MODEL SIMULATION REPORT FOR THE FOLLOWING SCENARIOS:

BASELINE OPERATIONS: CURRENT OPERATIONS ON EEL RIVER AND CURRENT OPS ON RUSSIAN RIVER, compared with

SCENARIO 3: FULL POTTER VALLEY PROJECT (PVP) DECOMISSIONING ON EEL RIVER AND FISH FLOW EIR AND FIRO OPERATIONS ON RUSSIAN RIVER

Table SC3-1. Summary of modeling scenarios evaluated by the Water Supply Work Group. Modeling for scenarios bounded in red are summarized in this document.

Modeling Scenarios Updated 4/16/19		**Russian River & Lake Mendocino Alternatives**		
		Current Operations	Lake Mendocino FIRO (Hybrid) with Fish Flow EIR Operations	Raise Coyote Valley Dam
Potter Valley Project Alternatives	Current Operations	Baseline: Existing Climate (n=1)		
		Baseline FC: Future Climate (n=4)		
	PVP Revised Operations	Scenario 4: Existing Climate (n=1)		
	Run-of-the-River		Scenario 2: Existing Climate (n=1)	
			Scenario 2FC: Future Climate (n=4)	
	PVP Decommission	Scenario 1: Existing Climate (n=1)	Scenario 3: Existing Climate (n=1)	Scenario 5: Preliminary analysis with Existing Climate (includes two sub-scenarios)

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1. SUMMARY OF ASSUMPTIONS

Primary model assumptions for each scenario are summarized in Table SC3-2 and highlight key assumptions that differ. These assumptions are summarized in more detail below.

Table SC3-2. Summary of modeled scenarios and assumptions.

Model	Assumptions	Baseline Operations	Scenario 3 PVP Decommission and Lake Mendocino FIRO with Fish Flow EIR Operations
PVP ResSim	Plot Legend	PVP Current Operations	PVP Decommission
	Operations	RPA/Current Operations	No Scott Dam/No Tunnel Div
	Year Storage Capacity	2016	None
	Max Tunnel Capacity	170	0
	Hydrology	Historical-Cardno	Historical-Cardno
Russian River ResSim	Plot Legend	Current Operations	Hyb FIRO + Fish Flow EIR
	Minimum Flows	BO TUC/D1610	Fish Flow EIR
	Hydrologic Index	D1610	Fish Flow EIR
	LM Year Storage Capacity	2001	2001
	Calpella Reach Loss	~8,600 acre-ft	~8,600 acre-ft
	Calpella Reach Source	Natural flows/Tunnel Div	Natural Flows/Pumpback
	Upper River Losses	Fish Flow EIR	Fish Flow EIR
	Hydrology	Historical-USGS BCM	Historical-USGS BCM
Both	Simulation Period	WY 1911-2017	WY 1911-2017

Baseline Operations Model Assumptions

Baseline Conditions

- *Current Operations on the Russian River remain in place.*
- *Current Operations on the Eel River remain in place.*

Eel River:

- Current minimum flow released based on 2002 Biological Opinion RPA flows
- Historical Cardno hydrology for Lake Pillsubry inflow (no climate change)
- Cardno 2018 estimates of daily unimpaired tributary accretion between E-2 and E-11
- 2017 Block Water hydrograph released from slide gate, triggered when E-11 flows drop below 250 cfs after April 1
- Maximum PVP diversion capacity = 170 cfs to best represent historical→simulated volumetric mass balance for discretionary power generation diversions (full capacity is 300 cfs; current derated capacity is 240 cfs)
- Regression equation used for the timing of Scott Dam gate closure
- Drought, Maintenance, and Testing flow variances excluded
- Storage based on Lake Pillsbury 2016 bathymetric survey (water supply storage capacity is 76,876 ac-ft)
- Based on the model verification, the PVP model may exhibit some bias in accretions between Scott Dam and Cape Horn dam in the spring of some years due to downstream gage error- this

translates into over/under estimate of flows below Van Arsdale (E-11) that is consistently applied to all scenarios

- Van Arsdale storage used to meet RPA flows
- Buffers for mininum instream flows range from 5 cfs to 20 cfs below E-11 (Van Arsdale), depending on magnitude of the minimum instream flow. Flow buffer for meeting minimum instream flows on the East Fork Russian River at the E-16 PVP diversion are always 5 cfs. These flow buffers are for all scenarios where applicable.
- Calpella reach demands, which includes PVID demands, are approximately 8,600 acre-feet annually

<u>Russian River:</u>

- Flow source to Lake Mendocino = Unimpaired Flows + modeled PVP diversions –Calpella reach loss
- Historic unimpaired flows computed using USGS Basin Characterization Model.
- Storage based on Lake Mendocino 2001 bathymetric survey (water supply storage capacity is 111,000 ac-ft).
- Minimum flow releases to the East Branch Russian River below Potter Valley Powerhouse and below Lake Mendocino based on 2008 Biological Opinon RPA and 1986 Decision 1610.
- Minimum flood control releases based on existing ACOE rule curve (no Forecast Information Reservoir Operations [FIRO].
- Hydrologic index used for minimum flow releases based on 1986 Decision 1610 (inflow to Lake Pillsbury rather than Lake Mendocino)
- Assumptions for losses in the East Branch Russian River include 8,600 ac-ft loss from E-16 to Calpella and none from Calpella to Lake Mendocino
- Buffer for minimum instream flows below Lake Mendocino range from 5 cfs to 20 cfs, depending on the time of year and river reach, and are consistently used for all scenarios
- Hydrologic index used for minimum flow releases based on 1986 Decision 1610 (inflow to Lake Pillsbury)
- Assumed annual flow losses from Calpella to Lake Mendocino=8,600 ac-ft, losses below Lake Mendocino based on Fish Flow EIR based on depletion analysis for the period (clarification is in progress)

