored water in San Luis Reservoir will either directly impact water deliveries or increase the risk of delivery reductions.

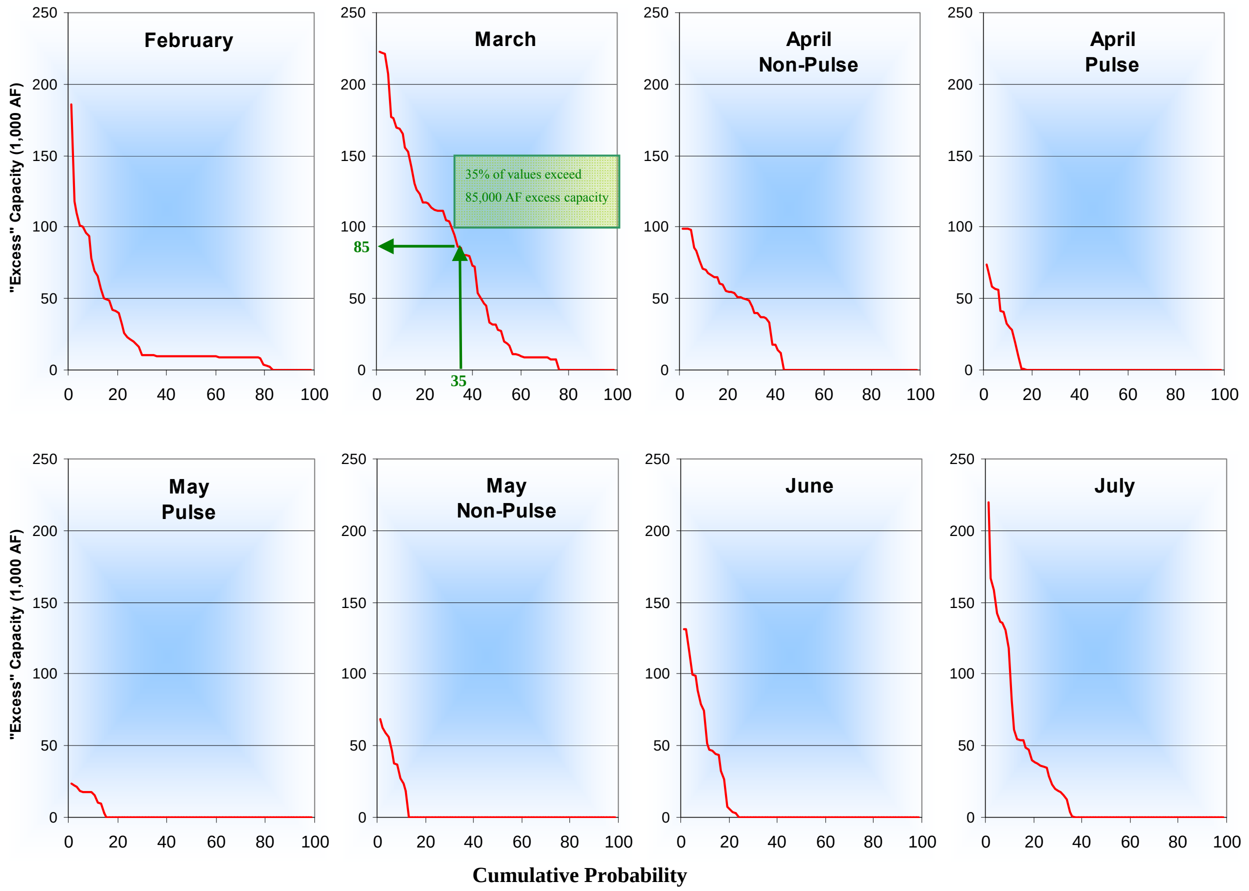


Figure A-23. Monthly Cumulative Probability of Excess Jones Pumping Plant Capacity

Figure A-24 illustrates modeled CVP water supply allocations and the CVP San Luis Reservoir annual low point. Years where deliveries are 100 percent and a coincidental low point is high enough to support recirculation occur only in wetter years where both Delta flows and SJR flows are high. In these wetter years typically no demand for recirculation occurs. Therefore, results indicate that although water supply in San Luis Reservoir may be available for recirculation in certain circumstances, use of San Luis Reservoir for recirculation in the operational scenario of no impact to CVP users is not needed.

For at least one alternative plan analyzed for this project, recirculation demands are met in higher priority than CVP Delta export deliveries and operations are changed to accommodate recirculation. Because the wasteways used for recirculation are upstream, or up canal, from O'Neill Forebay, it is not possible to release water from San Luis Reservoir directly to the SJR for recirculation. However, by use of water pumped at Jones or Banks pumping plants that would have otherwise been integrated into a San Luis Reservoir operation for CVP deliveries, San Luis Reservoir operation will be affected by recirculation.

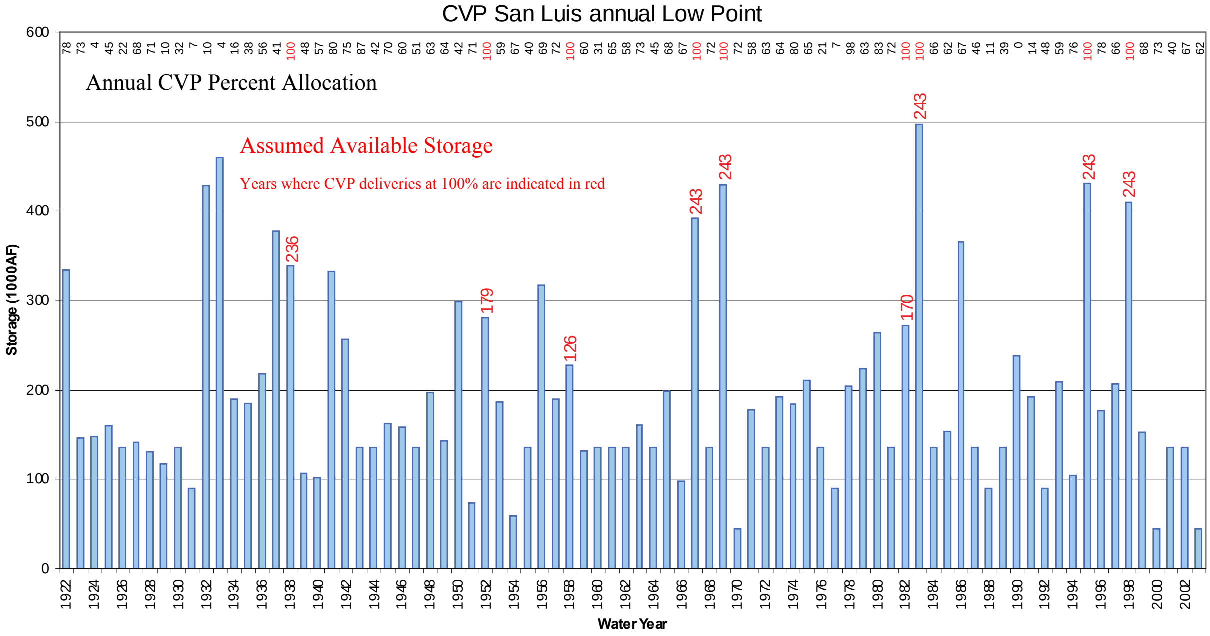


Figure A-24. Available CVP San Luis Storage

A.4.3 Use of Excess Banks Pumping Plant Capacity

Banks Pumping Plant is located 2.5 miles southwest of Clifton Court Forebay and 11.5 miles northeast of Livermore, California. The plant is the first pumping plant for the California Aqueduct and the South Bay Aqueduct with a design capacity of 10,670 cfs. Banks Pumping Plant initially flows into the Bethany Reservoir, where the South Bay Aqueduct begins, and continues south past O’Neil Forebay and San Luis Reservoir to Dos Amigos Pumping Plant.

