Russian River Watershed

Final Viability Assessment of the Forecast Informed Reservoir Operations at Lake Mendocino

Baseline Conditions

June 2020

Prepared for: Lake Mendocino FIRO Steering Committee

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Table of Contents:

<u>I.</u>	Ove	erview	1
<u>II.</u>	Net	twork Elements	1
	<u>A.</u>	Upper Watershed	3
	<u>B.</u>	Middle Watershed	6
	<u>C.</u>	Lower Watershed	9
<u>III.</u>	HE	C-ResSim Data Development	11
	<u>A.</u>	Inflows	11
	<u>B.</u>	Consumptive Withdrawals	12
	<u>C.</u>	Lookback Data	12
	<u>D.</u>	Miscellaneous External Data	14
<u>IV.</u>	Coy	yote Valley Dam (Lake Mendocino)	14
<u>1.</u>]	Phys	sical Characteristics	14
	<u>A.</u>	Pool	16
	<u>B.</u>	Evaporation	
	<u>C.</u>	Dam	
	<u>D.</u>	Power Plant	19
<u>2. C</u>)pera	ation Sets	20
	<u>A.</u>	Baseline Operation Set	21
	<u>B.</u>	Rule Descriptions	23
		<u>1.</u> <u>Rule: Limit Rel thru Pwr Plant</u>	24
		2. Rule: MaxReleaseFlood_Gates	25
		3. <u>Rule: Dummy_Pillsbury TS</u>	26
		4. Rule: RVWD Full Diversion	27
		5. Rule: Min25-Release	
		6. IF_Block: WSC I-1610 Q-TUCP	29
		7. IF_Block: DROC_April2016	
		8. Rule: IROC_BIOP	
		9. IF_Block: Hopland fn of WF	
		10. Rule: MaxReleaseWCM-FC	45
<u>V.</u>	Wa	arm Springs Dam (Lake Sonoma)	45
<u>1.</u>]	Phys	sical Characteristics	48
	<u>A.</u>	Pool	
	<u>B.</u>	Evaporation	
	C.	<u>Dam</u>	

<u>2. C</u>)pera	tion Sets	50
	<u>A.</u>	Baseline Operation Set	.50
	<u>B.</u>	Rule Descriptions	.52
		1. Rule: MaxReleaseFlood_Gates	.53
		2. Rule: Min70-Base Hatchery	.53
		3. If_Block: WSC I-1610 Q-TUCP	.54
		4. Rule: DROC_BIOP	.58
		5. Rule: IROC_BIOP	.59
		6. Rule: MaxatGeyserville	.60
		7. Rule: MaxatGuerneville Gage	.61
		8. IF Block: Rising 5000	.62
<u>VI.</u>	<u>Roi</u>	<u>iting</u>	66
VII	<u>Div</u>	ersions	68
	<u>A.</u>	Potter Valley Project	.68
	<u>B.</u>	Consumptive Withdrawals	.68
VII	<u>[.</u>	Baseline Validation Results	71
	<u>1.</u>	<u>1986 Event</u>	.72
	<u>2.</u>	<u>1995 Event</u>	.73
	<u>3.</u>	<u>1997 Event</u>	.73
	<u>4.</u>	2006 Event	.74
<u>IX.</u>	<u>Rer</u>	resentation of Baseline Operation	76
	<u>A ty</u>	pical flood operation and conservation operation simulated at Coyote Valley Dam for the	
	<u>Bas</u>	eline alternative is provided in this section.	.76
	<u>A.</u>	Coyote Valley Dam	.76
		1. Flood operations	.76
		2. Conservation Operation	.77
<u>X.</u>	Des	cription of State Variables	78
	<u>A.</u>	StorageState	.78
	<u>B.</u>	Slave CombineStorageid May31	.80
<u>XI.</u>	Ref	erence	80

List of Tables:

Table 1 list of Consumptive Diversions	 2

List of Figures:

Figure 1 HEC-ResSim Schematic Display	2
Figure 2 Overview Map_Upper Part of the Watershed	3
Figure 3 Network Elements_Upper Part of the Watershed	
Figure 4 Overview Map_Middle Part of the Watershed	
Figure 5 Network Elements_Middle Part of the Watershed	8
Figure 6 Network Elements_Confluence of Dry Creek and Russian River	9
Figure 7 Overview Map_Lower Part of the Watershed	10
Figure 8 Network Elements_Lower Part of the Watershed	11
Figure 11 Coyote Valley Dam Area	15
Figure 12 Coyote Valley Dam Outlet Area	16
Figure 13 Reservoir Editor – Physical Tab - Lake Mendocino Pool	17
Figure 14 Reservoir Editor – Physical Tab - Lake Mendocino Evaporation	18
Figure 15 Reservoir Editor – Physical Tab - Lake Mendocino Dam	19
Figure 16 Reservoir Editor – Physical Tab - Lake Mendocino Power Plant	20
Figure 17 Zone Elevations for Baseline Operation Set - Lake Mendocino	21
Figure 15 Release Allocation - Lake Mendocino	22
Figure 16 Zones and Rules - Lake Mendocino	24
Figure 17 Limit Rel thru Pwr Plant Rule	25
Figure 18 MaxReleaseFlood_Gates Rule	26
Figure 19 Dummy_Pillsbury TS Rule	27
Figure 20 RVWD Full Diversion Rule	28
Figure 21 Min25-Release Rule	29
Figure 25 WSC I-1610 Q-TUCP Rule	30
Figure 26 Minimum Requirements at Downstream Locations	31
Figure 27 WSC I-1610 Q-TUCP Rule - (State 1 or 2)	32
Figure 28 WSC I-1610 Q-TUCP Rule - (State 3)	33
Figure 29 WSC I-1610 Q-TUCP Rule - (State 4)	34
Figure 30 WSC I-1610 Q-TUCP Rule - (Dry)	35
Figure 31 WSC I-1610 Q-TUCP Rule- (Critical)	35
Figure 32 Decreasing Rate Of Change (DROC_April2016) Rule	36
Figure 33 March15-May 15 - DROC_April2016 Rule	37
Figure 34 May 16-March 14 - DROC_April2016 Rule	37
Figure 35 Increasing Rate Of Change (IROC_BIOP) Rule	
Figure 36 Hopland fn of WF Rule	40

Figure 37	Hopland fn of WF_State is Rising	41
Figure 38	Hopland fn of WF_State is Falling	42
	Hopland fn of WF_State is Falling pool Elev>=755	
	Hopland fn of WF_State is Falling_Pool elev <755	
Figure 41	MaxReleaseWCM-FC Rule	45
Figure 42	HEC-ResSim Map Display Showing Location of Warm Springs Dam	47
Figure 43	Reservoir Editor - Physical Tab - Lake Sonoma Pool	48
Figure 44	Reservoir Editor - Physical Tab - Lake Sonoma Evaporation	49
Figure 45	Reservoir Editor - Physical Tab - Lake Sonoma Dam	50
Figure 46	Zone Elevations for Baseline Operation Set - Lake Sonoma	51
Figure 47	Release Allocation - Lake Sonoma	52
Figure 48	Zones and Rules - Lake Sonoma	52
Figure 49	MaxReleaseFlood_Gates Rule	53
Figure 50	Min70-Base Hatchery Rule	54
Figure 51	WSC I-1610 Q-TUCP Rule	55
Figure 52	WSC I-1610 Q-TUCP Rule - (Normal)	56
Figure 53	WSC I-1610 Q-TUCP Rule - (Dry)	57
Figure 54	WSC I-1610 Q-TUCP Rule - (Critical)	58
Figure 55	DROC_BIOP Rule	59
Figure 56	IROC_BIOP Rule	60
Figure 57	MaxatGeyserville Rule	61
Figure 58	MaxatGuerneville Gage Rule	62
Figure 59	Rising_5000 Rule	65
Figure 61	Diversions	68
Figure 62	"Calpella Div" and "Redwood Valley Div" Diversions	69
Figure 63	"Hopland Div" and "Cloverdale Div" Diversions	70
Figure 64	"Healdsburg Div" and "Dry Creek Div" Diversions	70
Figure 65	"Hacienda Div" Diversion	71
Figure 66	Baseline Validation Results 1986 Event	72
Figure 67	Baseline Validation Results _1995 Event	73
Figure 68	Baseline Validation Results 1997 Event	74
Figure 69	Baseline Validation Results 2006 Event	75
Figure 70	Baseline Validation Results _2000-2017	75
Figure 71	Simulated Flood Operations - POR Baseline Lake Mendocino	77
Figure 72	Simulated Conservation Operations – POR Baseline Lake Mendocino	78

HEC-ResSim Model of the Baseline Alternative

I. Overview

This report describes the HEC-ResSim model for the existing condition alternative (named "Baseline") of the Final Viability Assessment (FVA) of Forecast Informed Reservoir Operations (FIRO) research and development project at Lake Mendocino in the Russian River watershed in the State of California. The HEC-ResSim baseline alternative represents current reservoir operation and boundary condition assumptions, such as extra-basin diversions and evaporation losses. The results serve as a "baseline" for relative comparisons to alternative reservoir operation plans.

HEC-ResSim version 3.4 Build 106, which is an unreleased development version, was used to model the reservoir operations. The reservoir systems model was developed using NGVD 29. The HEC-ResSim model contains one network named "POR" and simulates the reservoir operation for the Period of Record (POR) of 1985-2017. In addition, five scaled events were evaluated to capture possible flood events larger than those experienced: actual events from 1986, 1997, 2006, March 1995, and a synthetic event referred to as "Extended 2006".

The FVA HEC-ResSim model was derived from the HEC-ResSim model created by HEC on Feb 2018 for the Preliminary Viability Assessment (PVA) study for FIRO (HEC, 2018). HEC got the original PVA HEC-ResSim model from Sonoma Water and that watershed is the updated version of the HEC-ResSim model created by HEC on July 2012 (HEC, 2012).

II. Network Elements

Figure 1 shows the HEC-ResSim schematic displayed to the full extents of the Russian River watershed. The orange lines represent the stream alignment, with small green circles marking the endpoints and junctions. The light blue shapes indicate Lake Mendocino and Lake Sonoma. The red lines show the subbasin delineations. Red circles indicate HEC-ResSim junctions, which were created to establish locations for model inputs, outputs, or places of interest, such as gages providing observed values for model calibration. Many of the junctions indicate changes in stream flow, such as a confluence, diversion out of the river, or a contribution from a local subbasin. The white "halo" around certain junctions indicates a local flow assignment, where local flow enters the network. Some junctions also played a role in reservoir rules. Specifically, squares around a HEC-ResSim junction indicate that a reservoir operates to meet a flow requirement for that location.

The junctions are connected by reaches, dark blue lines, with small blue arrows that indicate direction of flow. Reaches are used to route flow along the river. The detail of the routing reaches are discussed in *Section VI* of this report. On the schematic (Figure 1), black arrows represent diversions, which are explained in detail in *Section VII* of this report. Each HEC-ResSim element carries a label, although the rendering is scale-dependent and usually few labels are visible unless the user has magnified a region in the schematic.

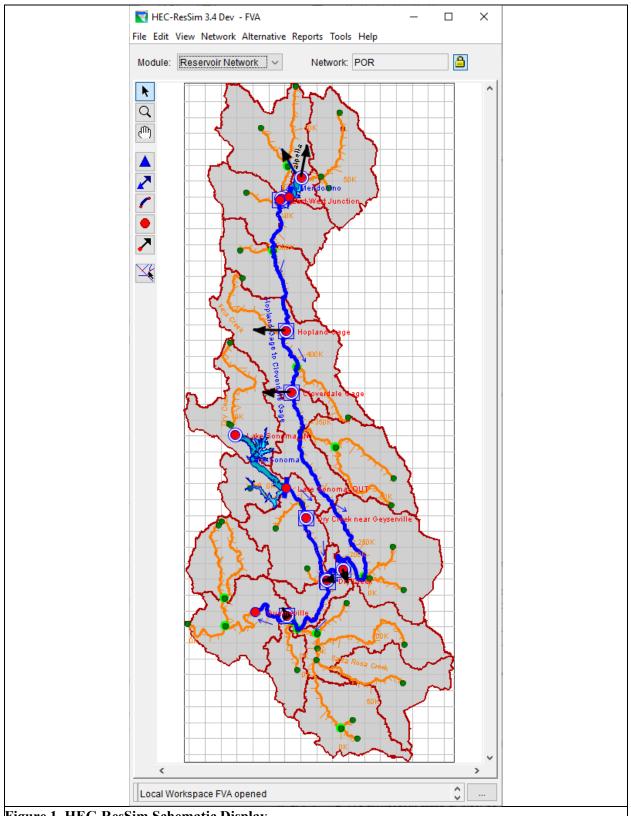


Figure 1 HEC-ResSim Schematic Display

A. Upper Watershed

Figure 2 shows an overview map of the upper part of the watershed, which includes the area above Lake Mendocino and the area below the confluence of East Fork and West Fork.

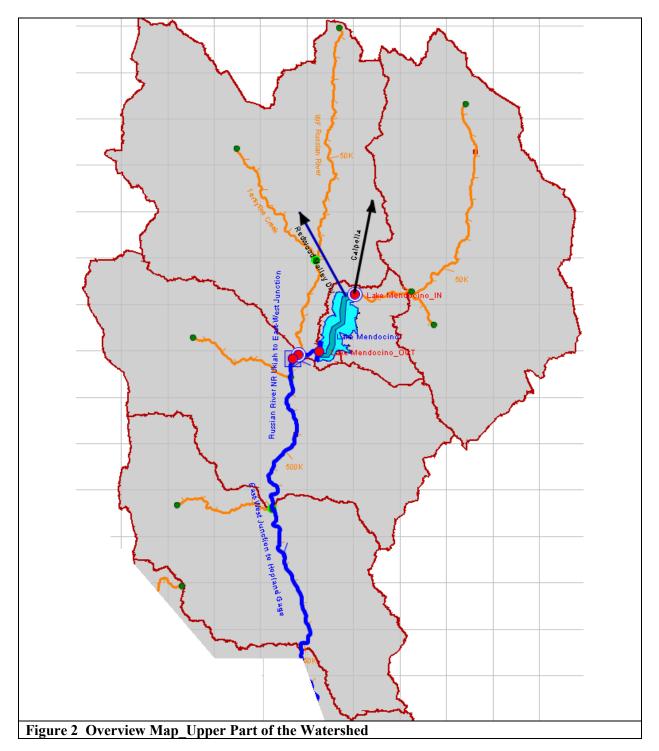


Figure 3 shows the key network elements in the upper part of the watershed.