Differences between Model Assumptions for Baseline and Scenario 3

<u>Eel River</u>*, same as Baseline, except:

- No Eel River storage
- No Block Water hydrographs released due to full PVP decommissioning
- Maximum Diversion Capacity = 0 cfs due to full PVP decommissioning

**Note also the same as Scenario 1.*

<u>Russian River</u>, same as Baseline, except:

- Potter Valley Irrigation District (PVID) diversions and/or storage from local runoff, with pumpback from Lake Mendocino

<u>Scenario 3:</u>
<u>PVP Decommission and Lake Mendocino FIRO with Fish Flow EIR Operations</u>

- *Russian River operations updated to meet Lake Mendocino FIRO and Fish Flow Operations*
- *Full decommissioning of Potter Valley Project, including all dams and diversions*

- Russian River flows are based on the Fish Flow EIR, which includes different flow ranges as compared to the D1610 flow regime. The difference in D1610 and Fish Flow EIR flow regimes varies by month and water year condition, ranging from a difference of 0 cfs to 80 cfs. The greatest differences occur in the wettest year types during summer months. Both flow regimes have a floor of 25 cfs.
- Maximum conservation storage of Lake Mendocino is assumed to be equal to the flood pool encroachment (FIRO guide curve) that was approved for the water year 2019 FIRO major deviation to the Water Control Manual, which allows for additional winter (November 1 through March 1) water supply storage maximum from 68,400 ac-ft to 80,050 ac-ft (Figure SC3-1). Modeling does not simulate forecast based operations therefore storage levels, releases and downstream flows could differ from the simulation results.

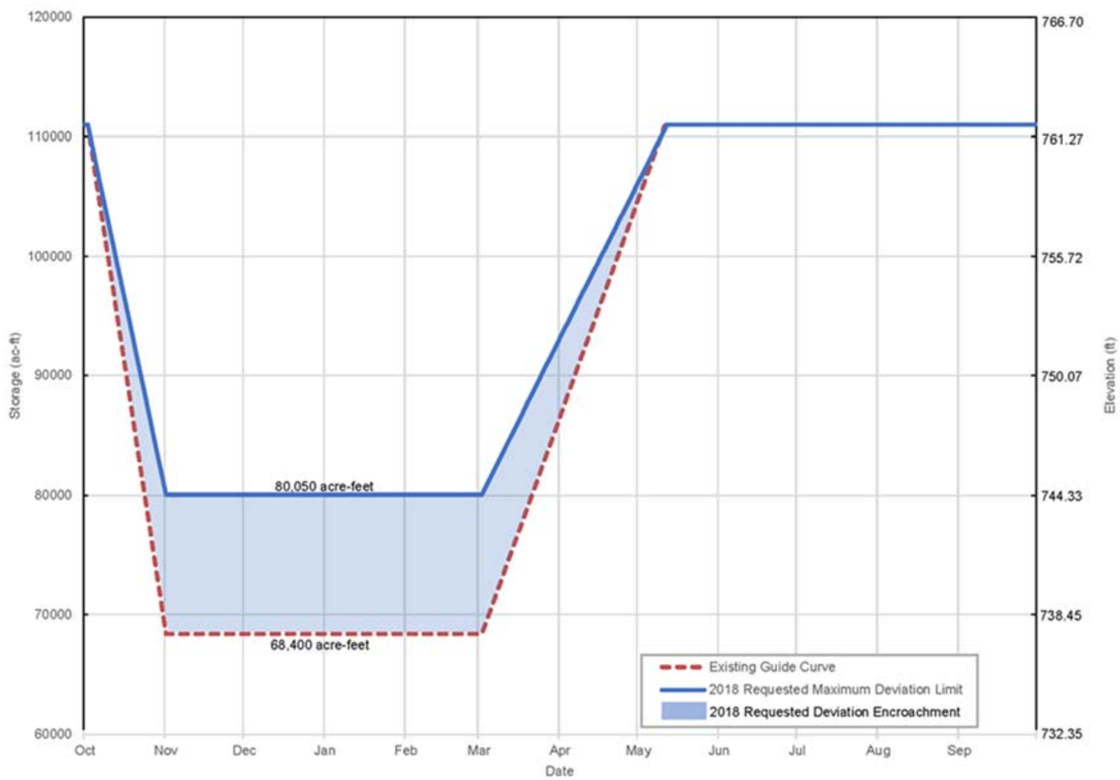

Figure SC3-1. The existing FIRO rule curve is adjusted to allow additional storage by raising the winter (November 1 through March 1) storage maximum from 68,400 ac-ft to 80,050 ac-ft.