For excess capacity to exist at Banks Pumping Plant the following three criteria must occur: (1) unused physical capacity, (2) available unused capacity based on regulatory standards, and (3) use of Banks Pumping Plant for recirculation must not adversely affect SWP operations. In addition to regulatory standards, Banks Pumping Plant’s capacity is reserved for Phase 8 water transfers and Article 55 transfers. Regulatory standards considered when determining excess capacity at Banks Pumping Plant are those contained in SWRCB D-1641.

Due to the location of the wasteways used for recirculation, it is not possible for water pumped at Banks Pumping Plant to be directly released to the SJR. However, pumping at Banks Pumping Plant can be used to satisfy CVP demands for Delta export storage and delivery that would otherwise be met from Jones Pumping Plant (similar to Joint Point of Diversion). In each alternative plan evaluated, excess capacity at Jones Pumping Plant is used prior to use of Banks Pumping Plant.

Figure A-25 illustrates cumulative probability plots of available Banks Pumping Plant capacity for periods when demands for recirculation exist.

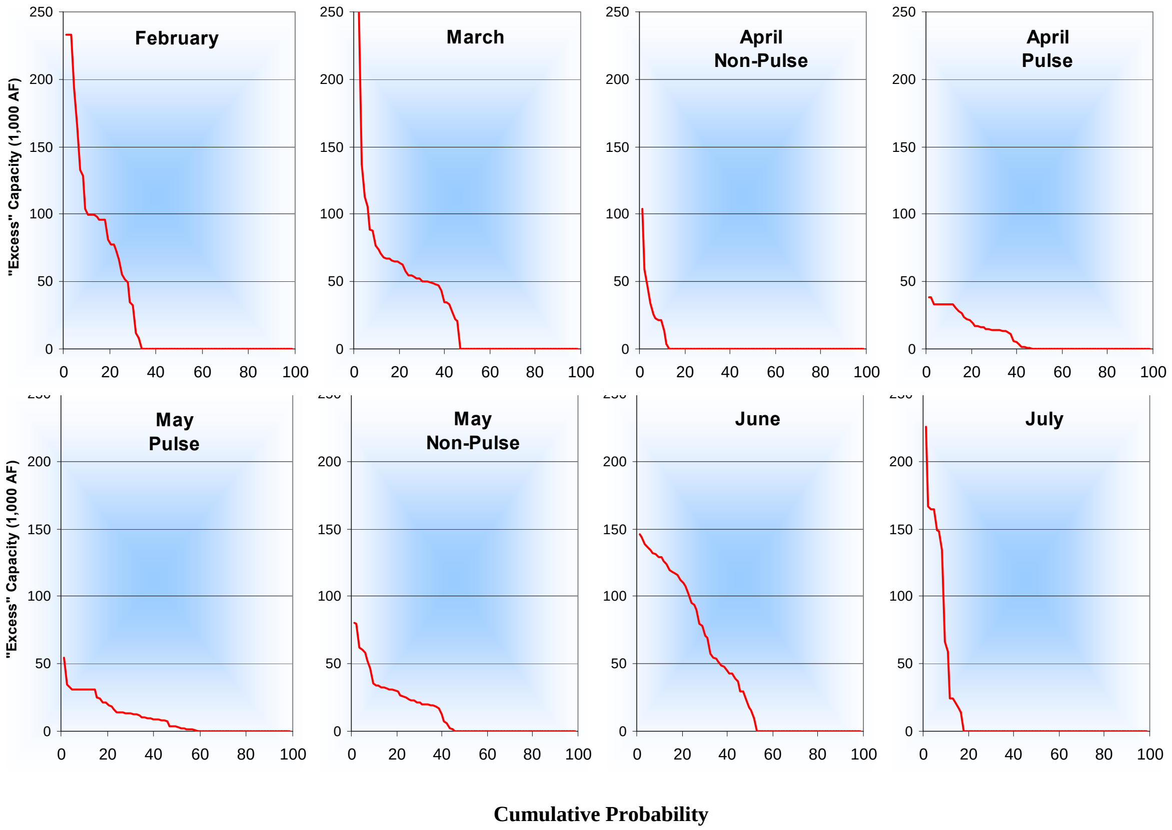


Figure A-25. Monthly Cumulative Probability of Excess Banks Pumping Plant Capacity

A.4.4 Recirculation Priority above CVP Delta Export Agricultural Service and M&I Contract Deliveries

When excess capacity at both Jones and Banks pumping plants is insufficient to meet demand for recirculation, it is possible to give demand for recirculation a priority over CVP Delta export agricultural service and M&I contractor deliveries. Due to the location of the wasteways used for recirculation, Jones Pumping Plant provides the only source of water that can physically be used for recirculation. For this reason, pumping at Jones Pumping Plant limits the maximum rate that deliveries may be reduced to meet recirculation demands. Another limiting factor is CVP Delta export water supply allocations: in some of the extreme drought years CVP deliveries are very low and it may not be possible to reduce deliveries to provide supply water for recirculation. It is assumed that releases from CVP reservoirs north of the Delta are not made in support of recirculation.

A.5 Evaluation of Alternative Plans

A.5.1 Description of Alternative Plans

The DMC Project Team refined the alternatives described in the Initial Alternatives Information Report to develop a short list of alternative plans for analysis in the PFR. That report presented three main alternatives based on the specific overall planning objective they serve or major facilities they use. These main alternatives were:

- Alternative 1 – Supplement Current Operation - Recirculation flows are added on top of New Melones releases, which typically remain at current levels.
- Alternative 2 – CVP Alone - Only Jones Pumping Plant is used for recirculation flows or to place water in storage.
- Alternative 3 – Enhance New Melones Water Supply - New Melones releases are added as necessary on top of recirculation flows.

Each of these main alternative plans contained either two or five operational scenarios. The operational scenarios varied in the priority for use of the facilities to transport water for recirculation in relation to other existing uses and were designed to optimize a particular planning objective such as achieving water quality standards or minimizing impacts to Westside CVP contractors.

Preliminary screening of these alternative plans was conducted using post-processing of CalSim II results and sequential CalSim II studies to determine the need for recirculation and the availability of facilities to supply water. These preliminary analyses were used to guide the team in refining the alternatives and selecting those for further analysis in the PFR. The alternative plans presented on **Figure A-26** are analyzed in the PFR.