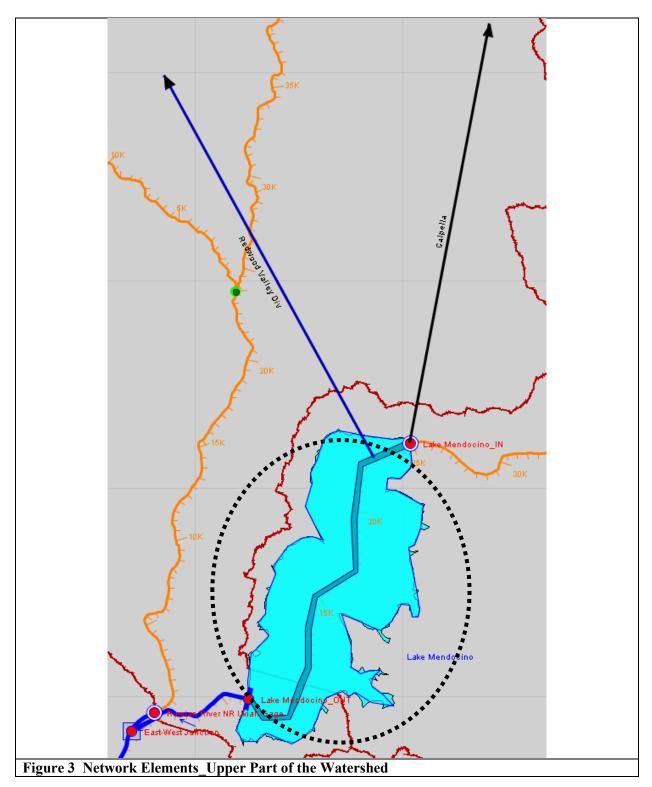
The light blue area marked with the dotted circle in Figure 3 shows the location of Lake Mendocino. The reservoir pool contains a diversion named "Redwood Valley Div" and is shown with a dark blue arrow in Figure 3.

The "Lake Mendocino_IN" junction is the headwater junction on the East Fork Russian River and it marks the upstream end of the reservoir. Subbasin flows for the East Fork enter the HEC-ResSim model here, and provide the inflow to the reservoir. Diversion flows from the Eel River enter the Russian River at this junction (*Section VII.A*). The Calpella diversion also occurs here.

The downstream end of the reservoir is marked by the junction named "Lake Mendocino_OUT".

The "Russian River NR Ukiah Gage" junction is located very low in the West Fork, just above the confluence with the East Fork, and is the headwater junction on the West Fork Russian River. The flows for the West Fork subbasin are added at this location. Flows at this location play a role in Lake Mendocino flood operation rules.

The "East-West" junction marks the confluence of East Fork and West Fork, and Lake Mendocino operates to provide minimum flows at this location.



B. Middle Watershed

Figure 4 shows an overview map of the middle part of the watershed, which includes the area above Lake Sonoma to the confluence of Dry Creek with the Russian River, as well as Hopland Gage to the confluence with Dry Creek.

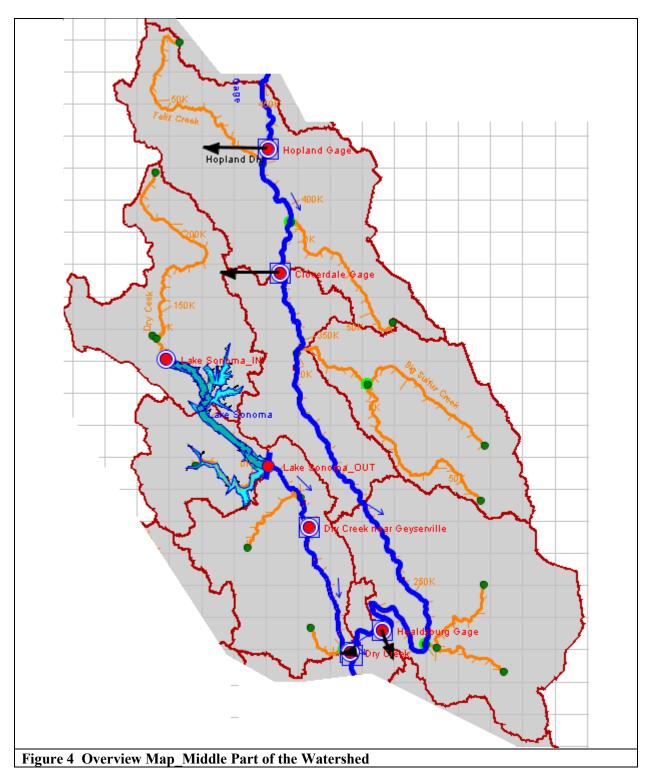


Figure 5 shows the network elements in the middle part of the watershed.

The light blue area marked with the dotted circle in Figure 5 shows the location of Lake Sonoma. The "Lake Sonoma_IN" junction is the headwater junction on Dry Creek. It marks the upstream end of the reservoir, and adds local inflow from the catchment surrounding the reservoir. The downstream end of the reservoir is marked by the junction named "Lake Sonoma_OUT".

"Dry Creek near Geyserville" is a downstream control point where Lake Sonoma operates for maximum flow. It also captures a portion (7.7%) of the local flow at Guerneville Gage junction. Another portion, 13.3%, of the local flow at Guerneville Gage enters the system at "Dry Creek" junction and the remaining 79% of the local flow at Guerneville Gage enters the system at "Guerneville Gage" junction.

Lake Mendocino operates for both minimum and maximum flows at the "Hopland Gage" junction. This location also marks the location of a diversion (Hopland Div) and adds local flows from the subbasin below East-West junction.

"Cloverdale Gage" junction represents the location of the Cloverdale stream gage and captures the local flows from a subbasin above this junction. It also marks the location of a diversion (Cloverdale Div). Lake Mendocino operates for minimum flow at this junction.

"Healdsburg Gage" is the downstream location that Lake Mendocino operates for the minimum flow. It also marks the location of a diversion (Healdsburg Div) and captures local flows from a subbasin above this junction.

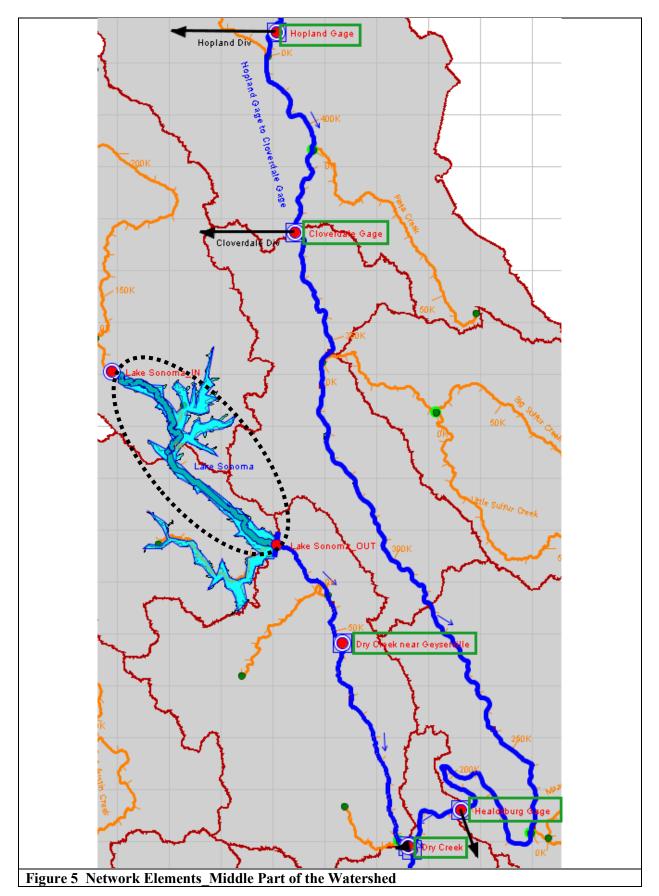
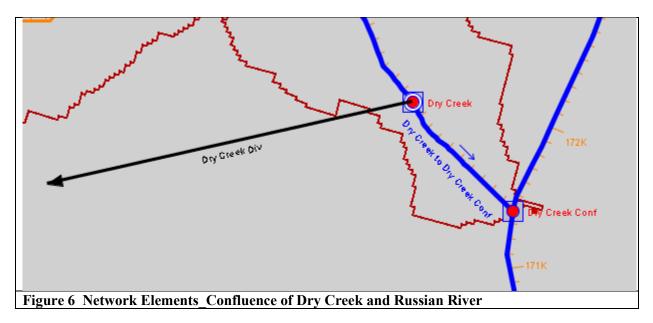


Figure 6 shows the confluence of Dry Creek and Russian River with "Dry Creek Conf" junction. "Dry Creek" and "Dry Creek Conf" junctions are downstream control locations where Lake Sonoma operates for minimum flow. A portion of the local flow at Guerneville Gage junction (13.3%) is added to the system at "Dry Creek" junction. This junction also marks the location of a diversion ("Dry Creek Div").



C. Lower Watershed

Figure 7 shows an overview map of the lower part of the watershed, below the confluence of the Russian River and Dry Creek.

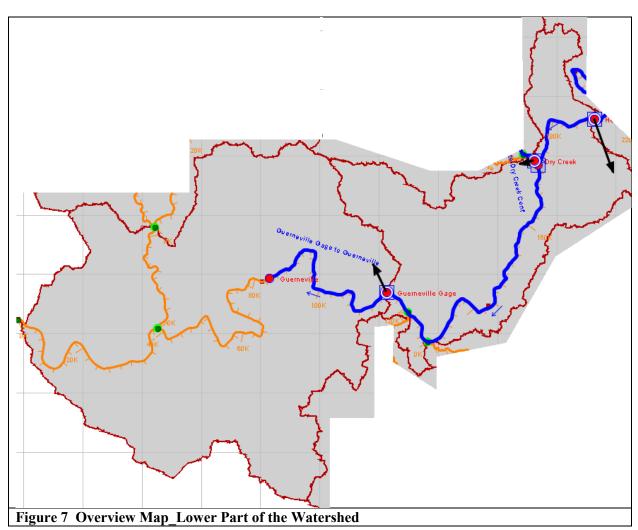
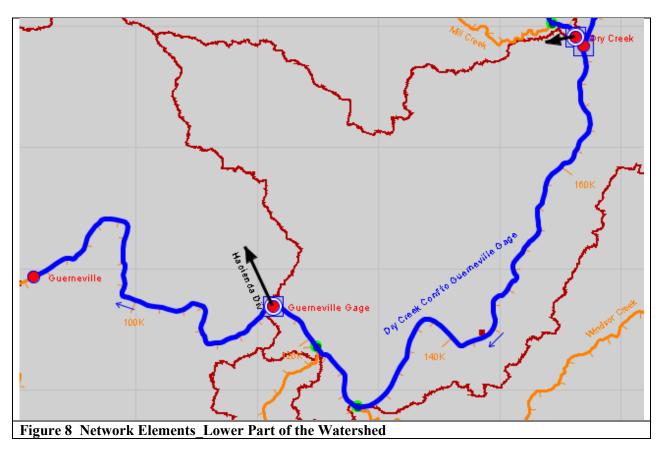


Figure 8 shows the network elements in the lower part of the watershed. "Guerneville Gage" is a downstream control location where Lake Sonoma operates for both minimum and maximum flows. The remaining portion (79%) of the local flow at Guerneville is added to this junction. It also marks the location of a diversion (Hacienda Div).

The most downstream point of the watershed is marked with the "Guerneville" junction.



The Russian River watershed has no explicit system operation. However, Lake Sonoma operates to provide minimum flows in the lower Russian River (at the "Dry Creek Conf" and "Guerneville Gage" junctions) and to comply with maximum flow limitations at Guerneville, so Lake Mendocino releases to the Russian River can indirectly impact Lake Sonoma releases.

III. HEC-ResSim Data Development

A. Inflows

The California-Nevada River Forecast Center (CNRFC) of the National Weather Service (NWS) provided both reservoir inflows and local inflows at HEC-ResSim junctions along the Russian River and Dry Creek. The CNRFC flows resulted from a period of record hourly simulation of the watershed model used in producing streamflow forecasts for the Russian River. Some of the flows were later replaced by others computed in a mass balance approach by Sonoma Water.

The only other inflow to the system was the diversion from the Eel River through the Potter Valley Project (PVP) into the headwaters of the East Fork Russian River. The PVP flows used in this study were modeled by Sonoma Water to reflect Pacific Gas and Electric's (PG&E's) operation of the Potter Valley Hydroelectric Project since 2006 under an amended FERC license. Details are provided in the Lake Mendocino Water Supply Reliability Evaluation Report (SCWA, 2015, Section 2.2, Technical Memorandum).

B. Consumptive Withdrawals

Sonoma Water provided a time-series of estimated diversions from the Russian River (*Section VII.B*). The seven diversions out of the system (Table 1) used in the HEC-ResSim model represent simplified net aggregations of specific diversions, return flows, aquifer recharge, and a variety of distributed losses.

	Table 1 list of Consum
Diversion Name	Location
Redwood Valley Div	Coyote Valley Dam
Calpella Div	Lake Mendocino_IN junction
Hopland Div	Hopland Gage Junction
Cloverdale Div	Cloverdale Gage Junction
Healdsburg Div	Healdsburg Junction
Dry Creek div	Dry Creek Junction
Hacienda Div	Guerneville Gage

The diversion values were generally derived according to the procedures described in the Lake Mendocino Water Supply Reliability Evaluation Report, with some refinements and updates implemented for the FIRO project (SCWA, 2015).

C.Lookback Data

The initial conditions for the reservoir simulation were defined in the Lookback tab of the HEC-ResSim Alternative Editor (Figure 9). In addition to establishing the initial reservoir elevation and values for state variables, the lookback period provided a warm-up period for the reservoir simulation. The data provided during the lookback period allowed the start of the simulation to proceed with fully defined values in operational rules. The lookback period must also cover the time required to route releases to the farthest downstream control point. The longest such dependency in this study was 7 days, which was used as the lookback period for all the reservoir simulations.

In the Lookback tab of the POR baseline simulations, diversion flows were set to zero and state variables were set to their default values. The lookback releases for Lakes Mendocino and Sonoma were taken from preliminary simulation results and set to release from the power plant outlet. The lookback elevations for Lake Mendocino and Lake Sonoma were set to their guide curve values (737.5 for Lake Mendocino and 451.1 for Lake Sonoma) (Figure 9).