Example Hydrographs Comparing Flow Management Results

Example hydrographs have been provided for a recent dry year (Water Year [WY] 2015) and a recent dry year (WY 2017), as examples of how flows are predicted to change under Scenario 3, compared to baseline operations at Cape Horn Dam (E-11, Figure SC3-2 and Figure SC3-3), Lake Mendocino storage (Figure SC3-4 and Figure SC3-5), and the Russian River at Cloverdale (Figure SC3-6 and Figure SC3-7).

Cape Horn Dam (E-11). The Eel River hydrograph in a dry water year is similar to baseline, although flows are lower in October and in late spring, but slightly higher during the summer and early fall period (Figure SC3-2). Peak flow magnitudes are also higher than baseline conditions, as they would no longer be attenuated by storage in Lake Pillsbury. Under wetter conditions, flows are similar in the wet season, but unimpaired flows drop below baseline operations flows in the dry season (Figure SC3-3).

Lake Mendocino. During drier water years, the model predicts Scenario 3 storage in Lake Mendocino to be consistently higher than baseline operations in the spring and summer as a result of the increased diversion capacity during winter months and reduced flow released due to the Fish Flow EIR. During the drier year example, storage reaches a low of 2,100 ac-ft at the beginning of the water year. (Figure SC3-4). In all year types, simulated flood control releases occur when storage levels reach the FIRO guide curve to approximate the water supply benefit of FIRO (Figure SC3-4 and Figure SC3-5). The FIRO guide curve increases the maximum winter water supply storage levels (November 1 to March 1) from 68,400 ac-ft to 80,000 ac-ft and decreases the rate of change in water supply storage for the spring (March 1 to May 10) and fall (October 1 to October 30) transition periods. The simulated flood control releases do not incorporate any forecast information, and therefore the results only represent an approximation of storage levels, releases and downstream flows under FIRO. During the summer and fall, the storage is depleted more rapidly compared to baseline due to no PVP diversions, despite the lower releases prescribed in the Fish Flow EIR.

Russian River at Cloverdale. During drier water years, daily average flows at Cloverdale are consistently lower than baseline operations, although the hydrograph shows a similar flow pattern. Peak flow events are similar under both scenarios and are a result of flood control releases from Lake Mendocino and/or tributary accretion (Figure SC3-6). Daily average flows are also lower during wetter water years. From early March through May, spring releases into the Russian River (plus tributary accretion) at Cloverdale are slightly higher than baseflow operations because Lake Mendocino is reaching and exceeding the rule curve for balancing water storage with flood control, and thus additional water is being released downstream during this period. Independent of water year type, lower baseflows during the summer and fall result from lower minimum instream flow requirements in the Fish Flow EIR that range from 0 cfs to 80 cfs lower than baseline operations minimum flow requirements, not necessarily because there is less water availability from cessation of PVP diversions. (Figure SC3-7).

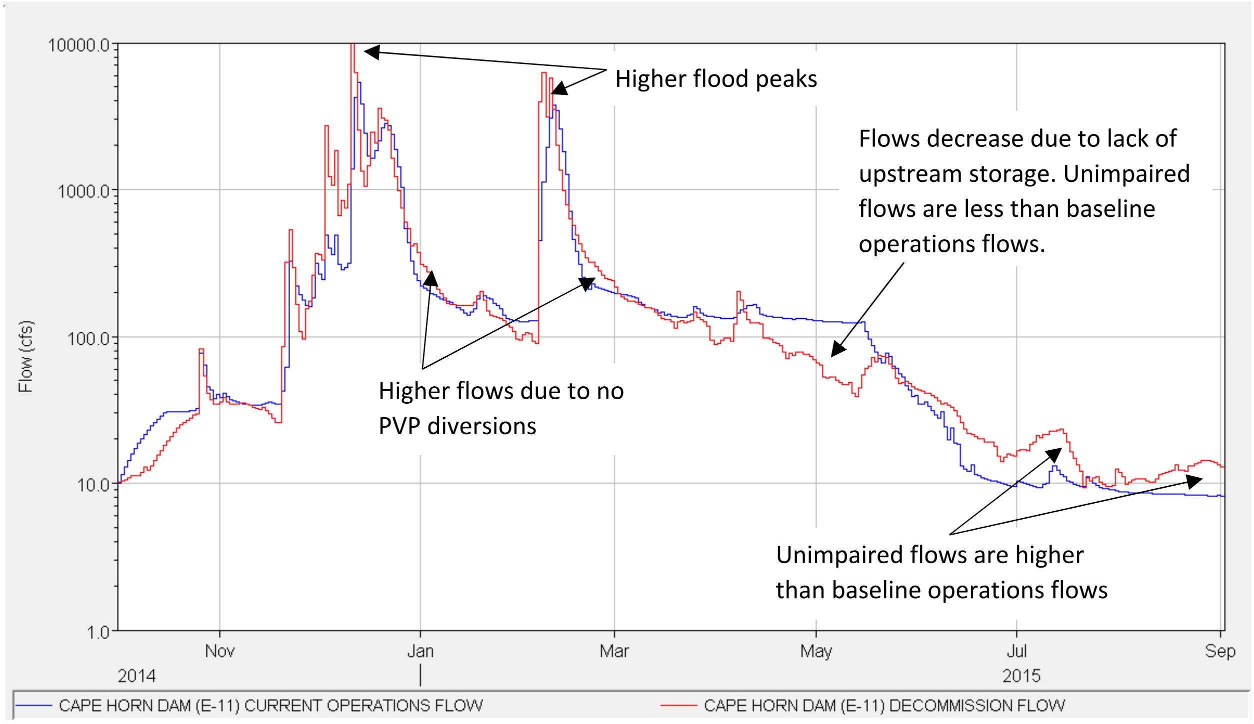

Figure SC3-2. Model results for Eel River flow below Cape Horn Dam (E-11) comparing baseline operations and Scenario 3. Water Year 2015 is shown as an example of a drier water year type.