Alternative A1 – *Supplement Vernalis compliance using available Jones Pumping Plant capacity.* This alternative plan uses only available capacity at Jones Pumping Plant to supplement explicit New Melones flow and water quality releases. No changes in water supply for either CVP Delta export or New Melones water users would occur.

Alternative A2 – *Enhance New Melones water supply and Vernalis compliance using available Jones capacity.* This alternative plan is similar to Alternative A1 except recirculation water is released prior to explicit New Melones releases for Vernalis flow and water quality purposes. This scenario can result in reduced demand from New Melones for Delta releases (to the extent that recirculation water is available) and increased water for New Melones water users. Because only available capacity at Jones Pumping Plant is used, no major changes in

CVP Delta export water supply would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones Pumping Plant.

A

Federal Facilities Only

- Excess Jones PP
- No CVP/SWP impact

A1
Supplement Vernalis Compliance

- Supplemental to New Melones release

A2
Supplement Vernalis Compliance and Enhance New Melones Water Supply

- Prior to New Melones release

B

Federal and State Facilities

- Excess Jones PP
- Excess Banks PP

B1
Supplement Vernalis Compliance

- Supplemental to New Melones release

B2
Supplement Vernalis Compliance and Enhance New Melones Water Supply

- Prior to New Melones release

C

Federal and State Facilities

Limited Reduction of CVP Deliveries

- Excess Jones PP for Vernalis flow and water quality
- Excess Banks PP for Vernalis flow and quality
- CVP facilities then used for recirculation for Vernalis flow in priority to CVP Delta export deliveries
- Prior to New Melones release

D

Federal and State Facilities

Recirculation Priority to CVP Deliveries

- Excess Jones PP and Banks PP used first for Vernalis flow and quality
- CVP facilities then used for recirculation for Vernalis flow and quality in priority to CVP Delta export deliveries
- Prior to New Melones release

Key:
CVP = Central Valley Project
PP = Pumping Plant
SWP = State Water Project

Figure A-26. Alternative Plans Analyzed in the PFR

Alternative B1 – *Supplement Vernalis compliance using available Jones/Banks pumping plant capacity*. This alternative plan is similar to Alternative A1 except that pumping from Banks Pumping Plant is added when capacity is available. Recirculation flow supplements New Melones releases (i.e., no changes in New Melones operations). No changes in water supply for either CVP Delta export or New Melones water users would occur.

Alternative B2 – *Enhance New Melones water supply and Vernalis compliance using available Jones/Banks pumping plant capacity*. This alternative plan is similar to Alternative A2 except that pumping from Banks Pumping Plant is added when capacity is available. Water is released prior to explicit New Melones Delta releases, which may result in enhanced New Melones water supply. No major changes in CVP Delta export water supply would occur.

Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

Alternative C – *Limited Reduction of CVP Delta export Deliveries for enhanced New Melones water supply and Vernalis compliance using Jones/Banks pumping plants.* This alternative plan is similar to Alternative D (below) except that recirculation water that could affect CVP Delta export deliveries would only be used only to comply with Vernalis flow requirements in SJR. Recirculation could occur for water quality compliance if it was determined to be available at Banks/Jones pumping plants without affecting to deliveries. Recirculation flow would be released prior to explicit New Melones Delta Releases to enhance New Melones water supply. Jones Pumping Plant would be used as needed to contribute to flow compliance and water supply benefits to New Melones. Reductions in CVP Delta export water contractor deliveries would be less than those under Alternative D. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

Alternative D – *Reduced CVP Delta export Deliveries to enhance New Melones water supply and Vernalis compliance using Jones/Banks pumping plants.* This alternative plan would use recirculation, as needed, to attempt to provide compliance with Vernalis water quality objectives and enhance New Melones water supply. Recirculation water would be released prior to explicit New Melones Delta releases for flow and water quality objectives, resulting in additional water supply in New Melones. Reductions in CVP Delta export water contractor deliveries would occur. No major changes to SWP deliveries would occur. Some minor reductions in Delta exports are required to maintain Delta inflow and export ratios because recirculation water would not count as Delta inflow water as it is recaptured at Jones or Banks pumping plants.

A.6 Analytical Results

Water operations analyses have been performed for Alternatives A1 through D for both the existing LOD and the future LOD (**Attachment A1**). Results from these water operations analyses are presented with increasing level of detail, beginning with a general summary and ending with month-to-month water operations details.

A.6.1 Results Summary

Recirculation may occur each year beginning in February and is generally not used after June in each alternative plan. For the purpose of this analysis the months of April and May have been separated into pulse (Apr-P and May-P) and nonpulse (Apr and May) periods to capture the difference in operation for the Vernalis Adaptive Management Plan (VAMP) and non-VAMP periods. **Table A-4** contains average monthly and annual recirculation for the existing LOD and **Table A-5** contains average monthly and annual recirculation for the future LOD. Results for both levels of development are similar, with the main difference being a decrease in use of recirculation to meet water quality objectives for the future LOD due to the removal of the Grasslands Bypass Project discharge.

Table A-4. Existing Level of Development Average Recirculation (1,000 AF)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Apr-P	May-P	May	Jun	Jul	Aug	Sep	Total
A1	0	0	0	0	1	2	0	0	0	0	1	0	0	0	5
A2	0	0	0	0	2	4	1	0	0	0	2	0	0	0	10
B1	0	0	0	0	2	3	0	1	1	1	3	0	0	0	11
B2	0	0	0	0	3	5	1	1	1	1	5	0	0	0	18
C	0	0	0	0	5	6	3	2	4	2	7	0	0	0	30
D	1	0	0	0	6	11	4	2	4	3	7	0	0	0	40

Key:

AF = acre-feet
Apr-P and May-P = pulse periods
Apr and May = nonpulse periods

Table A-5. Future Level of Development Average Recirculation (1,000 AF)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Apr-P	May-P	May	Jun	Jul	Aug	Sep	Total
A1	0	0	0	0	1	3	1	0	0	0	2	0	0	0	7
A2	0	0	0	0	2	4	1	0	0	0	2	0	0	0	9
B1	0	0	0	0	2	4	1	0	1	1	3	0	0	0	12
B2	0	0	0	0	3	4	1	1	1	1	5	0	0	0	16
C	0	0	0	0	4	6	4	2	3	2	7	0	0	0	28
D	0	0	0	0	5	9	4	2	3	2	7	0	0	0	32

Key:

AF = acre-feet
Apr-P and May-P = pulse period
Apr and May = nonpulse periods

A.6.2 Analysis of Results

Frequency and magnitude of recirculation and effects to the SJR at Vernalis are presented in the form of monthly exceedance probability plots for both existing and future LODs. Monthly exceedance probability plots are only presented for months when recirculation is used to satisfy needs in the SJR at Vernalis. Again, April and May have been separated into pulse and nonpulse periods.

Effects to New Melones Reservoir and the Stanislaus River are summarized in terms of changes in storage in New Melones Reservoir and average changes in water allocations under the Stanislaus IPO for both existing and future LODs.