In the Lookback tab of the scaled event baseline simulations, diversion flows were set to zero, and state variables were set to their default values. Constant outflows of 100 cfs from the power plant outlet were used for both Lake Sonoma and Lake Mendocino. The lookback storage values for Lakes Mendocino and Sonoma were taken from the time series of POR storage (Figure 10).

lame:	Baseline									
escription:										
eservoir Ne	twork POR									
Run Control	Operations	Lookback	Time-Series	Observed Data	DSS Out	put Hotstart	Yield Analysis	Ensemble	Monte Carlo	
	Location			Variable			Туре		Default Valu	e
_ake Sonom	na-Pool		Lookback El	evation	C	Constant		~		451.1
Lake Sonoma-Pool		Lookback Storage		C	Computed		~			
ake Sonom	na-Controlled C	outlet	Lookback R	elease	C	Constant		~		0.0
ake Sonom	na-Power Plant		Lookback R	elease	Т	ime-Series		~		
ake Sonom	a-Uncontrolled	d Outlet	Lookback Sp	bill	C	Constant		\sim		0.0
ake Mendo.	cino-Pool		Lookback El	evation	C	Constant		\sim		737.5
ake Mendo	cino-Pool		Lookback St	orage	C	Computed		\sim		
ake Mendo.	cino-Controlled	d Outlet	Lookback R	elease	C	Constant		\sim		0.0
ake Mendo.	cino-Power Pla	ant	Lookback R	elease	Т	ime-Series		\sim		
ake Mendo.	cino-Uncontrol	led Outlet	Lookback Sp	pill	C	Constant		\sim		0.0
ake Mendo	cino-RVCWD E	Div	Lookback R	elease	C	Constant		\sim		0.0
lopland Div	-Cntrl		Lookback Di	version	C	Constant		\sim		0.0
Healdsburg	Div-Cntrl		Lookback Di	version	C	Constant		\sim		0.0
Dry Creek Di	iv-Cntrl		Lookback Di	version	C	Constant		\sim		0.0
Hacienda Di	v-Cntrl		Lookback Di	version	C	Constant		\sim		0.0
Calpella-Cnt	trl		Lookback Di	version	C	Constant		~		0.0
Cloverdale E	Div-Cntrl		Lookback Di	version	C	Constant		\sim		0.0
Slave_Comb	oineStorageid_	May31	Lookback St	ate Variable	C	Constant		\sim		1.0
StorageState	e		Lookback St	ate Variable	C	Constant		\sim		1.0

Name: 1986-200 Description: ... Reservoir Network POR Run Control Operations Lookback Time-Series Observed Data DSS Output Hotstart Yield Analysis Ensemble Monte Carlo Location Variable Туре Default Value Lake Sonoma-Pool Lookback Elevation ^ Computed \sim Lake Sonoma-Pool Lookback Storage Time-Series ~ Lake Sonoma-Controlled Outlet Lookback Release Constant ~ 0.0 100.0 Lake Sonoma-Power Plant Lookback Release Constant ~ ~ Lake Sonoma-Uncontrolled Outlet Lookback Spill Constant 0.0 ~ Lake Mendocino-Pool Lookback Elevation Computed Lake Mendocino-Pool Lookback Storage Time-Series Lake Mendocino-Controlled Outlet Lookback Release Constant ~ 0.0 Lake Mendocino-Power Plant Lookback Release Constant 100.0 Lake Mendocino-Uncontrolled Outlet Lookback Spill Constant 0.0 Lake Mendocino-RVCWD Div Lookback Release Constant 0.0 \sim Hopland Div-Cntrl Lookback Diversion Constant ~ 0.0 Healdsburg Div-Cntrl Lookback Diversion Constant 0.0 \sim Dry Creek Div-Cntrl Lookback Diversion Constant \sim 0.0 Hacienda Div-Cntrl Lookback Diversion Constant \sim 0.0 Calpella-Cntrl Lookback Diversion Constant \sim 0.0 Cloverdale Div-Cntrl Lookback Diversion Constant \sim 0.0 Slave_CombineStorageid_May31 Lookback State Variable Constant \sim 1.0 Lookback State Variable 1.0 🗸 StorageState Constant Figure 10 Lookback Data – Scaled Events Baseline

D. Miscellaneous External Data

Rules and state variables used in the simulations required certain inputs to be specified throughout the analysis period. The Lake Pillsbury storage amount was used by the state variable (*StorageState*), which computed a storage index. The details of state variables are discussed in *Section X* of this report. Also, a time series referring to a hydrologic index, which may be "Normal", "Dry", or "Critical," was used in the *WSC I-1610 Q-TUCP* If Block in the Lake Mendocino operation set (*Section IV.2.B.6*).

IV. Coyote Valley Dam (Lake Mendocino)

Coyote Valley Dam (CVD) project was authorized by the Flood Control Act of 1944 for the purposes of flood control, water supply, recreation and stream flow regulation. It was constructed by the United States Army Corps of Engineers (USACE) in 1959. Lake Mendocino was created with the construction of the CVD project on the East Fork of the Russian River.

Inflow into the reservoir consists of natural flows from the contributing watershed area and additional water from the Eel River diverted through the Potter Valley Project, a hydroelectric facility owned and operated by PG&E. The City of Ukiah operates a hydroelectric facility at the CVD that utilizes incidental releases. USACE coordinates releases from CVD during flood management operations. The operation of CVD is performed by USACE-San Francisco District project operators. As the local sponsor, Sonoma Water coordinates water supply release from CVD in accordance with its water rights permits and the State Water Resources Control Board (SWRCB) Decision 1610. The California Department of Fish and Wildlife operates a fish facility. National Marine Fisheries Service (NMFS) has an ongoing cooperation agreement with USACE regarding making modifications to ramping procedures to minimize and avoid adverse impact to listed salmonids.

The flood control and water supply operation was established in the Water Control Manual published by USACE originally in April 1959, modified in 1986 and most recently revised in 2003.

1. Physical Characteristics

Coyote Valley Dam is an earth embankment dam approximately 160 feet high with a crest length of 3,500 feet. Lake Mendocino has a total current storage capacity of 116,500 acre-feet (AF), which includes a water supply pool of between 68,400 AF and 111,000 AF, depending on the time of year. Based on reservoir bathymetric surveys (original in 1952 and most recently in 2001), the average sedimentation rate in the reservoir is estimated to be 143 acre-feet per year.

The watershed of the reservoir has an area of approximately 105 square miles, which is approximately seven percent of the total watershed area of the Russian River Basin. Average annual inflow into the reservoir since the construction of Coyote Valley Dam is approximately 230,000 AF, with a maximum annual inflow of 443,000 AF in 1983 and a minimum annual inflow of 60,000 AF in 1977. Inflow into the reservoir consists of unimpaired flows from the

contributing watershed area and a portion of the water diverted though the Potter Valley Project from the Eel River.

The Coyote Valley Dam and adjacent area, looking north in a "tilted" satellite view, is displayed in Figure 11. The spillway of Lake Mendocino is located in a low saddle about 0.6 miles upstream from the southern abutment of the dam. The spillway discharges flows through Howard Creek until joining the Russian River just north of the Ukiah city limits. The spillway structure consists of an 800-foot long approach channel and a 200-foot wide rectangular weir. Since construction of Coyote Valley Dam, the spillway has only been activated once in December of 1964 when reservoir inflows exceeded 14,000 cfs.

Location of the controlled outlets for Lake Mendocino are displayed in Figure 12. Water is conveyed to the outlet works of Coyote Valley Dam by a single reinforced concrete pipe approximately 720 feet long and eleven feet and ten inches in diameter. The flow through this



Figure 11 Coyote Valley Dam Area



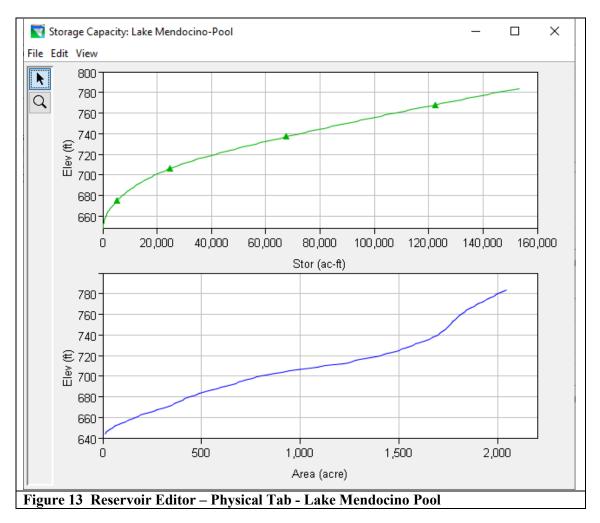
Figure 12 Coyote Valley Dam Outlet Area

tunnel may be directed to the power plant, or passed through a flood control gate. Maximum release capacity of the controlled outlet is approximately 7,500 cfs when the water surface elevation is within the Emergency Release Pool (above elevation 773 feet mean sea level). The powerhouse contains two turbine/generator units with rated power generation capacities of 2,500 and 1,000 kilowatts.

The physical characteristics of the reservoir are separated between the *Pool* and the *Dam* in the HEC-ResSim model.

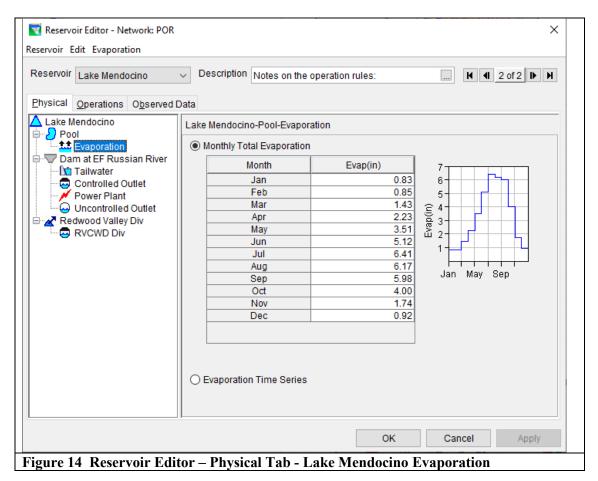
A. Pool

The *Elevation-Storage-Area* defines the pool as shown in Figure 13. The Lake Mendocino elevation-storage-area relationship was taken from the 2003 version of the Coyote Valley Dam Water Control Manual, Exhibit A (USACE, 2003).



B. Evaporation

Monthly evaporation losses from Lake Mendocino are contained in Figure 14. These values were provided by Sonoma Water.



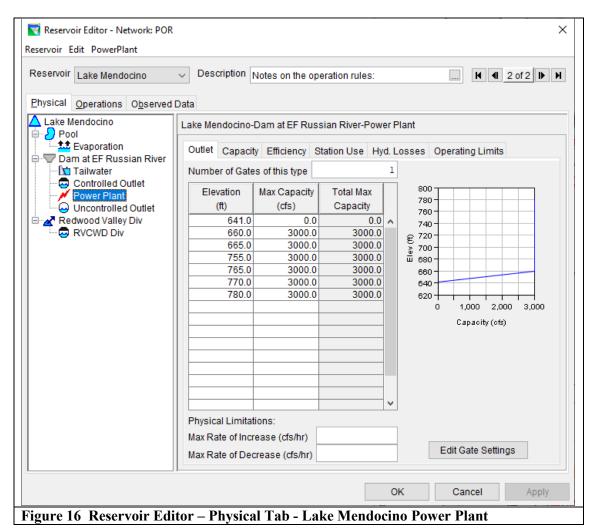
C. Dam

The dam consists of four types of outlets: (1) a controlled outlet, (2) a power plant, (3) an uncontrolled spillway, and (4) a diverted outlet. Each of these outlets is defined in the model as shown in Figure 15, and the dam release table reflects the composite release capacity of all of the outlets.

Lake Mendocino	✓ Description	Notes on the o	peration rules:		H 4 2 of 2 D H
Physical Operations Observed	Data				
Lake Mendocino	Lake Mendocino-	Dam at EF Ru	ssian River		
Dam at EF Russian River	Elevation at top	of dam (ft)		784.	.0
Tailwater	Length at top of	dam (ft)		500.	.0
Power Plant	Composite Rel	ease Capacity			
Controlled Outlet Arrow And Arrow Arrow And Arrow And Arrow And Arrow And Arrow And Arrow And Arr	Elevation	Controlled	Uncontrolled	Total	800
	(ft)	(cfs)	(cfs)	(cfs)	- ⁷⁶⁰
	641.0	900.0	0.0	900.0 🔨	
	660.0	5,800.0	0.0	5,800.0	te € 680
	665.0	6,050.0	0.0	6,050.0	Ξ ₆₄₀
	680.0	6,800.0	0.0	6,800.0	+++++++
	700.0	7,700.0	0.0	7,700.0	0 40,000
	720.0	8,500.0	0.0	8,500.0	Flow
	740.0	9,000.0	0.0	9,000.0	(cfs)
	755.0	9,375.0	0.0	9,375.0	
	760.0	9,500.0	0.0	9,500.0	
	765.0	9,750.0	0.0	9,750.0	
	768.0	9,900.0	2,200.0	12,100.0	
	769.0	9,950.0	3,300.0	13,250.0	
	770.0	10,000.0	4,600.0	14,600.0	
	771.0	10,050.0		16,250.0	
	772.0	10,100.0	8,600.0	18,700.0	1
	773.0	10,150.0		20,750.0	
	775.0	10,250.0		26,050.0	
	778.0	10,400.0	25,000.0	35,400.0	
	780.0	10,500.0	32,000.0	42,500.0	
	781.0	10,500.0		46,000.0	
	784.0	10,500.0	47,300.0	57,800.0	
				×	
				ОК	Cancel Apply

D. Power Plant

The power plant outlet capacity is defined in the model as shown in Figure 16. The power plant installed capacity is 3.5 MW with an overload factor of 1, constant efficiency of 80%, constant station use of 0 cfs, and constant hydraulic loss of 0 ft. The power plant outlet capacity is 3,000 cfs.



2. Operation Sets

USACE determines the schedule and amount of water released from Lake Mendocino during flood control operations, while Sonoma Water manages releases from the conservation pool. Regulation for flood control and water supply operations are described in the "Coyote Valley Dam Water Control Manual - Appendix I", which was originally published by USACE in April 1959 and revised in August 1986. Exhibit A of the Coyote Valley Dam Water Control Manual was most recently revised in September 2003 to incorporate the most recent bathymetric survey information (USACE, 2003).

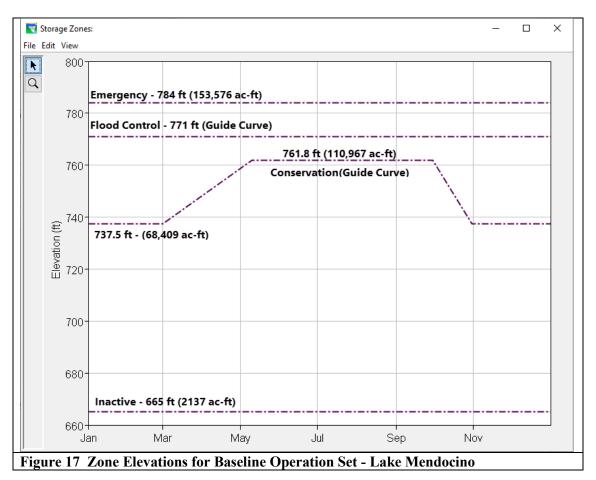
Most of the river downstream relies heavily on Lake Mendocino for flow augmentation during the dry season. The Russian River is facing rising municipal and agricultural demands, while also supporting instream flow requirements for fish species that are listed as threatened. The scarcity of water has become more critical in recent years due to substantial reductions in the water diverted to Lake Mendocino from the neighboring Eel River, through the Potter Valley Project.

Operation of Lake Mendocino is described in the updated Water Control Manual and includes operations for both flood control and water supply (USACE, 2003).

Within HEC-ResSim, different operation sets can be defined for each reservoir, containing the rules for determining reservoir releases. The rules are placed in the different operating zones in order of priority. Rules describe minimum or maximum reservoir releases, which can be based on a number of factors, such as downstream flow and current reservoir storage. Below is a description of the "Baseline" operation set for Coyote Valley Dam at Lake Mendocino.

A. Baseline Operation Set

The Baseline operation set of this study is meant to represent the current operation (existing condition) of the reservoir. Zones are used to define the operational storage levels in the reservoir, to determine the reservoir release through analysis of the rules contained within each zone. Figure 17 shows the definition of Lake Mendocino's "Baseline" operational zones, which consist of zones of Emergency, Flood Control, Conservation, and Inactive zone. These zones each contain a set of operational rules for reservoir operation.



Water management operations at Coyote Valley Dam manage water supply storage in the reservoir according to the reservoir guide curve defined in the Coyote Valley Dam Water Control Manual (Figure 17) and water needs below the reservoir. The guide curve sets the maximum threshold for storage of conservation water in the reservoir.

The top of the conservation operation zone varies seasonally (as shown in Figure 17). From January 1 to March 1 it is set to 737.5 feet (68,409 AF), and from May 10 through September 30, it is 761.8 feet (110,967 AF). The guide curve is lowered in October back to 737.5 feet to empty reservoir flood space, since the flood season in the Russian River watershed typically extends between November through the end of March. Lowering the guide curve in these months provides added flood protection (42,558 AF). The guide curve begins increasing in March because 1) it becomes less likely for large rainfall-runoff events to occur in the Russian River watershed; and 2) it is important to capture (store) any late season runoff before the drier summer and fall months.