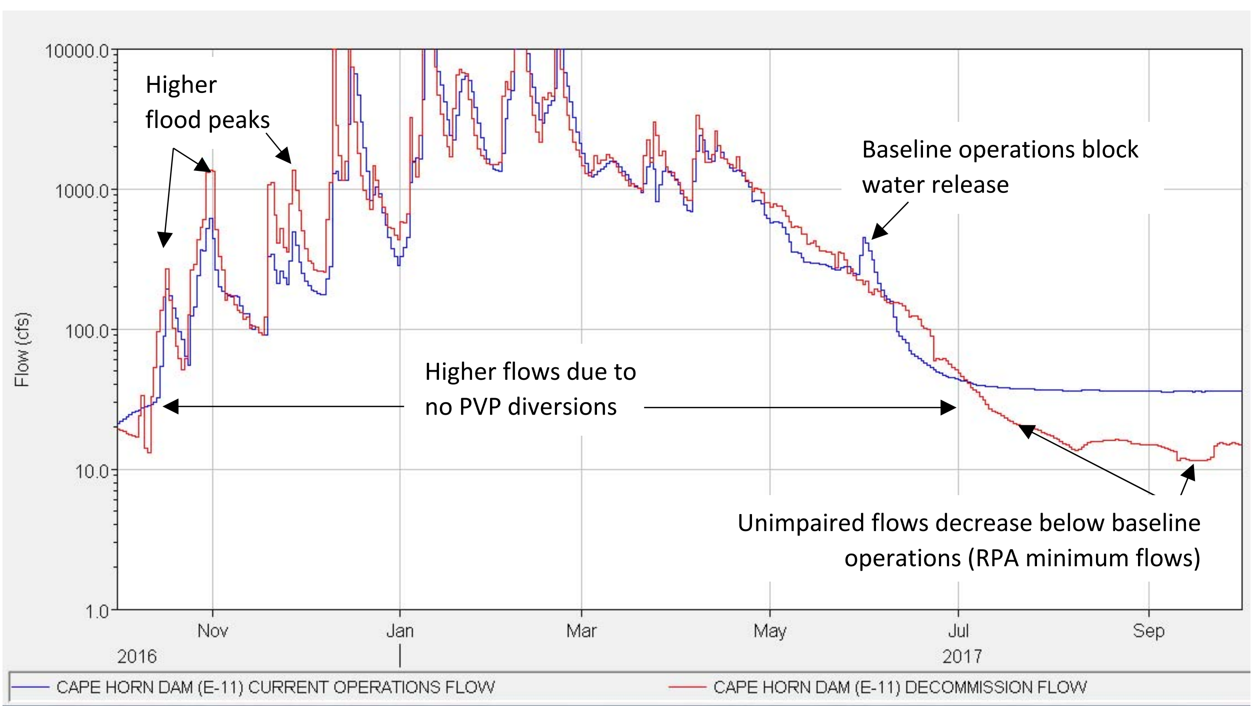

Figure SC3-3. Model results for Eel River flow below Cape Horn Dam (E-11) comparing baseline operations and Scenario 3. Water Year 2017 is shown as an example of a wetter water year type.