Existing Level of Development

Figure A-27 contains cumulative probability plots for recirculation modeled with the Condition 1 filter. Plots on **Figure A-27** contain volumes of recirculation in 1,000 AF for each period; however, the recirculation volumes for April and May are separated into pulse and nonpulse periods rather than totaled for each month. Need for recirculation during the pulse period is lower than during the nonpulse period because releases from the SJR tributaries for VAMP incidentally improve water quality conditions.

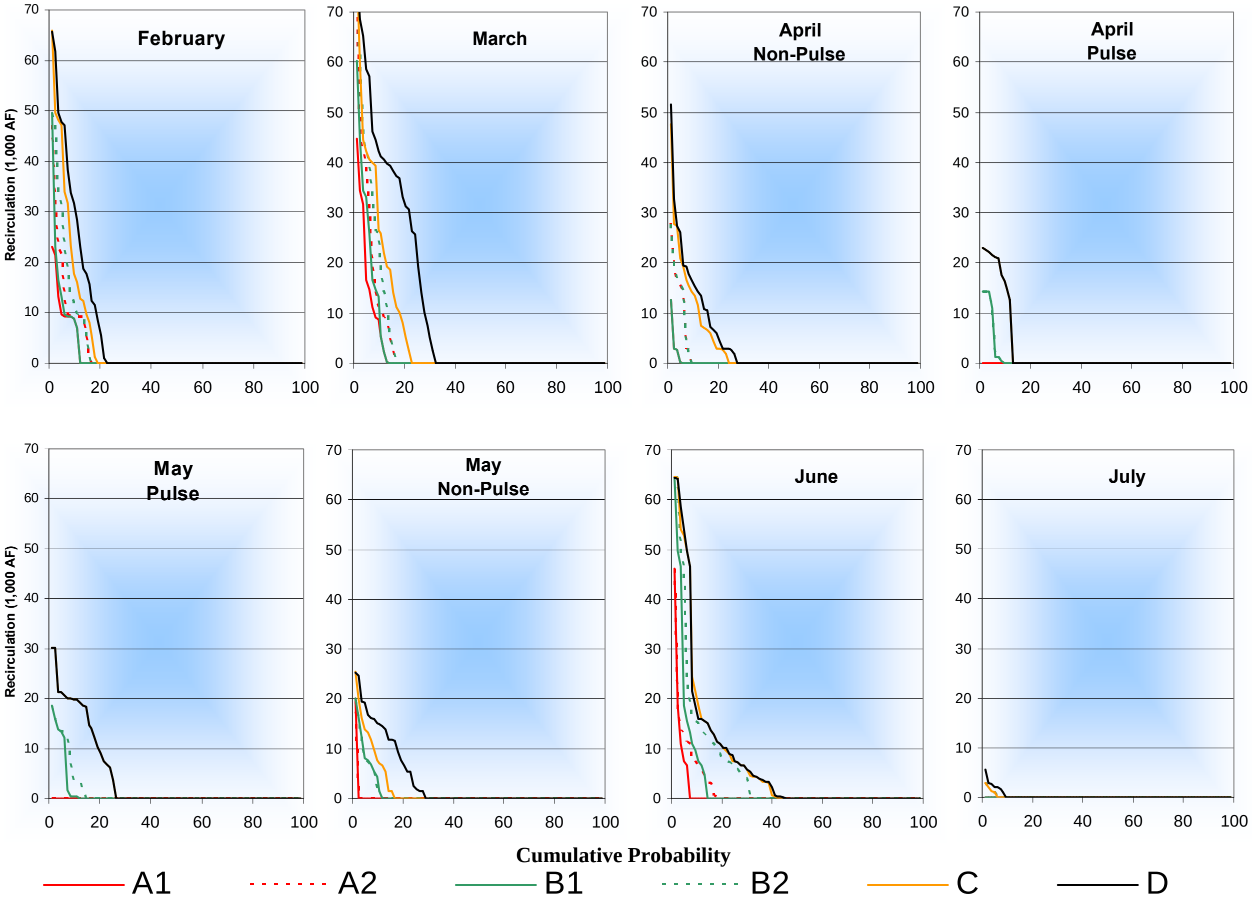


Figure A-27. Cumulative Probability for Existing Level of Development Recirculation (1,000 AF)

Figure A-28 contains cumulative probability plots of modeled SJR EC at Vernalis with the existing LOD. The SJR EC objective for February and March is 1,000 µmhos/cm, while the objective for April through July is 700 µmhos/cm; therefore, the scales on the plots differ according to the standard. During several months, the SJR EC at Vernalis is higher than the standard in the alternative plans. In these cases, recirculation is not capable of meeting the EC objective. For example, in the month of February approximately 10 percent of the average monthly EC values are predicted to exceed 1,000 µmhos/cm for existing conditions, and approximately 1 to 6 percent of the average monthly EC values are expected to exceed 1,000 µmhos/cm for the alternative plans modeled using the existing LOD.