The guide curve (Figure 17) that was explained in this section was first implemented in the spring of 2007. Prior to 2007, the increase in the conservation pool from 68,400 AF did not begin until 1 April and reached a maximum level of conservation storage of 86,400 AF (elevation 748 feet) on 20 April. Prior to 2007, the increase in the conservation pool could start on 1 March, but Sonoma Water had to provide a written request to USACE annually.

In the HEC-ResSim model, the available outlets are given an order of priority for release. Figure 18 shows a sequential release allocation approach specified for available outlets along Coyote Valley Dam. The power plant gets the release first until it reaches release capacity. After the capacity through the powerhouse is reached, the remainder of the release goes through the controlled outlet.

The Coyote Valley Dam outlets do not conform to the standard HEC-ResSim release allocation method. The reservoir can either release for power generation or for flood control, meaning the gate and the power house cannot be used at the same time. The HEC-ResSim model contains the ratings for both the gate and powerhouse. Generally, the gate would be used for flood control schedule 3 or higher levels. HEC added a new rule called "limit Rel thru Pwr Plant" to zero the power plant capacity at 755 feet, so that the total controlled outlet capacity above that level reflects only the gate rating. The HEC-ResSim model allocates the release through the powerhouse, up to its maximum of 3000 cfs, with the rest going through the gate.

Operations Observed Data Operation Set Baseline Description Zone-Rules Rel. Alloc. Outrages Stor. Credit Decented Elev	
Zone-Rules Rel. Alloc. Outages Stor. Credit Dec. Sched. Projected Elev	
Allocation Set 1 Release Location: Lake Mendocino-Dam at EF Russian River	
P-V Lake Mendocino-Dam at EF Russian River (1.0) - Sequential Allocation Type: Sequential	~
Lake Mendocino-Power Plant	
Lake Mendocino-Redwood Valley Div (1.0) - Balanced Lake Mendocino-Controlled Outlet	

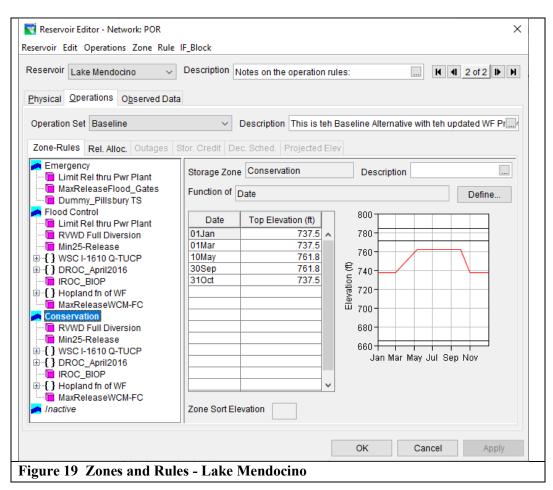
B. Rule Descriptions

HEC-ResSim organizes reservoir-operating criteria into "operation sets", which allowed the study to use the same reservoir model to compare different water management alternatives simply by switching to a different operation set. An overview of the *Baseline* operations set is displayed in Figure 19.

On the Operations tab of the HEC-ResSim Reservoir Editor (Figure 19), the left panel displays the storage zones described in the Coyote Valley Dam Water Control Manual, and the operating rules in each zone. Selecting a zone displays the definition for that zone throughout the calendar year. For example, Figure 19 displays the top of the conservation zone for Coyote Valley Dam. The rules for each zone were arranged in order of priority, with the highest priority on top. The rules reflected maximum releases, minimum releases, or explicitly specified releases.

The maximum flow rules generally came into play with Lake Mendocino in the flood control zone. In the conservation zone, their main application was when the Russian River rose enough to require reduced outflows. Similarly, the minimum flow rules typically only apply to operations when the reservoir pool was in the Conservation zone, with the main exception being the requirement to maintain at least 25 cfs outflow, regardless of zone, which often occurs during flood operation. Consequently, for simplicity the same rule definitions were applied to both the Flood Control and Conservation zones, even though some definitions were irrelevant at that reservoir level. Including the same full set of flow rules in both the Conservation and Flood Control zones also helped more accurately simulate times when the reservoir storage was very near to the guide curve, and could easily cross into the other zone.

Forecast-Informed Reservoir Operation (FIRO) study within Full Viability Assessment (FVA)



1. Rule: Limit Rel thru Pwr Plant

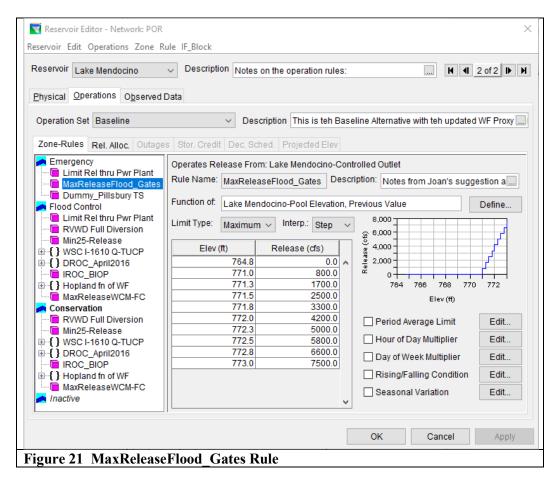
The Lake Mendocino power plant and associated facilities are operated generally in two modes: power generation mode and flood control mode. Power generation mode is in operation when the flood pool is at or below elevation 755 feet, and flood control mode is in operation when the flood pool exceeds elevation 755 feet. In the power generation mode the tainter valve is fully closed, and the turbines and bypass valves are opened as necessary to pass the required water release. In flood operation mode, the tainter valve is fully open and the turbines and bypass valves are fully closed.

The transition operations between power generating mode and flood control operations were modeled using the *Limit Rel thru Pwr Plant* rule. This rule (Figure 20) limits the release to zero from the power plant for elevations above 755 ft. This rule zeroes the power plant capacity at 755 feet, so that the total controlled outlet capacity reflects only the gate rating (only applied to the Flood Control and Emergency zones).

Lake Mendocino	✓ Description Notes	s on the operation rules:	K	4 2 of 2 ▶ ₩
hysical Operations Observed I		scription This is teh Ba	seline Alternative with teh upda	ated WF Proxy
Zone-Rules Rel. Alloc. Outage	s Stor. Credit Dec. S	ched. Projected Elev		
Emergency Limit Rel thru Pwr Plant MaxReleaseFlood Gates	Operates Release Fro Rule Name: Limit Re	om: Lake Mendocino-Po	wer Plant cription: This rule limits the re	lease to zer
Imarkereaserrioud_Gates Dummy_Pillsbury TS Flood Control Limit Rel thru Pwr Plant	Function of: Lake Me	ndocino-Pool Elevation,	Previous Value	Define
RVWD Full Diversion Min25-Release SC I-1610 Q-TUCP	Limit Type: Maximur Elev (ft)	n v Interp.: Linear Release (cfs)	3,000	
	665.0 754.9 755.0	3000.0 3000.0 0.0	0 660 680 700 720 74	0 760 780 800
MaxReleaseWCM-FC	784.0	0.0	Elev (ft)	
Min25-Release			Period Average Limit Hour of Day Multiplier	Edit
DROC_April2016 IROC_BIOP			Day of Week Multiplier	Edit
 Hopland fn of WF MaxReleaseWCM-FC Inactive 			Rising/Falling Condition	Edit
]			

2. Rule: MaxReleaseFlood_Gates

The rule *MaxReleaseFlood_Gates* (Figure 21) specifies releases from Lake Mendocino through the gate until the pool exceeds 773 feet, per the emergency release schedule of the Water Control Diagram (applies only in the Emergency Zone).



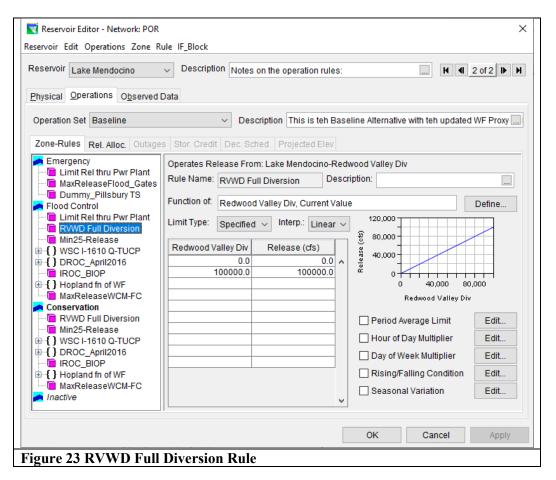
3. Rule: Dummy_Pillsbury TS

The rule *Dummy_Pillsbury TS* (Figure 22) exists to allow the HEC-ResSim model to ingest the Lake Pillsbury storage as an external time-series from an HEC-DSS file. The Pillsbury storage is used by the *StorageState* state variable. This rule calls for a minimum release of zero cfs, so it did not affect releases. The rule was applied outside the Conservation and Flood Control zones to avoid unnecessary evaluations during simulations, thereby reducing model run times.

eservoir Edit Operations Zone R Reservoir Lake Mendocino	Je IF_Block Uescription Notes on the operation rules:	K 4 2 of 2 D H
Physical Operations Observed	✓ Description This is teh Baseline Alternativ	e with teh updated WF Proxy 🔜
Emergency Limit Rel thru Pwr Plant MaxReleaseFlood_Gates Flood Control Limit Rel thru Pwr Plant KWWD Full Diversion KWC I-1610 Q-TUCP C DROC_April2016 ROC_BIOP Apoland fn of WF MaxReleaseWCM-FC	s Stor. Credit Dec. Sched. Projected Elev Operates Release From: Lake Mendocino Rule Name: Dummy_Pillsbury TS Description: Function of: Pillsburry Storage, Current Value Limit Type: Minimum Interp.: Pillsburry Storage Release (cfs) 0.0 0.0 1000000.0 0.0	Define
Conservation Conservation Min25-Release Conservation Min25-Release Conservation Conservation	Hour of I Day of W Rising/F	Average Limit Edit Day Multiplier Edit Veek Multiplier Edit Falling Condition Edit al Variation Edit Cancel Apply

4. Rule: RVWD Full Diversion

The rule *RVWD Full Diversion* (Figure 23) specifies flow for the Redwood Valley diversion out of Lake Mendocino. The flow values were provided with a time-series as described in *Section VII.B*.



5. Rule: Min25-Release

The rule *Min25-Release* (Figure 24) forces Coyote Valley Dam to always release at least 25 cfs. The rule originates from SWRCB Decision 1610, and was modified by a Sonoma Water Temporary Urgency Change Petition (TUCP).

Lake Mendocino	✓ Description Note	s on the operation rules:		2 of 2 🕨
hysical Operations Observed	Data			
peration Set Baseline	∼ De	scription This is teh Ba	seline Alternative with teh update	d WF Proxy
Zone-Rules Rel. Alloc. Outage	s Stor. Credit Dec. S	ched. Projected Elev		
Emergency Limit Rel thru Pwr Plant MaxReleaseFlood_Gates	Operates Release Fr Rule Name: Min25-F	om: Lake Mendocino-Da Release Des	am at EF Russian River cription: East Fork Russian Rive	r Coyoteı
Dummy_Pillsbury TS	Function of: Date			Define
Limit Rel thru Pwr Plant RVWD Full Diversion Min25-Release	Limit Type: Minimu	m ∨ Interp.: Linear	25.2	
WSC I-1610 Q-TUCP	Date 01Jan	Release (cfs)	0 27.0	
IROC_BIOP Hopland fn of WF			24.8	
MaxReleaseWCM-FC Conservation			Jan Mar May Jul Sep	Nov
RVWD Full Diversion Min25-Release			Period Average Limit	Edit
WSC I-1610 Q-TUCP			Hour of Day Multiplier	Edit
The second se			Day of Week Multiplier	Edit
Hopland fn of WF MaxReleaseWCM-FC			Rising/Falling Condition	Edit
Inactive			 Seasonal Variation 	Edit

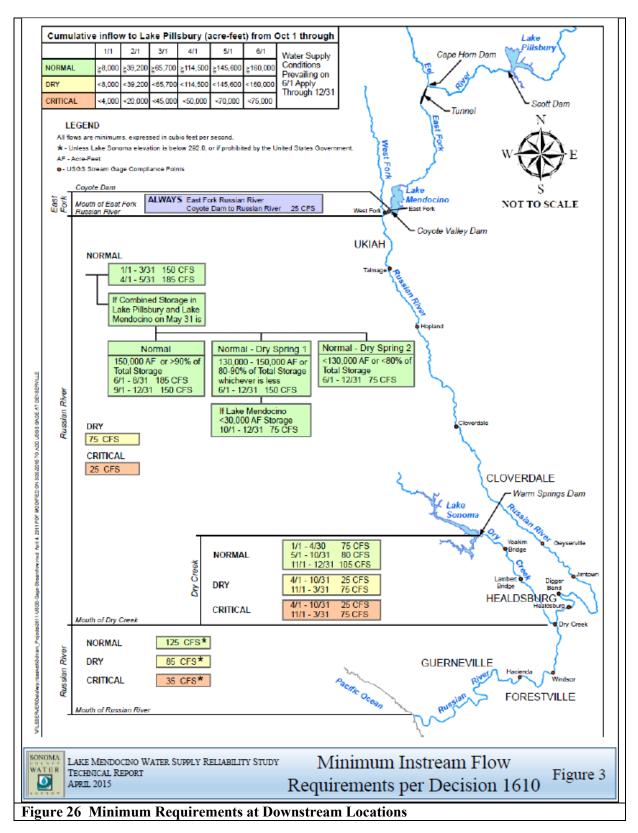
6. IF_Block: WSC I-1610 Q-TUCP

The IF_Block *WSC I-1610 Q-TUCP* (Figure 25) describes the downstream flow requirements. The first condition in the IF_Block refers to the hydrologic index, which may be "Normal", "Dry", or "Critical". The hydrologic index for each year in the POR is defined by an external time series provided by Sonoma Water. If the index is "Normal", then a second condition applies, which reflects the combined storage in Lake Mendocino on the Russian River and Lake Pillsbury on the Eel River. The state variable *StorageState* used to calculate the storage index (or state) is described in *Section X*.

Each case of the combined conditions specifies minimum flows that need to be maintained throughout the upper Russian River. The requirements were expressed for four locations (the East-West, Hopland Gage, Cloverdale Gage, and Healdsburg Gage). HEC-ResSim resolves the different flow requirements at these locations by taking the maximum of the minimums. The Sonoma Water Reliability Report (SCWA, 2015) describes the flow requirements in detail (Figure 26). Per recommendation of Sonoma Water, these flow targets were further padded by varying amounts to reflect "safety buffer" increments used in operations to overcome potential losses along the river.