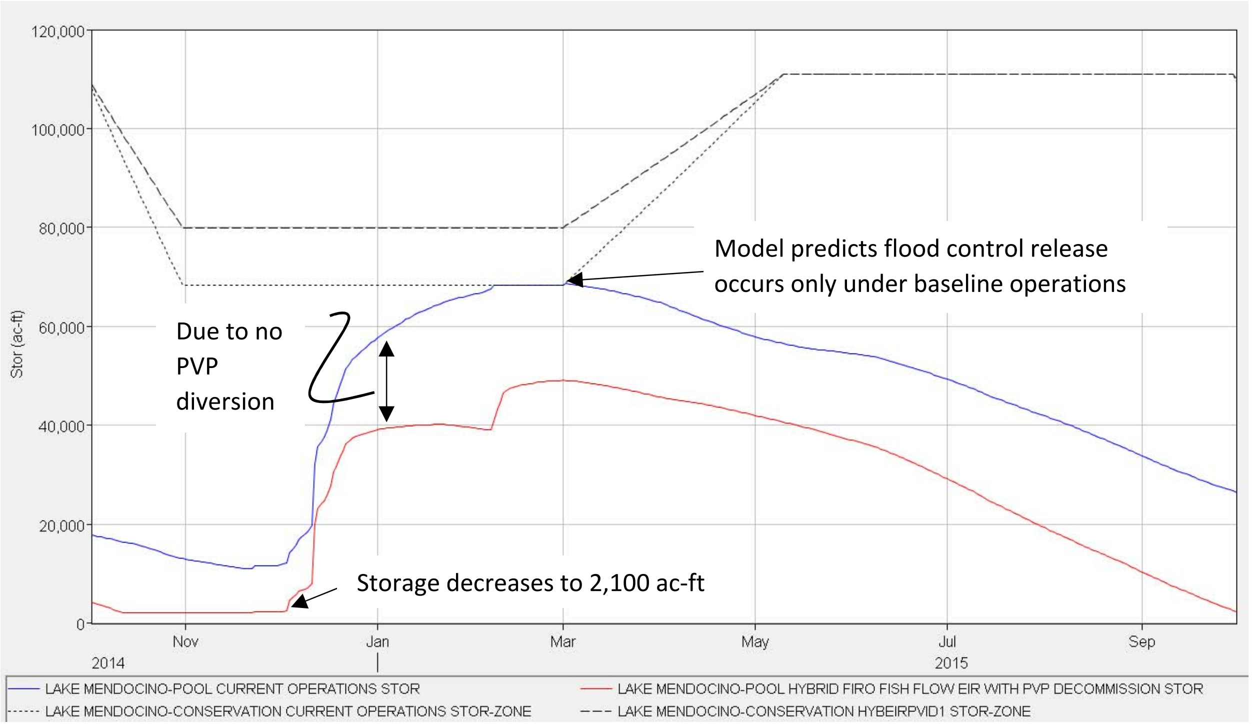

Figure SC3-4. Model results for Lake Mendocino storage comparing baseline operations and Scenario 3. Water Year 2015 is shown as an example of a drier water year type.

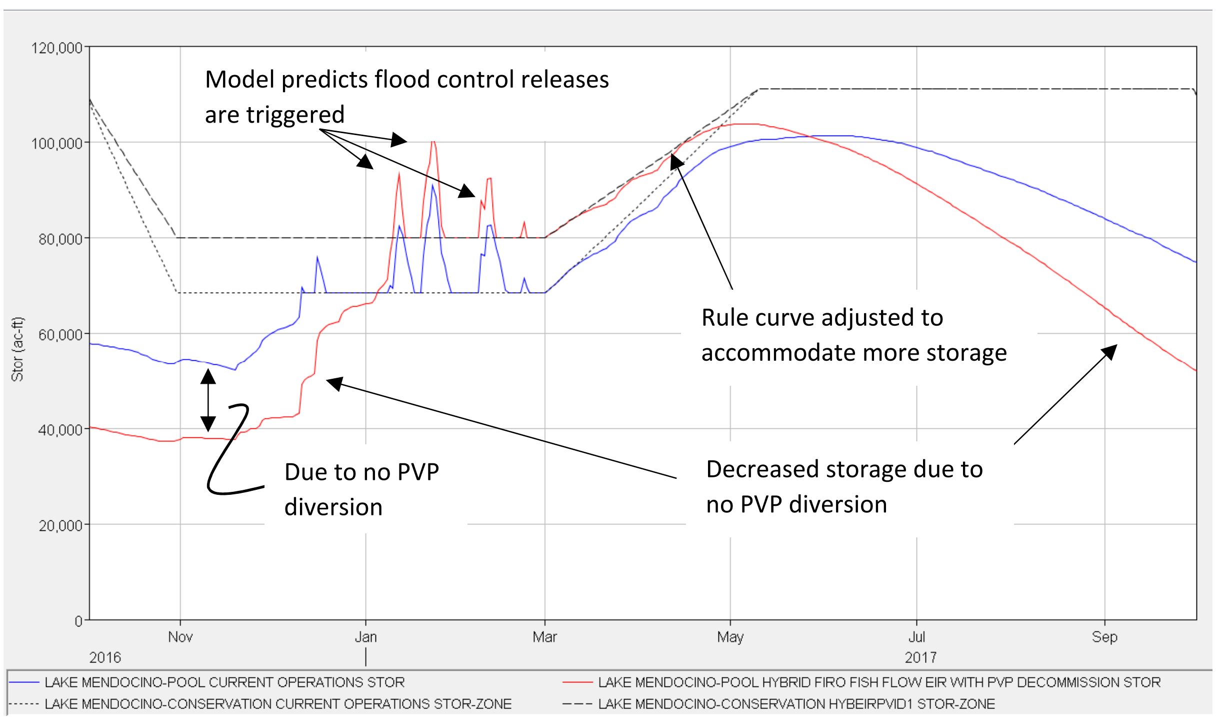

Figure SC3-5. Model results for Lake Mendocino storage comparing baseline operations and Scenario 3. Water Year 2017 is shown as an example of a wetter water year type.