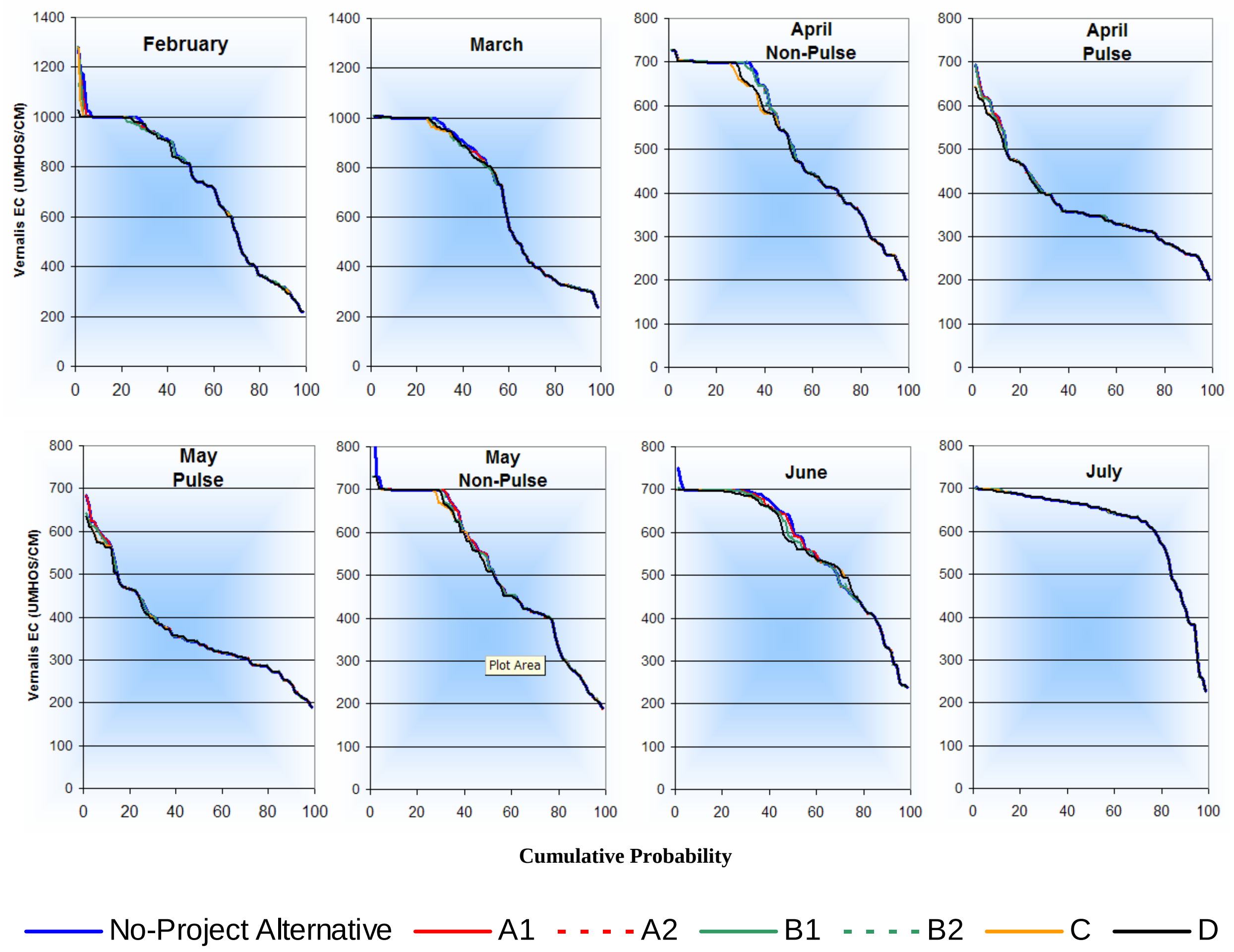


Figure A-28. Cumulative Probability of EC at Vernalis for Existing Level of Development Based on 82-Year Simulation by CalSim II

Figure A-29 contains cumulative probability plots of the additional flow in the SJR at Vernalis that would be required to meet the flow objective for Vernalis. These plots display existing conditions as well as alternative plans modeled using the existing LOD and demonstrate that recirculation with the Condition 1 filter is capable of increasing the flow in the SJR at Vernalis such that the flow objective is met more frequently. For several alternative plans, additional flow is needed to fully satisfy the objective.

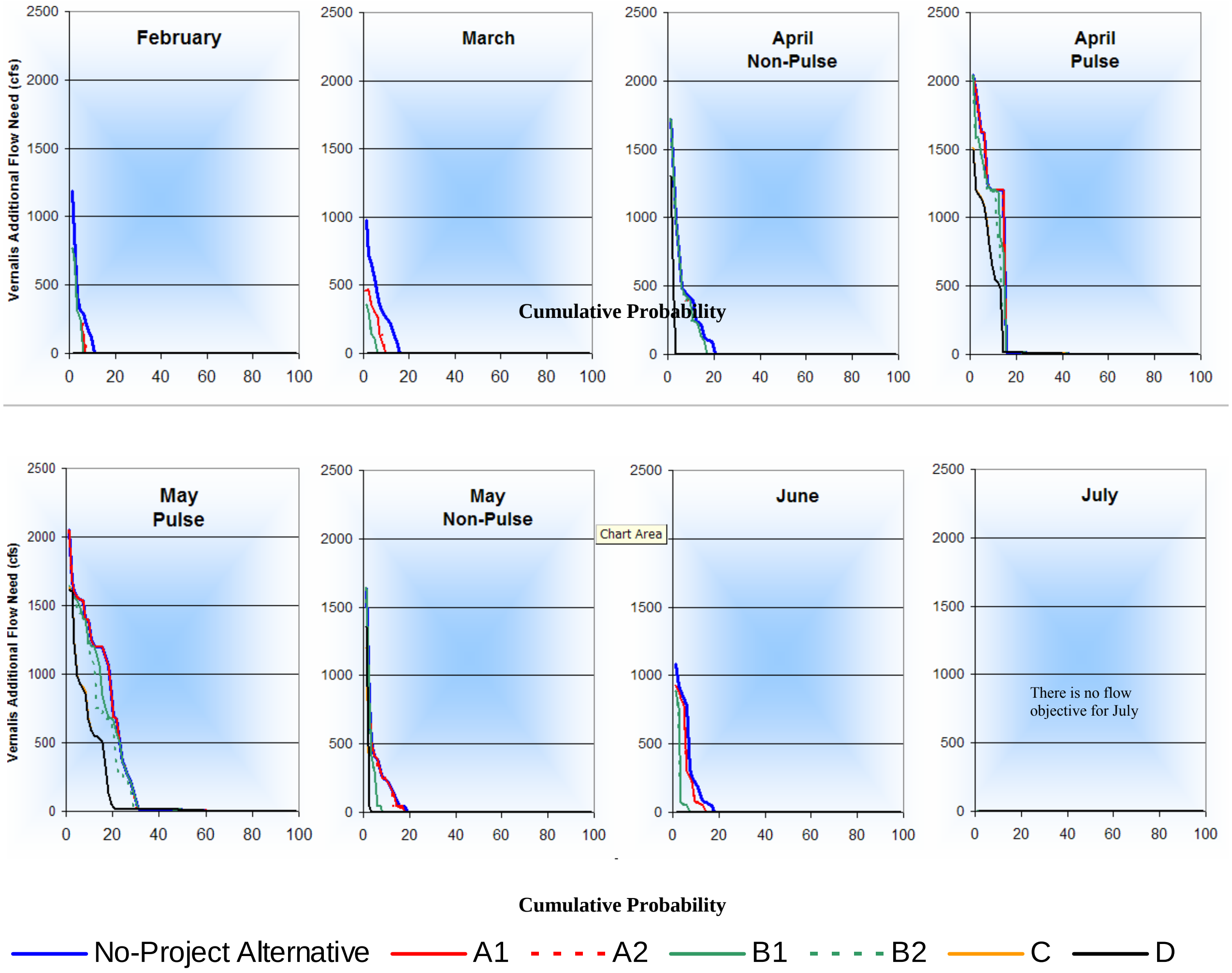


Figure A-29. Cumulative Probability of Flow at Vernalis Less than the Flow Objective for the Existing Level of Development (cfs)

New Melones carryover (end of September) storage and change in storage for alternative plans that affect Stanislaus River operations are displayed on **Figure A-30**. In Alternatives A1 and B1 recirculation is used to supplement releases from New Melones to meet Vernalis objectives and, therefore, does not influence its operation. On **Figure A-30**, the primary Y axis contains a scale for New Melones storage for existing conditions and the secondary Y axis contains a scale for the change in New Melones storage for each alternative. The largest increase in New Melones storage is just less than 60,000 AF, but is often much less. For the purpose of this analysis, increases in New Melones storage result in slightly increased allocations based on the current Stanislaus IPO. In some cases storage increases in New Melones resulted in increases in flood releases, a result of the modeling assumptions. A differently focused analysis, beyond the scope of the current assignment, could transition the additional storage into water supply allocations. **Table A-6** contains average annual changes in allocations and incidental changes in releases based on the operation of the IPO.