The details of this rule are shown in Figure 27 to Figure 31.

hysical Qperations Oggerved Data Operation Set Baseline Description This is teh Baseline Alternative with teh updated WF Proxy Rule for Hop[Zone-Rules Rel. Alloc. Outages Stor. Credit Dec. Sched Projected Elev Operates Release From: Lake Mendocino Name: WSC I-1610 Q-TUCP Description Delancy explained that the flow "buffle". Type Name Description Imit Rel thru Pwr Plant Flood Control Imit Rel thru Pwr Plant Flood Control F	eservoir Lake Mendocino 🗸 Descriptio	n Notes	on the o	peration rules:				K	4 2 of 2 ▶
Zone-Rules Rel. Alloc. Outages Stor. Credit Dec. Sched. Projected Elev Emergency Limit Rel thru Pwr Plant MarReleaseFlood_Gates Flood Control Limit Rel thru Pwr Plant Kimit Rel thru Pwr Plant K	hysical Operations Observed Data								
Emergency Emergency Markel thur Pwr Plant MarkeleaseFlood_Gates Flood Control Limit Rel thur Pwr Plant RevWD Full Diversion Min25-Release Flood Control Min25-Release Flood Control Min25-Release Flood Control Min25-Release Flood Control Min25-Cloverdale Flood Control Min25-Cloverdale Flood Control Min25-Cloverdale Min25-Cloverdale Min25-Cloverdale Min25-Cloverdale Min25-Cloverdale Min25-Cloverdale	Operation Set Baseline	~ [Descripti	on This is teh Base	eline Altern	ative with	n teh upda	ted WF Pro	xy Rule for Hopl
Imit Rel thu Pwr Plant IMaxReleaseFlood_Gales IDummy_Pillsbury TS Flood Control ILimit Rel thru Pwr Plant IF (Sod Control ILimit Rel thru Pwr Plant IF (Normal or DS) IF (Normal or DS	Zone-Rules Rel. Alloc. Outages Stor. Credit	Dec. Sc	hed. P	rojected Elev					
MaxReleaseFlood_Gales Image: Dummy_Pilisbury TS Flood Cortol Image: Dummy_Pilisbury TS Flood Cortol Image: Release Image: Dummy_Pilisbury TS Flood Cortol Image: Release		Opera	tes Rele	ase From: Lake Me	ndocino				
Flood Control Type Name Description Imit Rel thru Pwr Plant IF Normal or DS Imit Rel thru Pwr Flood IF Normal or DS Imit Rel thru Pwr Flood IF Normal or DS Imit Rel thru Pwr Flood IF Normal or DS Imit Rel thru Pwr Flood IF Normal or DS Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr Flood Imit Rel thru Pwr F	MaxReleaseFlood_Gates	Nam	e: WSC	I-1610 Q-TUCP	Descrip	otion: De	elaney expl	ained that t	he flow "buffe:
Image: Second secon	Flood Control	Туре		Name		Descrip	tion		
Image: Selease LUCL II Diff Image: Selease Image: Selease Image: Selease Image: Selease Image: Selease Image: Se									
↓ WSCL-1610 Q-TUCP ↓ IF (Normal or DS) ↓ IF (State 1 or 2) ↓ IF (State 1 or 2) ↓ IT UCPMin1-West Jct ↓ TUCPMin1-Hopland ↓ TUCPMin3-Healdsburg ↓ IT UCPMin3-Healdsburg ↓ IT UCPMin4-West Jct ↓ IT UCPMin4-Hopland ↓ IT UCPMin4-Healdsburg									
	TUCPMin1-Healdsburg ELSE IF (State 3) TUCPMin3-West Jct TUCPMin3-Cloverdale TUCPMin3-Healdsburg ELSE (State 4) TUCPMin4-Hopland TUCPMin4-Hopland TUCPMin4-Hopland TUCPMin4-Hopland TUCPMin4-Healdsburg ELSE IF (Dry) Min75-Hopland Min25-Hopland Min25-Hopland Min25-Cloverdale								



		IF (State	T or 2)				
Operates Release From	: Lake Mendocino		Operates Re	lease From	n: Lake Mendoc	ino	
Rule Name: TUCPMin1	-West Jct Descript	tion:	Rule Name:	TUCPMin1	-Hopland Descript		ion
Function of: Date			Function of:	Date			
Limit Type: Minimum	✓ Interp.: Step	•	Limit Type:	Minimum	✓ Interp.:	Step	•
Downstream Location:	East-West Junction		Downstream	Location:	Hopland Gage	•	
Parameter:	Flow	•	Parameter:		Flow		Ŧ
Date	Flow (cfs)		Da	te	Flow (cfs)	
01Jan	155.0		01Jan			170.0	
01Apr	190.0		01Apr			205.0	1
01May	130.0		01May			134.0	
16Oct	155.0		16Oct			170.0	
Rule Name: TUCPMin Function of: Date Limit Type: Minimum		cript		TUCPMin1 Date Minimum	I-Healdsburg	Descrip	tion •
Downstream Location:		-	Downstream	Location:	Healdsburg G	age	
Parameter:	Flow	~	Parameter:		Flow		Ŧ
Data	Flaur (afa)		Da	te	Flow (cfs)	
Date	Flow (cfs)		01Jan			170.0	
01Jan	170.0	~	01Apr			205.0	
							41
01Apr	205.0		01May			134.0	
01Apr 01May	205.0 134.0		01May 16Oct			134.0 170.0	

IF (State 1 or 2)

			EL	SEIF (State 3)					
Operates Rel	lease From	: Lake Mendocii	no		Operates Re	lease From	: Lake I	Mendocin	0	
Rule Name:	TUCPMin3	-West Jct	Descrip	tion	Rule Name:	TUCPMin3	-Hoplar	nd	Descript	tion
Function of:	Date			_	Function of:	Date				
Limit Type:	Minimum	✓ Interp.:	Step	•	Limit Type:	Minimum	•	Interp.:	Step	•
Downstream	Location:	East-West Jun	ction		Downstream	Location:	Hoplar	nd Gage		
Parameter:		Flow		•	Parameter:		Flow			•
Da	te	Flow (c	:fs)	1	Da	ate	1	Flow (cf	s)	
01Jan			155.0		01Jan				170.0	
01Apr		190.0			01Apr				205.0	1
01May			130.0		01May				134.0	1
01Oct			80.0		01Oct				95.0	
01Oct	lease Fror	n: Lake Mendo		1	010ct Operates Re	elease Fror	l n: Lake	Mendoci		
010ct Operates Re		n: Lake Mendo 3-Cloverdale								
010ct Operates Re			cino		Operates R				no	
010ct Operates Re Rule Name:	TUCPMin	3-Cloverdale	cino Descr		Operates Re Rule Name:	TUCPMin	3-Heald		no] Descri	
010ct Operates Re Rule Name: Function of:	TUCPMin Date Minimum	3-Cloverdale	cino Descr Step		Operates Re Rule Name: Function of:	TUCPMin Date Minimum	3-Healo	dsburg	no Descri Step	
010ct Operates Re Rule Name: Function of: Limit Type:	TUCPMin Date Minimum	3-Cloverdale	cino Descr Step		Operates Re Rule Name: Function of: Limit Type:	TUCPMin Date Minimum	3-Healo	dsburg Interp.:	no Descri Step	
010ct Operates Re Rule Name: Function of: Limit Type: Downstream	TUCPMin Date Minimum Location:	3-Cloverdale	cino Descr Step Gage		Operates Re Rule Name: Function of: Limit Type: Downstrean Parameter:	TUCPMin Date Minimum	3-Heald	dsburg Interp.:	no Descri Step age	ptior
010ct Operates Re Rule Name: Function of: Limit Type: Downstream Parameter:	TUCPMin Date Minimum Location:	3-Cloverdale Interp.: Cloverdale G Flow	cino Descr Step Gage	rip ~	Operates Re Rule Name: Function of: Limit Type: Downstream Parameter: D	TUCPMin Date Minimum n Location:	3-Heald	dsburg Interp.: dsburg G	no Descri Step age cfs) 170.	ptior
010ct Operates Re Rule Name: Function of: Limit Type: Downstream Parameter: Dat	TUCPMin Date Minimum Location:	3-Cloverdale Interp.: Cloverdale G Flow	cino Descr Step age s)	rip ~	Operates Re Rule Name: Function of: Limit Type: Downstrean Parameter: D 01Jan 01Apr	TUCPMin Date Minimum n Location:	3-Heald	dsburg Interp.: dsburg G	no Descri Step age cfs) 170. 205.	ptior
010ct Operates Re Rule Name: Function of: Limit Type: Downstream Parameter: Dat 01Jan	TUCPMin Date Minimum Location:	3-Cloverdale Interp.: Cloverdale G Flow	cino Descr Step age s) 170.0	rip ~	Operates Re Rule Name: Function of: Limit Type: Downstream Parameter: D	TUCPMin Date Minimum n Location:	3-Heald	dsburg Interp.: dsburg G	no Descri Step age cfs) 170.	ptior

			E	LSE (State 4)					
Operates Re	lease From	: Lake Mendoc	ino		Operates Re	elease From	: Lake Me	endocin	0	
Rule Name:	TUCPMin4	-West Jct	Descrip	otion:	Rule Name:	TUCPMin4	-Hopland	d	Descrip	tion
Function of:	Date				Function of:	Date				
Limit Type:	Minimum	✓ Interp.:	Step	•	Limit Type:	Minimum	→ Ir	nterp.:	Step	•
Downstream	Location:	East-West Jur	k		Downstream	Location:	Hopland	d Gage		
Parameter:		Flow		•	Parameter:		Flow			•
Da	ite	Flow (cfs)		Da	ate		Flow (cf	s)	
01Jan			155.0		01Jan				170.0	
01Apr			190.0		01Apr				205.0	
01May			130.0		01May				134.0	
01Jun			80.0	D	01Jun				95.0	1
-		n: Lake Mendo 4-Cloverdale	Deso	crip	Operates Ro Rule Name: Function of:				no Descri	ption
Limit Type:	Minimum	 Interp.: 	Step	\sim	Limit Type:	Minimum	•]	Interp.:	Step	-
Downstream	n Location:	Cloverdale (Gage		Downstream	n Location:	Healds	burg G	age	
Parameter:		Flow		\sim	Parameter:		Flow			•
Dat	te	Flow (c	fs)		D	ate		Flow (cfs)	
01Jan			170.0	~	01Jan				170.	_
01Apr			205.0		01Apr				205.	_
01May			134.0		01May				134.	_
01Jun			95.0		01Jun				95.	0
Figure 29	WSC I-	1610 Q-TU	JCP Ru	le - (State 4)					

		E	LSE	IF (Dry)				
Operates Releas	e From:	Lake Mendocino		Operates Re	lease From	: Lake Mend	docino	
Rule Name: Mini	75-West	t Jct Descri	ption	Rule Name:	Min75-Hop	land	Description:	
Function of: Date	е			Function of:	Date			
Limit Type: Mini	imum	✓ Interp.: Step	•	Limit Type:	Minimum	Ainimum 👻 Interp.: Step		
Downstream Loc	ation:	East-West Junction		Downstream	Location:	Hopland G	age	
Parameter:	[Flow	•	Parameter:		Flow	•	
Date		Flow (cfs)		Da	ate	Flo	w (cfs)	
01Jan							95.0 🔺	
	se From 175-Clo	: Lake Mendocino verdale Des	crip	Operates Re Rule Name:			ndocino Description	
Function of: Da	te			Function of: Date				
Limit Type: Min	- nimum	✓ Interp.: Linear	\sim	Limit Type:	Minimum	✓ International	erp.: Step 👻	
Downstream Loc	cation:	Cloverdale Gage		Downstream	n Location:	Healdsbu	ırg Gage	
Parameter:		Flow	\sim	Parameter:		Flow	•	
Date		Flow (cfs)		D	ate	FI	ow (cfs)	
01Jan		95.0	~	01Jan			95.0 🔺	
Figure 30 WS	SC I-1	610 Q-TUCP Ru	le - (Dry)				

ELSE (Critical)

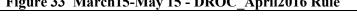
		ontrodity	
Operates Release From	: Lake Mendocino	Operates Release From	: Lake Mendocino
Rule Name: Min25-Wes	t Jct Description:	Rule Name: Min25-Hop	bland Description
Function of: Date		Function of: Date	
Limit Type: Minimum	✓ Interp.: Step ✓	Limit Type: Minimum	✓ Interp.: Step ✓
Downstream Location:	East-West Junction	Downstream Location:	Hopland Gage
Parameter:	Flow -	Parameter:	Flow -
Date	Flow (cfs)	Date	Flow (cfs)
01Jan	30.0 🔺	01Jan	45.0 🔺
Operates Release From Rule Name: Min25-Cl		Operates Release From Rule Name: Min25-Hea	
Function of: Date		Function of: Date	
Limit Type: Minimum	✓ Interp.: Linear ✓	Limit Type: Minimum	✓ Interp.: Step ✓
Downstream Location:	Cloverdale Gage	Downstream Location:	Healdsburg Gage
Parameter:	Flow ~	Parameter:	Flow -
Date	Flow (cfs)	Date	Flow (cfs)
01Jan	45.0 🔨	01Jan	45.0
Figure 31 WSC I-	610 Q-TUCP Rule- (C	Critical)	

7. IF_Block: DROC_April2016

The Decreasing Rate of Change (DROC) IF_Block, *DROC_April2016* (Figure 32 to Figure 34), reflects an agreement between USACE-San Francisco District and NMFS in April 2016, primarily intended to minimize fish stranding. The requirement updates the previous rules established under the 2008 Russian River BIOP, limiting the "ramp-down" of Coyote Valley Dam releases based on the magnitude of the discharge and time of year. Outflows greater than 4,000 cfs may be reduced by 1,000 cfs/hour, but only by 250 cfs/hour when between 4,000 cfs and 2,500 cfs, and only by 100 cfs/hour for flows less than 2,500 cfs. Releases less than 250 cfs must ramp down no faster than 25 cfs/hour for most of the year. Between 15 March and 15 May, releases below 250 cfs may also decline by no more than 50 cfs/day, which was implemented as 2.083 cfs/hr in the HEC-ResSim model.

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Figure 32 Decreasing Rate Of	Change	(DROC_April	2016) Rule	2

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Min25-Release	Type: Decreasing V 1,000	
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Figure 180C_BIOP Hopland fn of WF	250.0 2500.0 to 200	_
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RVWD Full Diversion	4000.0 250.0 0 4,000 8,000	I
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Min25-Release	4000.1 2000.0 0 4,000 8,000 4000.0 1000.0 v Release (cfs)	

8. Rule: IROC_BIOP

The rule *IROC_BIOP* (Figure 35) represents increasing rate of change operational requirements from the biological opinion (BIOP). Releases below 1,000 cfs may increase by only 1,000 cfs/hour, while higher outflows may ramp-up by 2,000 cfs/hour.

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9. IF_Block: Hopland fn of WF

The IF_Block *Hopland fn of WF* (Figure 36 to Figure 40) represents a special approach developed for the Russian River HEC-ResSim model to replace two existing rules specified in the Coyote Valley Dam Water Control Manual:

- 8,000 cfs maximum allowable flow at Hopland USGS gage (USGS 11462500)
- 25 cfs maximum allowable release when the Russian River at Ukiah USGS gage (USGS 11461000), located on the West Fork of the Russian River, is above 2,500 cfs

The *Hopland fn of WF* IF_Block contains rules regarding the goal of limiting flow at Hopland to 8,000 cfs. The standard HEC-ResSim rule for maintaining maximum releases at a downstream location computes the outflow by performing an approximate routing from the reservoir to the control point, and incorporates intervening local flows in future time steps. Such assumed knowledge of the near future conditions downstream may be appropriate when simulating release decisions, where experienced operators might consider a variety of information such as flows at the control point forecasted by the NWS. However, for this study to explore the impact on

release decisions of actual forecast information for the downstream local flows, the modeling team attempted a more limited representation of the actual decision logic typically employed by the operator for Lake Mendocino in the baseline condition.

In practice, the operator does not determine flood operation outflows by routing candidate releases from Coyote Valley Dam to Hopland, and does not know the local flow hydrographs. The operator makes judgments based on experience and awareness of basin conditions, primarily considering the level of Lake Mendocino and the flow observed at the nearby gage on the West Fork Russian River.