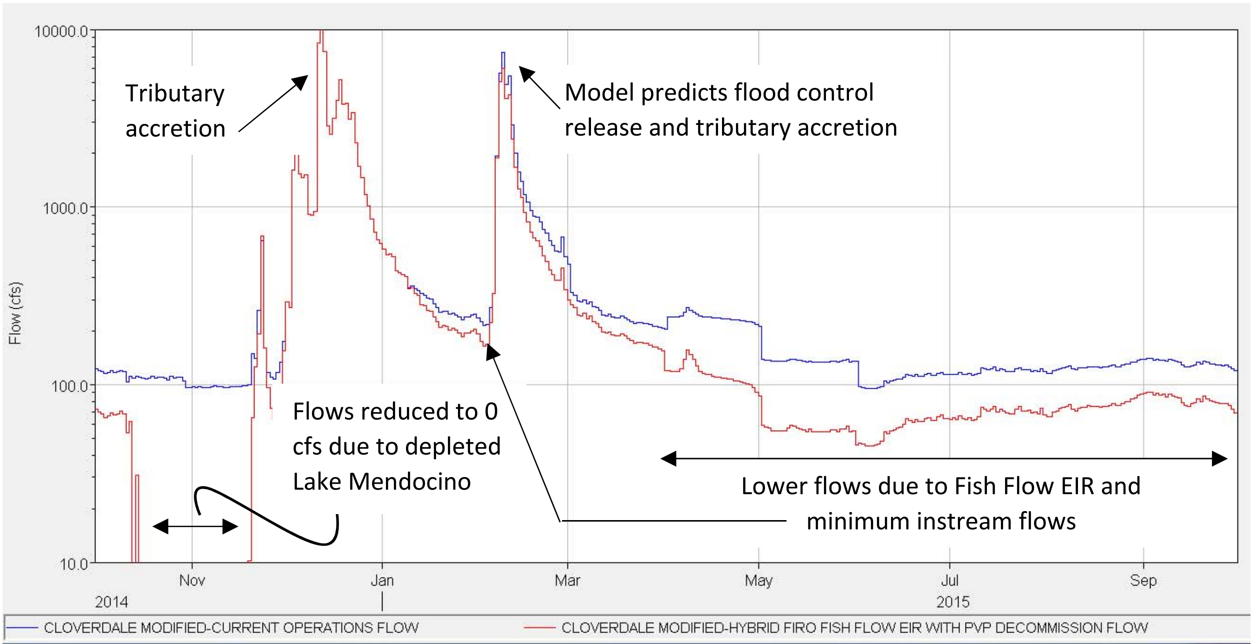

Figure SC3-6. Model results for Russian River flow at Cloverdale comparing baseline operations and Scenario 3. Water Year 2015 is shown as an example of a drier water year type.

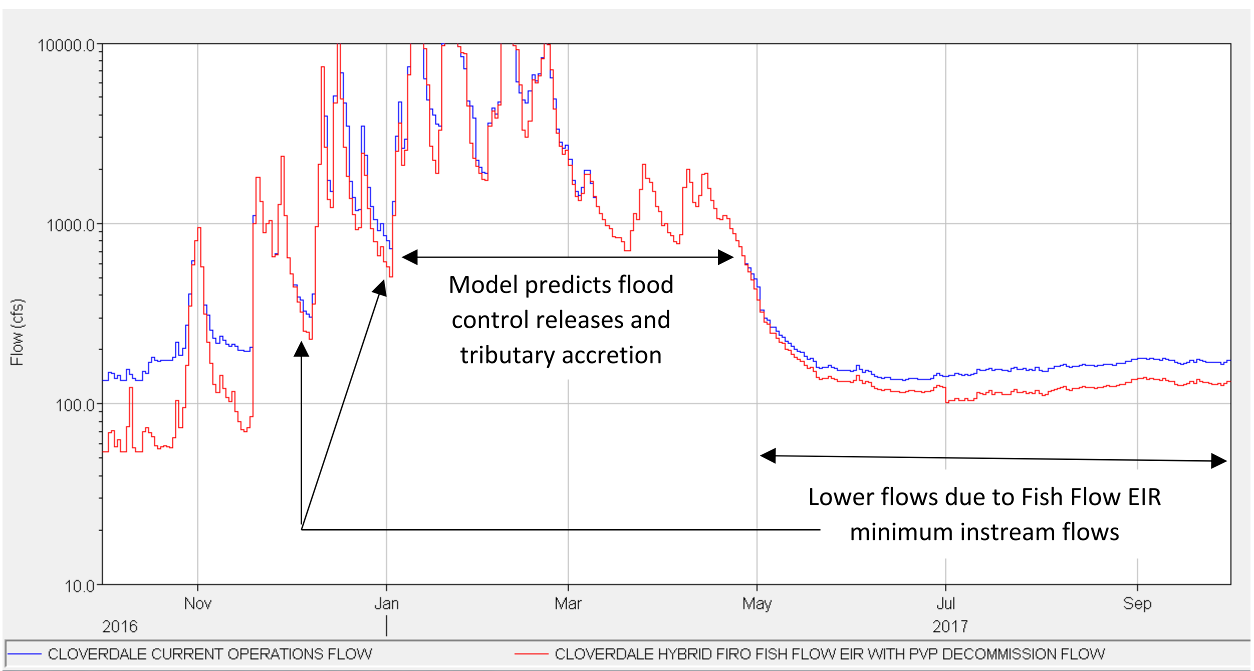

Figure SC3-7. Model results for Russian River flow at Cloverdale comparing baseline operations and Scenario 3. Water Year 2017 is shown as an example of a wetter water year type.