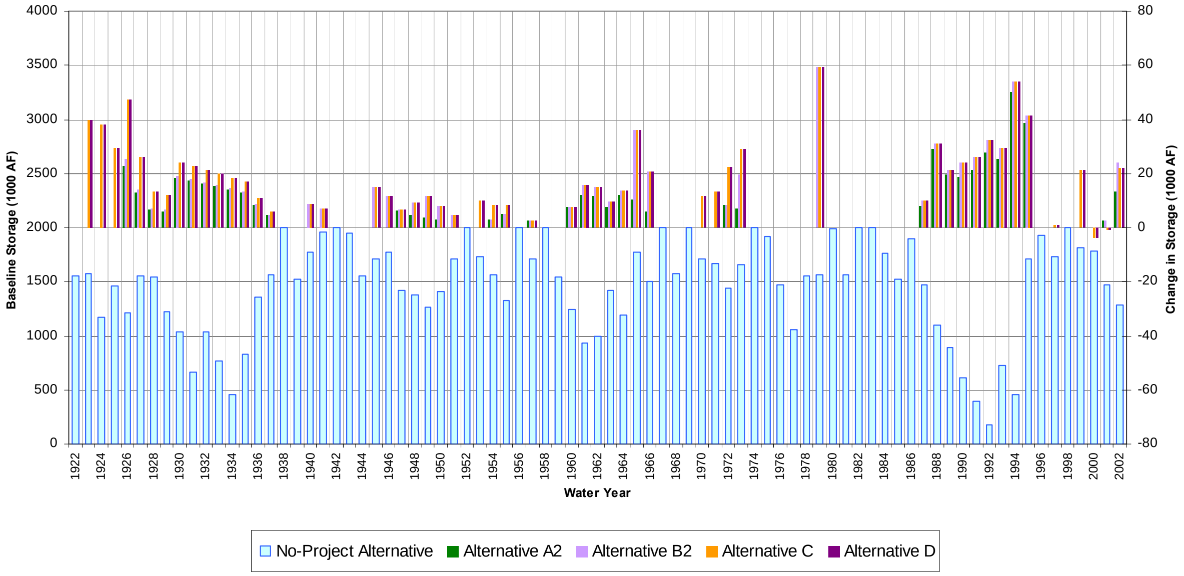


Figure A-30. Existing Level of Development New Melones Carryover (1,000 AF)

Table A-6. Average Annual Change in Allocation Under IPO, Existing LOD (1,000 AF)

	A1	A2	B1	B2	C	D
Stanislaus River Deliveries	0	0.2	0	0.3	0.4	0.7
Allocation to Instream Fishery	0	1.1	0	1.6	2.3	4.2
Release for Vernalis Quality	0	-3.4	0	-4.5	-4.5	-10.5
Release for DO	0	1.2	0	1.7	1.5	3.1

Key:

AF = acre-feet
DO = dissolved oxygen
IPO = Interim Plan of Operations
LOD = Level of Development

Future Level of Development

Figure A-31 contains cumulative probability plots for recirculation modeled with the Condition 1 filter. Plots on **Figure A-31** contain volumes of recirculation in 1,000 AF for each period; however, the recirculation volumes for April and May are separated into pulse and nonpulse periods rather than totaled for each month. The need for recirculation during the pulse periods is lower than during the nonpulse periods because releases from SJR tributaries for VAMP incidentally improve water quality conditions.

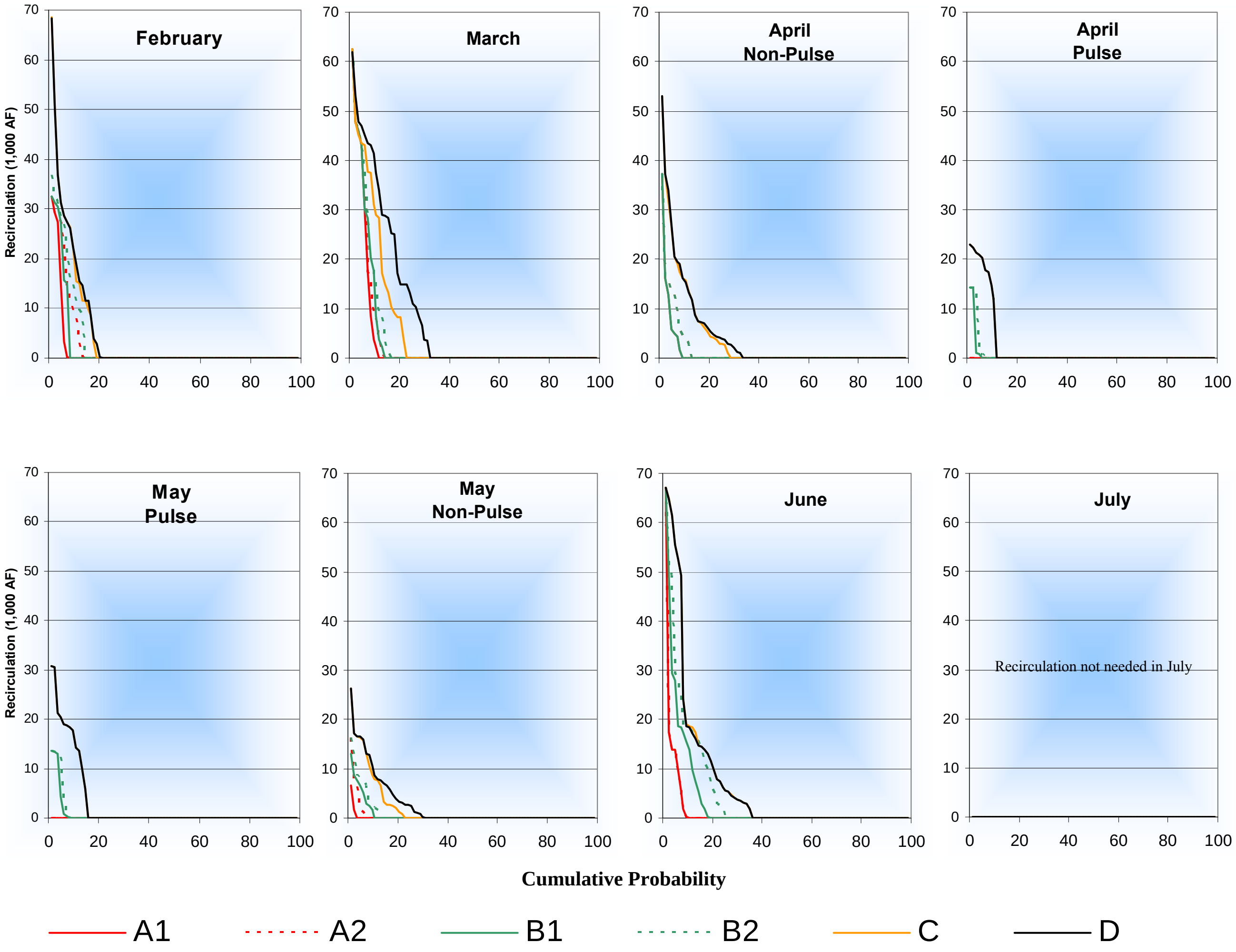


Figure A-31. Future Level of Development Recirculation

Figure A-32 contains cumulative probability plots of modeled SJR EC at Vernalis for the future LOD. The SJR EC objective for February and March is 1,000 µmhos/cm, while the objective for April through July is 700 µmhos/cm; therefore, the scales on the plots differ according to the objective. During several months, the SJR EC at Vernalis is higher than the objective for alternative plans. In these cases, recirculation is not capable of meeting the EC objective. Because water quality conditions in the SJR at the future LOD are better than the existing LOD, water quality objectives are met more often at the future LOD.