Flow at Hopland has three components: Lake Mendocino release, West Fork (WF) flow and local downstream flows above Hopland. For this study, a release decision referred to as a proxy rule was defined by using the WF flow as a surrogate for the local downstream flows above Hopland. Mass balance provides the following relationship, simplified to use just WF flow and rearranged for simplicity:

Release = 8000 - WF-Flow - local-downstream Release = 8000 - WF-Flow - WF-flow * ratio Release = 8000 - WF-Flow * ratio+1

The relationship between WF flow and downstream local flow was estimated from historical data, as is reflected in a multiplier. The value of the multiplier (ratio+1) varied in different conditions to reflect the amount of uncertainty around the assumed relationship and the need to hedge against that uncertainty. A larger multiplier lowers the release, providing greater hedging.

The *Hopland fn of WF* IF_Block models the decision process according to two conditions that define three situations, using a different value of ratio+1 in each situation. The two conditions are (1) whether flows on West Fork are rising or falling, and (2) if falling, whether reservoir elevation is greater or less than 755 feet.

When WF flow is rising, downstream flows are also assumed to be rising, and might vary greatly from the relationship estimated between WF flow and Hopland local flow. Thus a high multiplier (ratio+1) of 10 is employed. When WF flow is falling but elevation is below 755 feet, a less conservative release is made by using a lower multiplier (ratio+1) of 3. When elevation is greater than 755 feet, more concern rests with lowering the pool level, and release is least conservative with the lowest multiplier (ratio+1) of 2.3.

The basic statement of (Release = 8000 - WF-Flow * ratio+1) is often negative. So, it's actually MAX (0, Release = 8000 - WF-Flow * ratio+1).

Within the HEC-ResSim model, the proxy release relationship was captured in rules that define release as a function of WF flow. A rule exists for each of the 3 values of ratio+1, to be used in each of the three situations described above and listed below.

(1) Flow rising on the West Fork gage (Figure 37). This situation is the first condition (*Hopland fn of WF* IF_Block) and determines how to reduce releases in order to protect downstream locations.

(2) Flow declining on the West Fork gage (Figure 38) and the reservoir stage is above 755 feet (Figure 39). This situation is the second condition (*Hopland fn of WF* IF_Block), where the reservoir stage is above 755 feet and governs the emptying of the flood pool when the reservoir is high, and operators are more concerned with the reservoir level than the possibility of exceeding 8,000 cfs at Hopland.

(3) Flow declining on the West Fork gage and the reservoir stage is below 755 feet (Figure 40). This situation is the third condition (*Hopland fn of WF* IF_Block), where the reservoir stage is below 755 feet and governs the emptying of the flood pool when the reservoir is not high, and greater consideration is given to the Hopland flow.

Outflows in the rules were determined according to relationships using the West Fork Russian River flow described above, developed by Sonoma Water. Review with operators confirmed that these rules acceptably captured the actual operations for the rising and falling limbs of Russian River flows, without using forecast information.

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eevoir Edit Operations Zone Rule IF_ eservoir Lake Mendocino ↓ Dr hysical Operations Observed Data Operation Set Baseline Zone-Rules Rel. Alloc. Outages Stor Emergency E	escription Notes on the operation rule Description This is is Credit Dec. Sched. Projected Elev Operates Release From: Lake Meno Rule Name: Falling < 755 Function of: Russian River NR Uki Limit Type: Maximum II Flow (cfs) F 0.0 100.0 100.0 150.0 300.0 350.0 450.0 550.0 600.0 700.0 750.0 800.0 800.0 800.0	es: eh Baseline Alternative of locino Description: ah Gage Flow, Current V. ah Gage Flow, Current V. Release (cfs) 6400.0 6250.0 5650.0 55050.0 55050.0 55050.0 44000.0 4750.0 4600.0 3850.0 3550.0 3400.0 3400.0 3250.0	alue 7,000 6,000 6,000 3,000 0,000 1,000 0,000 Flow (cfs Period Average Limit Hour of Day Multiplier Day of Week Multiplie	Image: state of the
hysical <u>Operations</u> <u>Observed Data</u> Operation Set <u>Baseline</u> Zone-Rules <u>Rel Alloc.</u> Outages Stor Emergency Limit Rel thru Pwr Plant MaxReleaseFlood_Gates Dummy_Pillsbury TS Flood Control Limit Rel thru Pwr Plant Flood Control Limit Rel thru Pwr Plant KWD Full Diversion Min25-Release () WSC I-1610 0-TUCP () DROC_BIOP () Hopland fn of WF + Fl (Rising) ELSE (Falling) + ELSE (Falling) + ELSE (Elev >=755) Falling >= 755 Falling >= 755 Conservation RWD Full Diversion	escription Notes on the operation rule Description This is is Credit Dec. Sched. Projected Elev Operates Release From: Lake Meno Rule Name: Falling < 755 Function of: Russian River NR Ukia Limit Type: Maximum In Flow (cfs) F 0.0 100.0 150.0 100.0 150.0 150.0 150.0 0 0 150.0 150.0 100.0 150.0 150.0 100.0 150.0 100.0 150.0 100	eh Baseline Alternative v locino Description: ah Gage Flow, Current V: hterp.: Step Release (cfs) 6400.0 6550.0 5650.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 5550.0 3400.0 4150.0 4000.0 3550.0 3550.0 3400.0	alue 7,000 6,000 6,000 3,000 0,000 1,000 0,000 Flow (cfs Period Average Limit Hour of Day Multiplier Day of Week Multiplie	Image: state of the

10. Rule: MaxReleaseWCM-FC

The rule *MaxReleaseWCM-FC* (Figure 41) sets maximum flows at 4,000 cfs or 6,400 cfs, based on elevation, according to typical operational practices. The 4,000 cfs thresholds represented limits in the Water Control Diagram (Appendix A) for *Flood Control Schedule 1 and 2* and 6,400 cfs thresholds represented limits for *Flood Control Schedule 3*.

The hydraulics of weir flow over the 200-foot uncontrolled spillway quickly increases the outflow as the lake rises, so that the spillway provides all of the specified *Flood Control Schedule 3* (Appendix A) release and the gate stays closed. In situations with spillway flow, the outflow from Coyote Valley Dam could become largely outside the control of operators, with Lake Mendocino no longer providing as much flood protection to downstream locations. Lake Mendocino has never reached the *Emergency Release Schedule* (Appendix A).

servoir Lake Mendocino	 Description Notes 	on the operation rules:		2 of 2 🕨
nysical Operations Observed	Data			
peration Set Baseline	✓ Dese	cription This is teh Ba	aseline Alternative with teh updated	WF Proxy R.
Cone-Rules Rel. Alloc. Outage	s Stor. Credit Dec. Sch	ed. Projected Elev		
Emergency	Operates Release Fro	m: Lake Mendocino-D	am at EF Russian River	
Limit Rel thru Pwr Plant MaxReleaseFlood Gates	Rule Name: MaxRele	aseWCM-FC De	scription: Per Patrick in the FVA m	eeting on)
Dummy_Pillsbury TS	Function of: Lake Mer	ndocino-Pool Elevation	n Previous Value	Define
Limit Rel thru Pwr Plant RVWD Full Diversion	Limit Type: Maximun		6,500	
Min25-Release	Elev (ft)	Release (cfs)	6,000 - 5,500 - g 5,000 -	
April2016	737.5	4000.0		
IROC_BIOP ICC_BIOP I	746.0	4000.0		765 770 775
MaxReleaseWCM-FC	771.0	6400.0		
Conservation				
RVWD Full Diversion			Period Average Limit	Edit
Min25-Release			Hour of Day Multiplier	Edit
April2016			Day of Week Multiplier	Edit
IROC_BIOP			Rising/Falling Condition	Edit
MaxReleaseWCM-FC			Seasonal Variation	Edit

V. Warm Springs Dam (Lake Sonoma)

Warm Springs Dam was completed in 1983 on Dry Creek, creating Lake Sonoma. Warm Springs Dam was authorized by the Flood Control Act of 1962 for the purposes of flood control, water supply, environmental stewardship, and recreation. Congressional authorization in the mid-1970's added mitigation for fish identified in the Endangered Species Act to the mission set for both federal dams on the Russian River. Warm Springs Dam is compacted earth fill with an impervious core, with a maximum height above the streambed of 319 feet and a crest length of

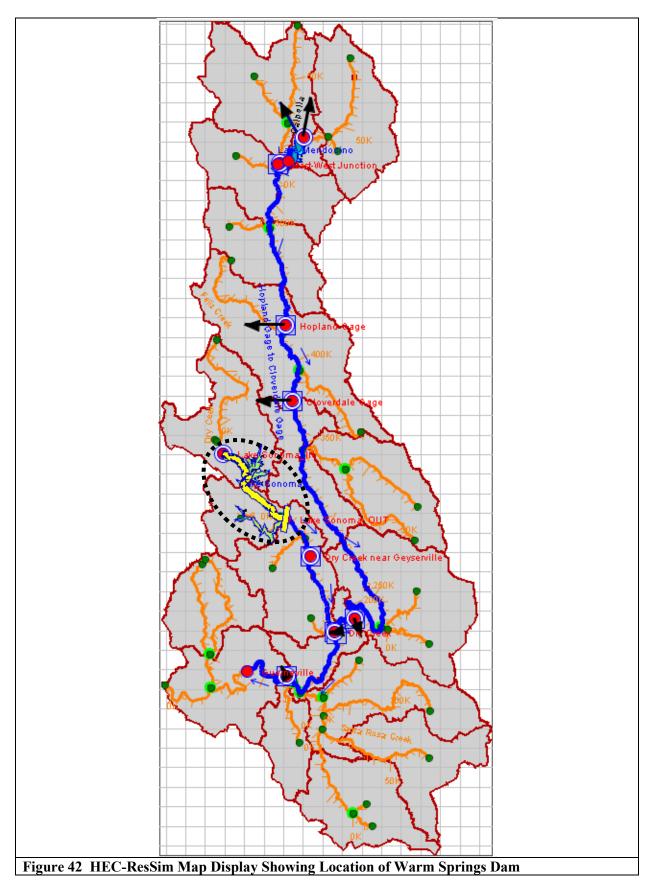
3,000 feet. Elevation of the dam crest is 519 feet. The adjacent uncontrolled spillway has a 100-foot long crest at elevation 495 feet.

The drainage area above Warm Springs Dam totals approximately 131 square miles, or about 25 percent more area than above Coyote Valley Dam. However, Warm Springs Dam offers 136,000 AF of flood control reservation between the guide curve and spillway crest, which is 1.8 times the flood control reservation at Lake Mendocino. The outlet works consist of low flow water quality outlet with three five-foot diameter intake tunnels (at elevations of 431, 391, and 352 feet). The flood control outlets at Warm Springs Dam consist of two 5' x 8' service gates and two 5' x 8' slide gates. These outlets restrict flows at the Yoakum Bridge near Geyserville (7,000 cfs), and at Guerneville, where flows cannot exceed 35,000 cfs.

Similar to Coyote Valley Dam, flood control operations at Warm Springs Dam typically require outflows to be minimized during storms. Lake Sonoma offers much more storage than Lake Mendocino, so reservoir operators have greater flexibility regarding when to release storage accumulated during storms. Storm storage retained in Lake Sonoma substantially reduces flood peaks on Dry Creek and its confluence near Healdsburg, but has a limited effect on flood peaks along the lower Russian River.

Similar to Coyote Valley Dam, Warm Springs Dam supports instream flows at locations on Dry Creek and the lower Russian River. Warm Springs Dam also maintains flow to a fish hatchery immediately below the dam. Coyote Valley Dam and Warm Springs Dam perform no explicit system operations. However, Warm Springs Dam releases needed to provide minimum flows on the Russian River do take prior releases from Coyote Valley Dam into consideration, representing an implicit system operation.

Figure 42 shows the location of Warm Springs Dam and its pool (Lake Sonoma) as it is represented in the HEC-ResSim model.



1. Physical Characteristics

Warm Springs Dam is compacted earth fill with an impervious core, with a maximum height above the streambed of 319 feet and a crest length of 3,000 feet. Elevation of the dam crest is 519 feet. The approximately 381,000 AF capacity (at spillway invert) of Lake Sonoma is used for flood control and flood conservation in the Russian River basin. The outlet works consist of a low flow water quality outlet with three five-foot diameter intake tunnels (at elevations 431, 391, and 352 feet). The flood control outlets consist of two 5' x 8' service gates and two 5' x 8' slide gates. Outlets are operated to restrict flows to 7,000 cfs at the Yokum Bridge near Geyserville and to not exceed 35,000 cfs on the Russian River at Guerneville.

The physical characteristics of the reservoir are separated between the Pool and the Dam in the HEC-ResSim model.

A. Pool

The Elevation-Storage-Area defines the pool as shown in Figure 43. The Lake Sonoma elevation-storage-area relationship was taken from the Warm Springs Dam Water Control Manual, Exhibit A.

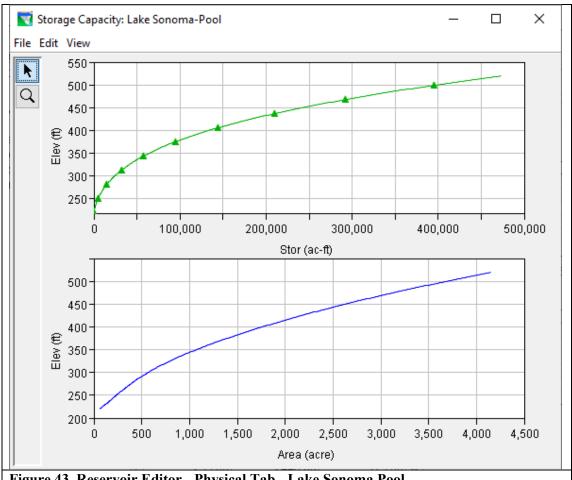


Figure 43 Reservoir Editor - Physical Tab - Lake Sonoma Pool

B. Evaporation

Monthly evaporation losses from Lake Sonoma are contained in Figure 44. The evaporation values were provided by Sonoma Water.