2. KEY METRICS

Table SC3-3. Summary of Eel River performance metrics for the WY 1911-2017 period of record (107 years).

Model Junction	Evaluation Metric	Baseline Operations	Scenario 3: PVP Decommissioning and Modified Russian River	Scenario 3 Percent Change from Baseline Operations Scenario
Lake Pillsbury	Average Annual Inflow (ac-ft)	411,870	411,870	0%
	Standard Deviation of Average Annual Inflow (ac-ft)	234,731	234,731	0%
	Relative Standard Deviation (%)	57%	57%	0%
	Minimum Average Annual Inflow (ac-ft)	30,447	30,447	0%
	Average Overall Storage (ac-ft)	50,858	N/A[1]	N/A[1]
	Average Low Point of Annual Storage (March -February) (ac-ft)	24,829	N/A[1]	N/A[1]
	Relative Standard Deviation (%)	8,005	N/A[1]	N/A[1]
	Standard Deviation of Low Point of Annual Storage (ac-ft)	32%	N/A[1]	N/A[1]
	Number of Years Below 35,000 ac-ft Storage from August-October[2]	65	N/A[1]	N/A[1]
	Number of Years Below 9,700 ac-ft Storage from August-October	6	N/A[1]	N/A[1]
	Number of Years Dead Pool (5,000 ac-ft Storage) reached at Any Time During the Year	5	N/A[1]	N/A[1]
Below Scott Dam (E-2)	Average June-September flows (cfs)	153	51	-67%
	Minimum Weekly June-September flows (cfs)	0[3]	0[3]	0[3]
	Standard Deviation of Minimum Weekly June-September flows (cfs)	61	80	32%
	Relative Standard Deviation (%)	239%	256%	7%
	Average October-December flows (cfs)	397	425	7%
	Minimum Weekly October-December flows (cfs)	0	0	0
	Standard Deviation of Minimum Weekly October-December flows (cfs)	950	1,088	15%
	Relative Standard Deviation (%)	619%	2126%	243%
	Average Water Year Volumes (ac-ft)	404,161	408,889	1%
	Standard Deviation of Average water year volumes (ac-ft)	230,136	234,895	2%
	Relative Standard Deviation (%)	57%	57%	1%
Below Cape Horn Dam (E-11)	Average June-September flows (cfs)	43	60	38%
	Minimum Weekly June-September flows (cfs)	0[3]	0[3]	0[3]
	Standard Deviation of Minimum Weekly June-September flows (cfs)	67	93	40%
	Relative Standard Deviation (%)	18%	18%	0%
	Average October-December flows (cfs)	373	519	39%
	Minimum Weekly October-December flows (cfs)	0	0	0
	Standard Deviation of Minimum Weekly October-December flows (cfs)	1,091	1,302	19%
	Relative Standard Deviation (%)	2525%	2178%	-14%
	Average Water Year Volumes (ac-ft)	413,281	496,144	20%
	Standard Deviation of Average water year volumes (ac-ft)	274,001	285,899	4%
	Relative Standard Deviation (%)	66%	58%	-13%

1 N/A because Lake Pillsbury is removed.

2 Metric can be triggered by one day (e.g. October 30), although the reservoir does not typically refill once it is dry.

3 In 1924, the local flows (accretion) reach 0 cfs from mid-July through mid-October in both baseline operations (reservoir depleted to meet RPA flows) and unimpaired conditions. Additionally, Lake Pillsbury was depleted from late August to late October in 1924.

Table SC3-4. Summary of Russian River performance metrics for the WY 1911-2017 period of record (107 years).

Model Junction	Evaluation Metric	Baseline Operations	Scenario 3: PVP Decommissioning and Modified Russian River	Scenario 3 Percent Change from Baseline Operations Scenario
Lake Mendocino	Average Annual Inflow (ac-ft)	173,380	97,057	-44%
	Standard Deviation of Average Annual Inflow (ac-ft)	67,567	58,396	-14%
	Relative Standard Deviation (%)	39%	60%	54%
	Minimum Average Annual Inflow (ac-ft)	21,099	4,260	-80%
	Average Overall Storage (ac-ft)	66,659	56,300	-16%
	Average Low Point of Annual Storage (March-February) (ac-ft)	45,034	28,422	-37%
	Standard Deviation of Low Point of Annual Storage (ac-ft)	16,508	14,272	-14%
	Relative Standard Deviation (%)	37%	50%	37%
	Number of Years Below Minimum Storage at Any Time During the Year (reservoir depletion)	1	13	1200%
Russian River at Cloverdale	Average June-September flows (cfs)	147	88	-40%
	Minimum Weekly June-September flows (cfs)	0	0	-
	Standard Deviation of Minimum Weekly June-September flows (cfs)	25	31	21%
	Relative Standard Deviation (%)	0%	0%	39%
Russian River at Healdsburg	Average October-December flows (cfs)	1,075	937	-13%
	Minimum Weekly October-December flows (cfs)	0	0	0
	Standard Deviation of Minimum Weekly October-December flows (cfs)	2,396	2,329	-3%
	Relative Standard Deviation (%)	0%	0%	6%
	Average water year volumes (ac-ft)	906,151	829,749	-8%
	Standard Deviation of Average water year volumes (ac-ft)	507,077	499,911	-1%
	Relative Standard Deviation (%)	56%	60%	8%

Table SC3-5. Summary of PVID performance metrics for the WY 1911-2017 period of record (107 years).