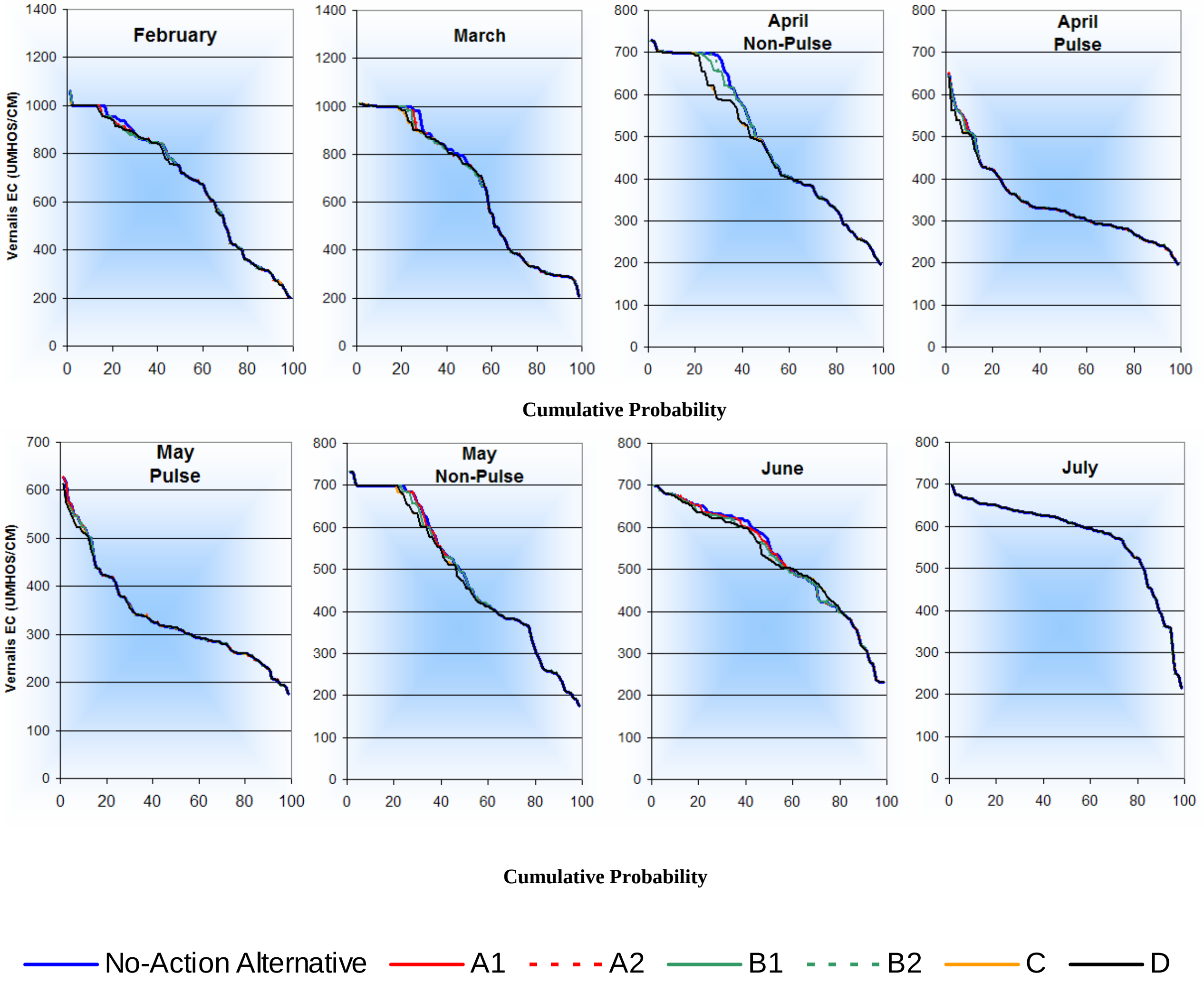


Figure A-32. Future Level of Development Vernalis EC

Figure A-33 contains cumulative probability plots of the additional flow in the SJR at Vernalis that would be required to meet the flow objective under the future LOD. These plots demonstrate that recirculation with the Condition 1 filter is capable of increasing the flow in the SJR at Vernalis such that the flow objective is met more frequently. Although existing and future LODs vary, need for additional SJR flow at the future LOD is similar to the existing LOD.