Reservoir Lake Sonoma	 ✓ Description 		H 4 1 of 2 D
Physical Operations Observed Lake Sonoma Pool Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek Image: Solution Dam at Dry Ceek	Data Lake Sonoma-Pool-Evaporat Monthly Total Evaporation Month Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec	Evap(in) 0.79 0.97 1.68 2.68 4.00 5.11 6.46 6.40 5.92 4.42 2.30 1.01	7 6 4 4 4 4 4 4 4 4 4 4 4 4 4
		ОК	Cancel Apply

C. Dam

The dam consists of three types of outlets: (1) a controlled, (2) a power plant, and (3) an uncontrolled outlet (spillway). Each of these outlets is defined in the model as shown in Figure 45, and the Dam release table reflects the composite release capacity of all of the outlets. The power plant and gates may be operated concurrently. There are no diversions from the pool, but a hatchery operates immediately below the dam.

eservoir Lake Sonoma	 Description 	n				K	4 1 of 2 ▶ ₩	
hysical Operations Observ	ved Data							
Lake Sonoma	Lake Sonoma-D	am at Dry Ce	ek					
Dam at Dry Ceek	Elevation at top	of dam (ft)		519.	0			
🚺 Tailwater	Length at top of	f dam (ft)		200.	0			
Controlled Outlet Very Plant	Composite Re	lease Capac	ity					
😔 Uncontrolled Outlet	Elevation	Controlled	Uncontroll	Total	1	Τ.		
	(ft)	(cfs)	(cfs)	(cfs)		500		
	221.0	0.0	0.0	0.0	io	400		
	221.0	2,477.6	0.0	2,477.6	Elevation	۠		
	292.0	4,186.0	0.0	4,186.0	E E	³⁰⁰		
	300.0	4,490.0	0.0	4,490.0		200 + 1		
	350.0	5,710.0	0.0	5,710.0		0	40,000	
	352.0	5,749.2	0.0	5,749.2			Flow	
	354.0	5,788.4	0.0	5,788.4			(cfs)	
	400.0	6,690.0	0.0	6,690.0			(,	
	480.0	7,756.7	0.0	7,756.7				
	495.0	7,956.7	0.0	7,956.7				
	495.8	7,967.3	400.0	8,367.3				
	496.7	7,979.3		8,979.3				
	497.7	7,992.7	1,750.0	9,742.7				
	500.0	8,023.3						
	500.2	8,026.0	4,000.0	12,026.0				
	501.7	8,046.0						
	504.2	8,079.3		17,579.3				
	505.0	8,090.0						
	507.1	8,090.0						
	510.0	8,090.0		30,266.3				
	513.0	8,090.0		53,090.0				
	515.0	0,050.0	40,000.0	v				
			1		_			

2. Operation Sets

Operation of Lake Sonoma is described in the updated Water Control Manual (2004) and includes operations for both flood control and water supply.

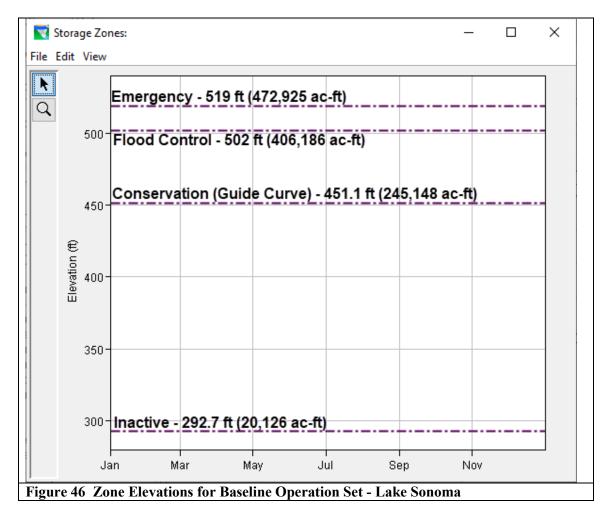
A. Baseline Operation Set

Lake Sonoma operates according to a guide curve, similar to Lake Mendocino, with rules defined for Emergency, Flood Control, and Conservation storage zones. The operation set supports instream flow requirements similar to the ones applicable to Lake Mendocino. Warm Springs Dam flood operations also resemble those of Coyote Valley Dam, in that the operation set reduces outflows to protect downstream locations until the river recedes.

The HEC-ResSim representation of Lake Sonoma operations was simpler than for Lake Mendocino, which in turn made the operations at Warm Springs Dam simpler. In addition, Lake

Sonoma has a greater ability to store floodwater, which lessens the urgency to clear the flood storage by "backfilling" receding flows downstream. The water supply operations of Lake Sonoma also face less stress in comparison to Lake Mendocino. Operations at Warm Springs Dam were modeled in the same manner as for each of the water management alternatives evaluated at Coyote Valley Dam. An operations set was defined for the Warm Springs Dam representing the Existing Conditions alternative, and was named Baseline.

Zones are used to define the operational storage in the reservoir to determine the reservoir release through analysis of the rules contained within each zone. Figure 46 shows the definition of Lake Sonoma's "Baseline" operational zones, which consist of zones of Emergency, Flood Control, Conservation, and Inactive zone. These zones each contain a set of operational rules for reservoir operation.



The guide curve for Lake Sonoma remains constant at 451.1 feet throughout the year.

The available outlets are given an order of priority for release. Figure 47 shows a sequential release allocation approach specified for available outlets along Warm Springs Dam. The power plant gets the release first until it reaches release capacity. After the capacity through the powerhouse is reached, the remainder of the release goes through the controlled outlet.

📷 Reservoir Editor - Network: POR			×
Reservoir Edit Operations Allocation			
Reservoir Lake Sonoma 🗸 Description			H 4 1 of 2 D H
Physical Operations Observed Data			
Operation Set Baseline	✓ Description		
Zone-Rules Rel. Alloc. Outages Stor. Credit Dec. St	ched. Projected Ele	V	
Allocation Set 1	Release Location:	Lake Sonoma-Dam at Dry Ceek	
🖮 🐺 Lake Sonoma-Dam at Dry Ceek - Sequential	Allocation Type:	Sequential	~
Lake Sonoma-Power Plant	Lake Sonoma-Po	wer Plant	
	Lake Sonoma-Co	ontrolled Outlet	
Figure 47 Release Allocation -	Lake Sonor	ma	

B. Rule Descriptions

Figure 48 shows a set of operational rules specified for each zone that reflects the operation set named *Baseline*.

Reservoir Lake Sonoma	✓ Description				K	4 1 of 2 ▶
Physical Operations Observed	Data					
Operation Set Baseline	~	Description				
Zone-Rules Rel. Alloc. Outage	s Stor. Credit D	ec. Sched. Projected	Ele	V		
Emergency	Storage Zone	Conservation		Description		
Flood Control Min70-Base Hatchery Hard WSC I-1610 Q-TUCP	Function of Dat		1			Define
	Date 01Jan Zone Sort Eleva	Top Elevation (ft) 451.1	*	500 450 500 500 500 500 500 500	May Jul S	ep Nov

1. Rule: MaxReleaseFlood_Gates

The rule *MaxReleaseFlood_Gates* (Figure 49) is the only rule in the emergency zone. It describes the emergency release schedule, which specifies how to operate the gates in conjunction with flow over the spillway. The rule sets a maximum release from Lake Sonoma through controlled outlet to less than 7,900 cfs until the pool is below 505 feet, per the emergency release schedule in Water Control Diagram (2004).

eservoir Lake Sonoma	 Description 			l of 2 🕨 ▶
Physical Operations Observed I	Data			
Operation Set Baseline	~ Dese	cription		
Zone-Rules Rel. Alloc. Outage	s Stor. Credit Dec. Sch	ed. Projected Elev		
 Emergency MaxReleaseFlood_Gates Flood Control 	Operates Release From Rule Name: MaxRelea	n: Lake Sonoma-Control seFlood Gates Descr		
Min70-Base Hatchery		oma-Pool Elevation, Pre	vious Value	Define
	Limit Type: Maximum	✓ Interp.: Step ✓	8000 8000	
MaxatGeyserville	Elev (ft)	Release (cfs)		
	502.0	800.0		04.5 505
Min70-Base Hatchery	502.6	2400.0	Elev (/l)	
	502.9	3100.0		F (1)
DROC_BIOP	503.2	3800.0	Period Average Limit	Edit
IROC_BIOP	503.6	4600.0	Hour of Day Multiplier	Edit
MaxatGeyserville	503.9	5300.0	Day of Week Multiplier	Edit
MaxatGuerneville Gage Rising 5000	504.3	7000.0	Rising/Falling Condition	Edit
/nactive	505.0	7900.0		
	 '	v	Seasonal Variation	Edit

2. Rule: Min70-Base Hatchery

The rule *Min70-Base Hatchery* (Figure 50) is the highest priority rule in the Conservation and Flood Control zones required for the fish hatchery. The rule sets the minimum release to 70 cfs for all simulation time-steps for hatchery purposes, per Sonoma Water personal communication.

Forecast-Informed Reservoir Operation (FIRO) study within Full Viability Assessment (FVA)

eservoir Lake Sonoma	 Description 		K (1 of 2 🕨 🕨
hysical Operations Observed	Data			
Operation Set Baseline	✓ Des	cription		
Zone-Rules Rel. Alloc. Outage	s Stor. Credit Dec. Sc	hed. Projected Elev		
MaxReleaseFlood_Gates Flood Control Min70-Base Hatchery WSC I-1610 Q-TUCP MaxatGeyserville AxatGeyserville AxatGuerneville Gage Rising_5000 Conservation Min70-Base Hatchery KSC I-1610 Q-TUCP ROC_BIOP RAXAtGeyserville	Operates Release Fro Rule Name: Min70-B Function of: Date Limit Type: Minimun Date 01Jan	ase Hatchery Descri	ption: Min release for WSD H.	Define
			Day of Week Multiplier Rising/Falling Condition Seasonal Variation	Edit Edit Edit

3. IF_Block: WSC I-1610 Q-TUCP

Similar to Lake Mendocino, the minimum flows required at different downstream locations per SWRCB Decision 1610 were specified according to the annual hydrologic index. The requirements were expressed for three locations (the Dry Creek, Dry Creek conf, Guerneville Gage). HEC-ResSim resolves the different flow requirements at the locations by releasing the maximum of the minimums from Lake Sonoma.

Per a recommendation from Sonoma Water, these flow targets were further padded by varying amounts to reflect "safety buffer" increments used in operations to overcome potential losses along the river. The details of this rule are shown in Figure 51 to Figure 54.

Reservoir Lake Sonoma 🗸 Do	escription				 1 of 2 🕨
Physical Operations Observed Data					
Operation Set Baseline	~	Description			
Zone-Rules Rel. Alloc. Outages Stor	. Credit D	ec. Sched. Proje	ected Elev		
Emergency MaxReleaseFlood_Gates	Operat	es Release From	: Lake Sonoma	3	
Flood Control	Name	WSC I-1610 Q-	TUCP D	escription:	
Min70-Base Hatchery	Туре	Name		Description	
➡ ➡ IF (Normal or DS)		F Normal or	r DS		
NormMin		EIF Dry			
NormMin-Dry Creek TUCPNorm-Jct Dry Creek	EL	SE Critical			
🔚 NormMin-Guerneville Gage					
ELSE IF (Dry)					
DryMin					
DryMin-Dry Creek TUCPDry-Jct Dry Creek					
DryMin-Guerneville Gage					
ELSE (Critical)					
Tritical Min					
🖳 🛅 CriticalMin-Dry Creek					
Min35-Jct Dry Creek					
CriticalMin-Guerneville Gag	je				
MaxatGeyserville					
MaxatGuerneville Gage					
A Conservation					
Min70-Base Hatchery					
MaxatGeyserville					
MaxatGuerneville Gage					
A Inactive					
<	>				

	1 (11011)		
Operates Release Fro	m: Lake Sonoma	Operates Release From	n: Lake Sonoma
Rule Name: NormMin	n Desc	Rule Name: NormMin-	Dry Creek Descrip
Function of: Date		Function of: Date	
Limit Type: Minimum	n 👻 Interp.: Step 👻	Limit Type: Minimum	✓ Interp.: Step ▼
		Downstream Location:	Dry Creek
Date 01Jan	Release (cfs) 75.0	Parameter:	Flow
01May	80.0		
01Nov	105.0	Date	Flow (cfs)
11		01Jan	88.0 🔺
		01May	93.0
		01Nov	118.0
Operates Release From	m: Lake Sonoma	Operates Release From	m: Lake Sonoma
Rule Name: TUCPNor	m-Jct Dry Creek Descrip	Rule Name: IormMin-	Guerneville Gage Descrip
Function of: Date		Function of: Date	
Limit Type: Minimum	✓ Interp.: Step ✓	Limit Type: Minimum	✓ Interp.: Step ✓
Downstream Location:	Dry Creek Conf	Downstream Location:	Guerneville Gage
Parameter:	Flow -	Parameter:	Flow ~
Date	Flow (cfs)	Date	Flow (cfs)
01Jan	159.0	01Jan	159.0 🔺
01May	84.0	01May	84.0
16Oct	159.0	16Oct	159.0
Figure 52 WSC I-	1610 Q-TUCP Rule - ((Normal)	

IF (Normal or DS)

ELSE IF	F (Dry)
Operates Release From: Lake Sonoma	Operates Release From: Lake Sonoma
Rule Name: DryMin Desc	Rule Name: DryMin-Dry Creek Descrip
Function of: Date	Function of: Date
Limit Type: Minimum 👻 Interp.: Step 👻	Limit Type: Minimum VInterp.: Step V
Date Release (cfs)	Downstream Location: Dry Creek
Date Release (cfs) 01Jan 75.0	Parameter: Flow -
01Jan 75.0 A 01Apr 25.0	
01Nov 75.0	Date Flow (cfs)
	01Jan 88.0 🔺
	01Apr 38.0 01Nov 88.0
	01Nov 88.0
Operates Release From: Lake Sonoma	Operates Release From: Lake Sonoma
Rule Name: TUCPDry-Jct Dry Creek Descrip	Rule Name: DryMin-Guerneville Gage Desc
Function of: Date	Function of: Date
Limit Type: Minimum 🔹 Interp.: Step 👻	Limit Type: Minimum V Interp.: Step V
Downstream Location: Dry Creek Conf	Downstream Location: Guerneville Gage
Parameter: Flow -	Parameter: Flow ~
Date Flow (cfs)	Date Flow (cfs)
01Jan 119.0 🔺	01Jan 119.0 🔨
01May 84.0	01May 84.0
160ct 119.0	16Oct 119.0
Figure 53 WSC I-1610 Q-TUCP Rule - (I	Dry)

Operates Release From: Lake Sonoma Rule Name: CriticalMin Punction of: Date Limit Type: Minimum Interp.: Step Minimum Interp.: Date Release (cfs) 01Jan 75.0 01Apr 25.0 01Nov 75.0 Date Flow (cfs) 01Nov 75.0 Operates Release From: Lake Sonoma Rule Name: Minimum Interp.: Step Date Flow (cfs) 01Jan 01Nov 75.0 Operates Release From: Lake Sonoma Rule Name: Min35-Jct Dry Creek Descript Descript Function of: Date Limit Type: Minimum Interp.: Step Downstream Location: Dry Creek Conf Parameter: Flow V Date Flow (cfs) Date Flow (cfs) Date Flow (cfs) Downstream Location: Durneville Gage Parameter: Flow </th <th></th> <th>ELS</th> <th>SE (C</th> <th>ritical)</th> <th></th> <th></th>		ELS	SE (C	ritical)		
Function of: Date Limit Type: Minimum Interp.: Step Ourstream Location: Date Release (cfs) 01Jan 75.0 01Apr 25.0 01Nov 75.0 Date Flow (cfs) 01Jan 75.0 01Apr 25.0 01Nov 75.0 Date Flow (cfs) 01Jan 88.0 01Apr 38.0 01Nov 75.0 Operates Release From: Lake Sonoma Rule Name: Min35-Jct Dry Creek Parameter: Descript Function of: Date Limit Type: Minimum Interp.: Downstream Location: Dry Creek Conf Parameter: Flow Date Flow (cfs) Date Flow (cfs)	Operates Release Fro	m: Lake Sonoma		Operates Re	lease Fron	n: Lake Sonoma
Limit Type: Minimum Interp.: Step Limit Type: Minimum Interp.: Step Downstream Location: Dry Creek Date Release (cfs) Date Flow Parameter: Flow Interp.: Step Downstream Location: Dry Creek D1Jan 75.0 Date Flow (cfs) Interp.: Step Date Flow (cfs) 01Apr 25.0 01Jan 88.0 Interp.: Step Interp.: <t< td=""><td>Rule Name: CriticalM</td><td>in Des</td><td>sc</td><td>Rule Name:</td><td>CriticalMin</td><td>n-Dry Creek Descript</td></t<>	Rule Name: CriticalM	in Des	sc	Rule Name:	CriticalMin	n-Dry Creek Descript
Date Release (cfs) 01Jan 75.0 01Apr 25.0 01Nov 75.0 Date Flow (cfs) 01Jan 88.0 01Apr 25.0 01Nov 75.0 Date Flow (cfs) 01Jan 88.0 01Jan 88.0 01Nov 75.0 Operates Release From: Lake Sonoma Operates Release From: Lake Sonoma Rule Name: Min35-Jct Dry Creek Function of: Date Limit Type: Minimum Interp.: Step Downstream Location: Dry Creek Conf Parameter: Flow Date Flow (cfs) Date Date Flow (cfs)	Function of: Date			Function of:	Date	
DateRelease (cfs)01Jan75.001Apr25.001Nov75.0DateFlow (cfs)01Nov75.0DescripDateOperates Release From: Lake SonomaRule Name:Min35-Jct Dry CreekFunction of:DateDateInterp.:Step +Downstream Location:Downstream Location:Dry Creek ConfParameter:FlowDateFlow (cfs)DateFlow (cfs)DateFlow (cfs)	Limit Type: Minimum	1 - Interp.: Step	•	Limit Type:	Minimum	✓ Interp.: Step ▼
O1Jan 75.0 01Apr 25.0 01Nov 75.0 01Nov 75.0 01Nov 75.0 01Nov 75.0 01Nov 75.0 01Nov 75.0 01Apr 88.0 01Apr 38.0 01Apr 38.0 01Nov 88.0 0200000000000000000000000000000000000			_	Downstream	Location:	Dry Creek
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4. Rule: DROC_BIOP

The rule *DROC_BIOP* (Figure 55) sets the allowable decreasing rate of change. The 2008 Biological Opinion report (BiOp) allows releases to be ramped down of 25 cfs/hr when outflows from the reservoir are less than 250 cfs, 250 cfs/hr when outflows from the reservoir are between 250 cfs and 1,000 cfs, and 1,000 cfs/hr when outflows from the reservoir are above 1,000 cfs.