Model Junction	Evaluation Metric	Baseline Operations	Scenario 3: PVP Decommissioning and Modified Russian River	Scenario 3 Percent Change from Baseline Operations Scenario
Diverted to Potter Valley via Tunnel (E-16)	Average Water Year Volumes (ac-ft)	78,077	0	-100%
	Standard Deviation of Average water year volumes (ac-ft)	14,615	0	-100%
	Relative Standard Deviation (%)	19%	0%	-99%
	Minimum Water Year Volume (ac-ft)	24,377	0	-100%
PVID pumpback from Lake Mendocino (May-Oct)	Average Water Year Volumes (ac-ft)	N/A[1]	14,109	N/A[1]
	Standard Deviation of Average water year volumes (ac-ft)	N/A[1]	2,601	N/A[1]
	Relative Standard Deviation (%)	N/A[1]	18%	N/A[1]
	Minimum Water Year Volume (ac-ft)	N/A[1]	0	N/A[1]
PVID water supply deficiencies (<15,140[2] ac-ft)	90th Percentile Deficiency Volumes (ac-ft)	0	5,161	-
	Maximum May -Oct Deficiency Volume (ac-ft)	5,996	15,140	152%
	Number of years May-Oct PVID delivery less than 15,140 ac-ft	2	22	1000%

1 N/A because PVID pumpback does not occur.

2 Reported 2016 water use

3. OVERVIEW OF RESULTS

This summary of results compares Scenario 3 (Russian River FIRO and Fish Flow EIR) to baseline operations, highlighting differences in flow and water storage availability at key locations in both the Eel River and Russian River basin.

Eel River Results (Below Scott Dam and Below Cape Horn Dam)*

- Eel River flows become run-of-the river (can no longer be managed due to loss of storage in Lake Pillsbury). Flows would no longer be impounded behind Scott Dam during winter months and stored for release during drier parts of the year.
- Daily average flow in the reach below Lake Pillsbury would generally be 100 cfs to 200 cfs higher in winter andspring, and 100 cfs to 200 cfs lower during summer and early fall months without Scott Dam.
- Daily average flow in the reach below Cape Horn Dam are also 100 cfs to 200 cfs higher in winter and spring. During summer and fall, they are 10 cfs to 50 cfs lower, depending on the exceedance condition.
- In January and February, flows below Scott Dam are 10 cfs to 200 cfs higher during wetter conditions and up to approximately 100 cfs lower during drier conditions.
- During March and April, flows below Scott Dam are 10 cfs to 400 cfs higher than baseline operations.
- Beginning in May and continuing through December, flows below Scott Dam are 100 cfs to 150 cfs lower than baseline operations. The difference between the two scenarios is greatest during the June through October period, and is largely independent of water year conditions.
- Flows below Cape Horn Dam are up to 400 cfs higher than baseline operations from January through May, with the exact difference varying by water year condition.
- Flows remain as much as 75 cfs higher in June, as spring recession flows begin to transition into low summer baseflows.
- Beginning in July and continuing through October, flows below Cape Horn Dam are similar to baseline operations because baseline operations flows are similar to unimpaired flows during summer months.
- During November and December, flows are higher during wetter water year conditions and lower during drier water year conditions, compared to baseline operations.

******Note same as Scenario 1.*

Potter Valley Diversion Results

- There are no longer diversions from the Eel River to the East Fork Russian River, such that Eel River water is no longer provided to PVID. Instead PVID supply is provided by pumpback from Lake Mendocino. The East Branch Russian River has limited natural flow during the dry season to support irrigation and other uses. PVID operations would need to be altered to store local runoff, and there may not be enough water supply to meet PVID demand.

Russian River Results

- Calpella demand of approximately 8,600 ac-ft/years is applied in model, but simulated depletion ranges from 600 ac-ft to 9,200 ac-ft, due to low unimpaired flows during the irrigation season and restricted PVID pumpback when Lake Mendocino storage drops below 15,000 ac-ft.
- Calpella flows and inflows to Lake Mendocino are <10 cfs to approximately 150 cfs lower than baseline operations due to the lack of PVP diversion.
- Storage in Lake Mendocino will be higher during wetter years compared to drier years. During drier year types, storage is consistently lower than baseline operations and may not always reach the increased flood storage elevation. The reservoir was depleted 13 years over the modeled 1910-2017 period of record.
- For wetter year types, maximum storage in Lake Mendocino will be greater than baseline operations due to the increase in the flood storage rule curve to allow an increased volume of storage.
- Releases from Lake Mendocino are adjusted to account for the lower minimum instream flows required in the Fish Flow EIR (ranging from 0 cfs to 80 cfs, depending on month and water year type).
- Along the Russian River downstream of Lake Mendocino (Forks, Hopland, Cloverdale, and Healdsburg), Scenario 3 flows outside of flood events will be lower than baseline operations because Fish Flow EIR minimum instream flows are lower than D1610 flows.

APPENDIX OF DETAILED RESULTS COMPARING BASELINE OPERATIONS AND SCENARIO 3