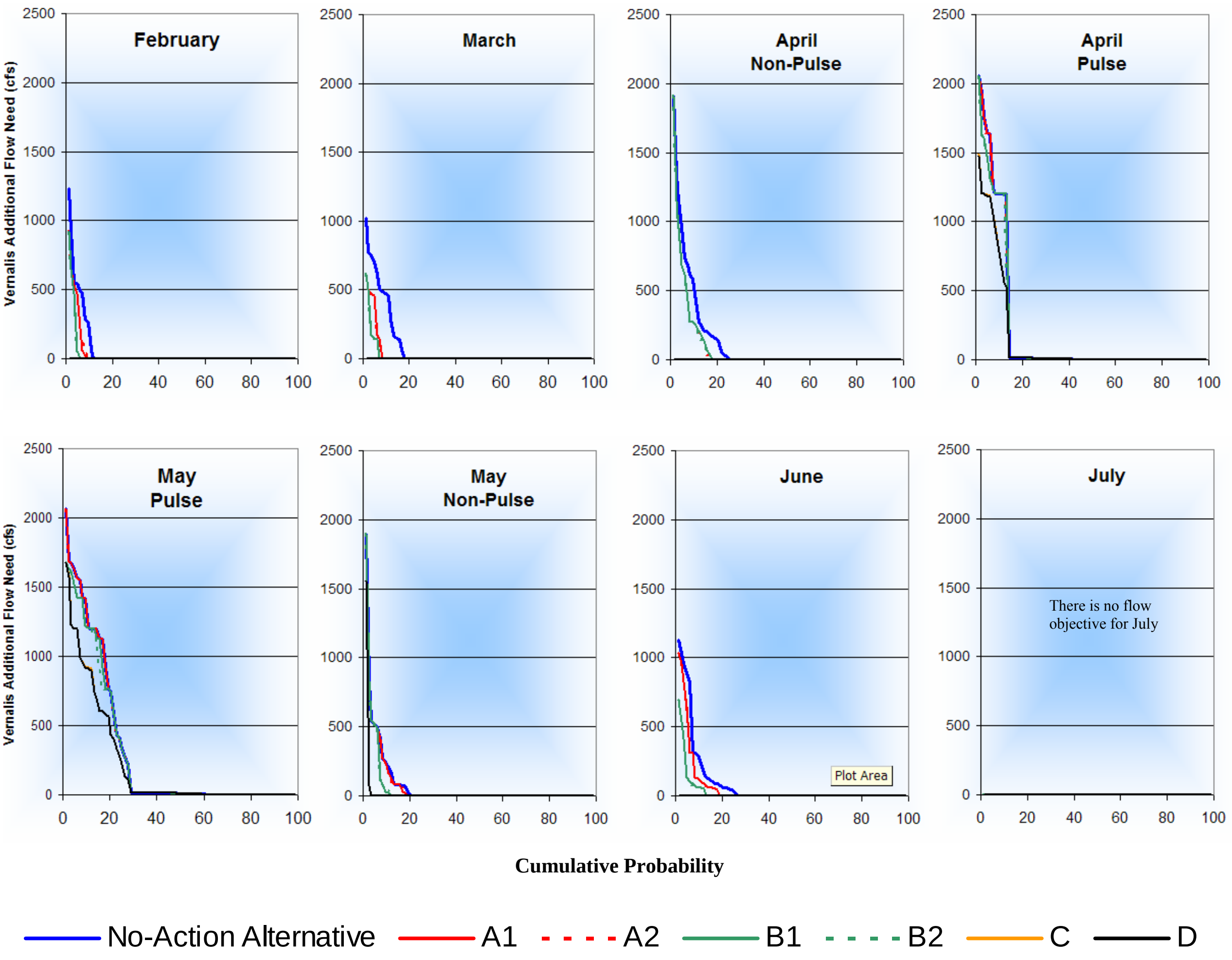


Figure A-33. Future Level of Development Vernalis Flow Below Standard (cfs)

New Melones carryover (end of September) storage and change in storage for alternative plans that affect Stanislaus River operations are displayed on **Figure A-34**. In Alternatives A1 and B1 recirculation is used to supplement releases from New Melones to meet Vernalis objectives, and, therefore, do not influence its operation. On **Figure A-34**, the primary Y axis contains a scale for New Melones storage for existing conditions and the secondary Y axis contains a scale for the change in New Melones storage for each alternative plan. The largest increase in New Melones storage is just less than 60,000 AF, but is often much less. For the purpose of this analysis, increases in New Melones storage result in increased allocations based on the current Stanislaus IPO. In some cases storage increases in New Melones resulted in increases in flood releases. **Table A-7** contains average annual changes in allocation based on the IPO. Effects to New Melones at the future LOD are less than existing LOD because of improved SJR water quality and less release from New Melones in the no action condition.

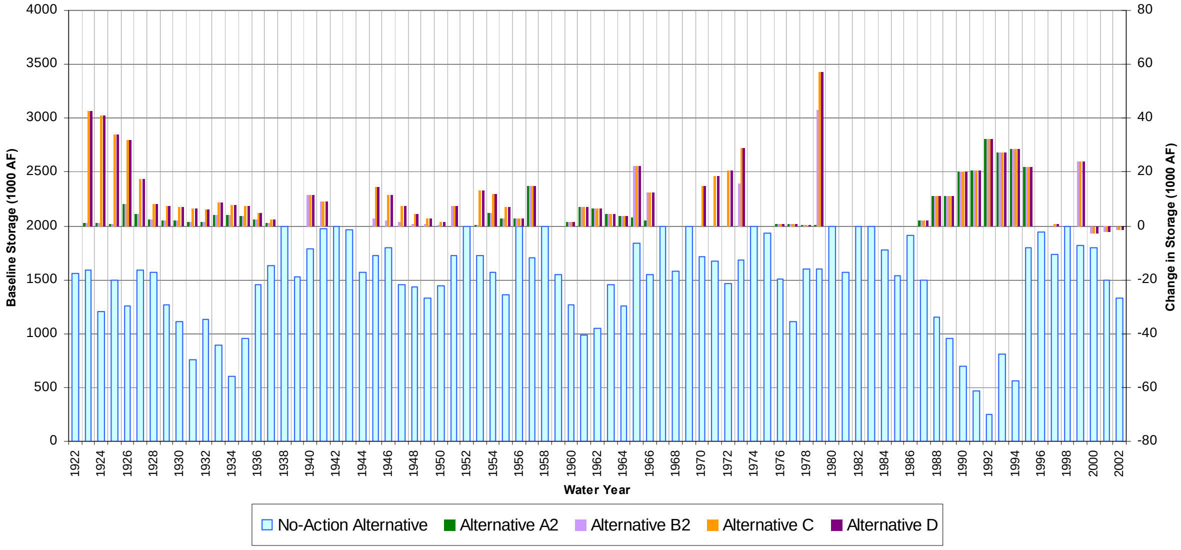


Figure A-34. Future Level of Development New Melones Carryover (1,000 AF)

Table A-7. Average Annual Change in Allocation Under IPO, Future LOD (1,000 AF)

	A1	A2	B1	B2	C	D
Stanislaus River Deliveries	0	0.1	0	0.1	0.3	0.4
Allocation to Instream Fishery	0	0.5	0	0.6	1.6	2.4
Release for Vernalis Quality	0	-1.8	0	-2.0	-2.0	-4.8
Release for DO	0	1.0	0	1.2	1.0	1.9

Key:

AF = acre-feet
LOD = Level of Development
DO = dissolved oxygen
IPO = Interim Plan of Operations

A.7 Sensitivity Analysis

For the modeling presented in **this appendix,** recirculation is used for two purposes: (1) to assist in meeting flow objectives at Vernalis, and (2) to assist in meeting EC objectives at Vernalis. **Attachment A2** includes the results of sensitivity analyses that were performed to expand on the CalSim II modeling presented here. The supplemental modeling scenarios were selected based on stakeholder comments, and included the following:

- **Sensitivity Analysis 1**. The 200 µmhos/cm buffer and the Condition 1 filter (described in Section A3.1) were removed to determine how these assumptions influenced the frequency and quantity of recirculation and compliance with water quality and flow objectives. Although the water quality modeled at Vernalis was allowed to be degraded for the purpose of flow compliance, it was not allowed to be degraded to a degree that the Vernalis WQO was not achieved.

- **Sensitivity Analysis 2**. Modeling assumptions regarding New Melones releases were modified to remove the release requirement for DO at Ripon on the Stanislaus River. A minimum flow was maintained in the Stanislaus River for fish, and the minimum flow was assumed to be 175 cfs in June and September and 200 cfs in July and August.
- **Sensitivity Analysis 3**. Water quality targets were developed for Vernalis EC that reflect the improved quality needed to increase compliance at three south Delta locations. These water quality targets were used as a basis for an additional modeling scenario.
- **Sensitivity Analysis 4**. To maintain a minimum water level at agricultural intakes just downstream of Vernalis during the irrigation season, this scenario allows for additional recirculation so that a minimum flow of 1,500 cfs is maintained in the SJR at Vernalis from April through August.

Methods and results of these analyses are presented in **Attachment A2**.

A.8 References

Bureau of Reclamation. 2005. *CalSim II San Joaquin River Model (Draft).* Mid Pacific Region, Sacramento, CA. April.

Bureau of Reclamation and California Department of Water Resources. 2007. *CalSim II San Joaquin River Peer Review Response*. January 17.

CALFED Science Program – California Water and Environment Modeling Forum. 2006. *Review Panel Report San Joaquin River Valley CalSim II Model Review* (Peer Review). January 12.