Operations Operations Operations Operation Set Baseline Description Zone-Rules Rel. Alloc. Outages Stor. Credit Dec. Sched. Projected Elev Cemergency MaxReleaseFlood_Gates Flood Control Operates Release From: Lake Sonoma Min70-Base Hatchery Operates Release From: Lake Sonoma Rel. Rising_5000 Description: Imergency Min70-Base Hatchery Description: Imergency MaxatGeyserville Decreasing 1,000 Min70-Base Hatchery Type: Decreasing 1,000 Min70-Base Hatchery Ninterpolate Linear 490 Min70-Base Hatchery Ninterpolate Elease (cfs) Rate Change (cfs/hr) 400 MaxatGeyserville NaxatGeyserville 250.0 250.0 200 400 <t< th=""><th>Lake Sonoma</th><th> Description </th><th></th><th></th><th></th><th></th><th>H 4</th><th>1 of 2</th><th>•</th></t<>	Lake Sonoma	 Description 					H 4	1 of 2	•
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5. Rule: IROC_BIOP

The rule *IROC_BIOP* (Figure 56) sets the allowable increasing rate of change. The 2008 Biological Opinion report allow releases to be increased up to 1,000 cfs/hr when outflows from the reservoir are less than 1,000 cfs, and up to 2,000 cfs/hr when outflows from the reservoir exceeds 1000 cfs.

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Rising_5000			~		Release (cfs)	

6. Rule: MaxatGeyserville

The rule *MaxatGeyserville* (Figure 57) ensures that Dry Creek near Geyserville does not exceed 7,000 cfs per limitation 3 in the Lake Sonoma Water Control Manual (2004). This rule is a downstream control rule that makes use of internal routing of future downstream flows to set the release.

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Figure 57 MaxatGeyse	OK Cance	Apply

7. Rule: MaxatGuerneville Gage

The rule *MaxatGuerneville Gage* (Figure 58) requires releases to avoid contributing to flows at the Guerneville Gage above 35,000 cfs per limitation 3 in the Lake Sonoma Water Control Manual (2004). This rule is a downstream control rule that makes use of internal routing of future downstream flows to set the release.

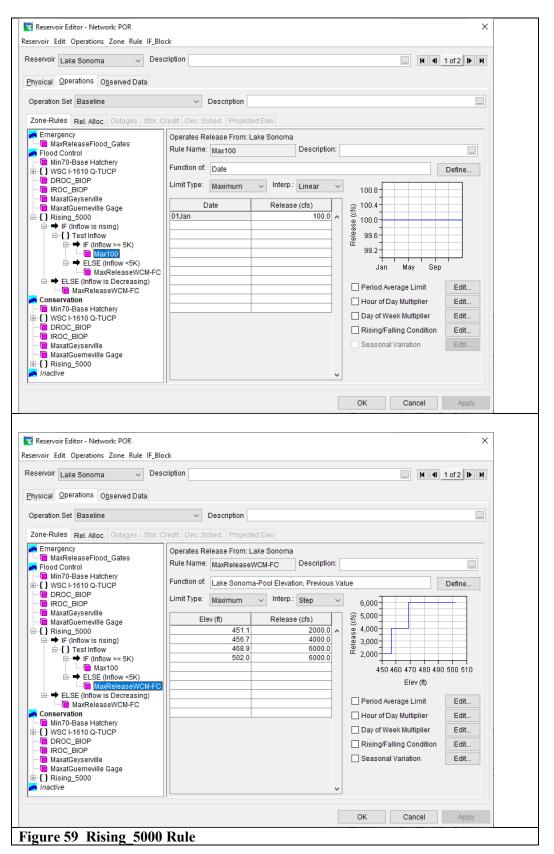
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8. IF_Block: Rising_5000

The IF_Block *Rising_5000* (Figure 59) contains the logic governing the releases to be made in accordance with *Flood Control Schedules 1* through 3 of the Water Control Diagram (Appendix A). *Rising_5000* sets maximum outflows based on the reservoir level, unless the reservoir inflows are over 5,000 cfs and rising. In this case, the outflows were limited to 100 cfs in order to reduce the hazard to an emergency water supply line.

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➡ ELSE (Inflow <5K) ■ MaxReleaseWCM-FC					
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VI. Routing

The HEC-ResSim software provides a set of hydrologic routing methods to be used by the modeler to represent the lag and attenuation effects on flow in a natural river system. The Modified Puls routing method was selected for use in this study because well-calibrated coefficients were available from an HEC-RAS model of the Russian River basin provided by Sonoma Water. HEC-ResSim's downstream operation logic attempts to account for the routing effects when one or more reservoirs are set to operate for a downstream requirement.

There are 11 reaches in the Russian River watershed. All of them use the Modified Puls routing method. The storage and outflow relationship for all routing reaches are shown in Figure 60.

	ResSim Reaches										
	Russian River NR	Lake Mendocino	East-West Junction	Hopland	Cloverdale	Healdsburg	Lake Sonoma_OUT	Dry Creek near	Dry Creek to	Dry Creek	
	Ukiah to	Out to	to	Gage to	Gage to	Gage to Dry	to Dry Creek		Dry	Conf to	Guernevil
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Q cfs	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume	Volume
100.00	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
100.00 200.00	3.42 5.31	10.57 15.61	187.92	181.48 271.11	425.27 633.07	49.67 70.72	28.91 44.05	100.32 153.53	3.98 5.53	201.40 292.35	182. 256.
300.00	7.51	19.75	275.33 347.01	343.43	810.21	88.84	57.53	199.45	6.82	369.04	320
400.00	9.25	23.43	410.26	406.81	971.34	106.50	70.02	241.56	8.06	437.89	380
500.00	10.95	26.86	467.78	465.68	1125.33	123.62	82.56	281.59	9.03	500.73	435
600.00	12.43	30.07	521.28	520.80	1274.28	139.10	93.80	319.62	9.93	560.24	485
700.00	13.80	33.22	571.72	573.71	1418.08	153.06	105.40	358.03	10.78	613.26	533
800.00	14.95	36.16	620.49	624.53	1562.09	166.49	117.15	394.90	11.60	663.19	579
900.00	16.02	38.90	667.29	673.76	1699.18	179.84	128.48	430.43	12.46	710.95	622
1,000.00	17.05	42.01	713.41	726.60	1828.46	192.91	139.88	464.47	13.37	757.34	664.
2,000.00	25.50	66.25	1129.09	1217.18	3032.61	313.70	234.46	797.92	22.79	1194.72	1017
3,000.00	32.42	87.23	1507.63	1638.36	4072.13	422.22	313.69	1123.45	29.94	1570.68	1313
4,000.00	39.59	107.01	1884.83	2007.61	5046.71	508.17	385.52	1393.10	34.52	1915.42	1581
5,000.00	46.88	125.78	2267.44	2374.33	5967.23	595.93	452.77	1635.32	40.31	2257.01	1843
6,000.00 7,000.00	54.75	144.64	2637.83	2704.90 3022.89	6854.45 7742.76	673.09 744.81	519.02	1855.42 2091.84	47.40	2598.23 2928.06	208 2309
8,000.00	60.38 65.73	161.52 176.73	3006.15 3378.94	3333.86	8587.32	813.86	581.36 643.86	2091.84	54.37 60.66	3348.85	2509
9,000.00	70.51	191.52	3785.07	3655.40	9444.80	878.98	712.73	2496.19	66.17	3696.60	2333
10,000.00	75.01	205.70	4232.04	3974.66	10247.49	949.61	776.50	2686.60	71.75	4022.74	2990
11,000.00	79.17	219.53	4724.29	4292.55	11007.76	1016.26	847.05	2875.04	77.57	4351.68	3222
12,000.00	83.26	233.42	5255.88	4665.11	11787.44	1077.95	919.98	3063.50	84.21	4669.60	3444
13,000.00	87.03	246.39	5805.69	5157.88	12529.36	1140.91	996.19	3252.60	90.46	4990.86	36
14,000.00	90.62	259.02	6367.13	5630.55	13230.31	1201.84	1072.87	3444.13	96.96	5316.44	3863
15,000.00	94.21	272.43	6929.30	6142.11	13928.74	1258.42	1154.64	3643.38	102.49	5640.05	4054
16,000.00	97.77	289.04	7496.29	6981.42	14672.34	1311.01	1236.27	3848.37	108.19	5942.71	4246
17,000.00	101.04	314.60	8100.89	7433.77	15185.00	1363.29	1319.17	4062.71	113.91	6250.11	4436
18,000.00	104.26	332.75	8770.65	8060.01	15907.71	1415.38	1401.61	4277.26	119.36	6557.50	4622
19,000.00	107.42	358.16	9357.60	8373.21	16633.79	1465.20	1487.21	4499.52	124.99	6860.57	4814
20,000.00 21,000.00	110.52 113.73	380.40 402.02	9944.65 10509.85	9110.91 9644.91	17274.23 17912.25	1515.09 1563.65	1561.50 1635.53	4722.09 4945.13	130.84 136.27	7174.38 7470.82	500 5193
25,000.00	126.36	402.02	12695.12	11175.28	20416.06	1755.54	1934.98	5854.55	156.27	8824.64	5195
30,000.00	148.39	581.07	15204.18	13641.52	23481.30	2013.50	2269.37	7066.88	184.68	10464.66	701
35,000.00	178.30	674.84	17661.58	16174.36	26470.95	2240.24	2609.13	8373.85	208.23	12252.56	8027
40,000.00	221.32	766.15	19709.55	18353.83	29806.65	2455.98	2960.43	9706.47	229.63	14101.01	9030
45,000.00	267.13	854.53	21742.88	20307.38	32840.53	2703.68	3306.78	11264.17	250.72	16104.12	997
50,000.00	318.31	948.52	23682.38	21945.45	36677.30	2921.24	3601.92	12620.03	271.72	18190.32	10958
55,000.00	374.58	1033.09	25639.31	23833.07	39315.97	3147.53	3885.63	14193.32	292.52	20228.89	11936
60,000.00	425.90	1127.98	27561.94	25951.45	42727.12	3375.00	4117.95	15763.64	312.75	22180.25	12918
65,000.00	477.01	1209.96	29446.30	27925.12	46601.97	3634.86	4345.05	16997.13	332.67	24306.46	13938
70,000.00	496.50	1289.07	31285.32	30019.98	49470.64	3900.82	4564.07	18109.77	352.14	26660.10	1495
75,000.00	527.72	1369.37	33102.90	32148.15	53580.46	4159.74	4781.66	19540.93	356.89	27296.02	15959
80,000.00	557.63	1446.71	34874.04	34160.27	59223.04	4490.16	4991.28	20957.48	378.97	32219.00	16942
90,000.00	614.84	1601.11	38419.20 41805.30	38115.16	70207.76 79721.70	5389.79	5404.88	22599.00	462.29	38816.62 44703.45	18872 20757
110,000.00	668.39 719.04	1768.64 1939.42	41805.30	41627.67 45611.12	89312.92	6322.20 7147.90	5782.57 6026.35	23785.05 25528.83	603.26 633.63	53070.50	20757
120,000.00	766.68	2102.81	48513.50	49559.00	97315.91	7854.98	6337.52	27255.39	663.99	58730.03	24225
130,000.00	812.33	2267.67	51796.70	53647.30	105193.15	8636.99	6651.65	28902.64	758.25	64029.68	25880
140,000.00	857.63	2433.26	55088.40	57591.10	117443.55	9518.38	6969.11	30500.44	839.08	72080.55	27474
150,000.00	899.38	2601.31	58437.90	61482.90	125888.15	10489.27	7262.82	32158.18	887.12	79359.88	29040
200,000.00	1091.38	3418.48	74865.10	80611.80	169715.46	14205.85	8725.76	39472.31	1469.86	113963.64	36415
300,000.00	1409.17	4949.06	108160.10	117753.00	250629.68	24091.06	11387.27	54268.68	3322.89	164510.60	49352
400,000.00	1700.94	6436.36	142123.50	153949.50	336691.99	33972.93	13871.76	70613.42	5291.68	214669.80	60840
100,000.00											

VII. Diversions

A. Potter Valley Project

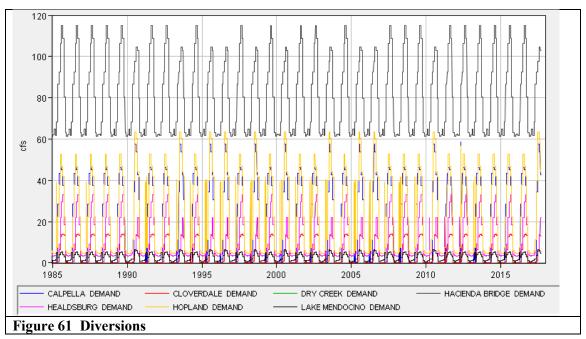
Water has been diverted from the Eel River to the upper reach of the East Fork of the Russian River for power generation purposes at the Potter Valley Project (PVP) since the early 1900s. Diversions from the Eel River through the PVP have historically averaged over 150,000 AF annually. Since 2006, operation of the PVP under the terms of Biological Opinion and the amended licenses has significantly reduced PVP diversions compared to historical levels. These reduced PVP flows have significantly reduced inflows into Lake Mendocino and impacted its water supply reliability. Also, the timing of the PVP diversion reductions has impacts on Lake Mendocino water supply reliability. Springtime diversions from the PVP have been greatly reduced since 2006. (SCWA, 2015).

The PVP flow is modeled as a local flow at "Lake Mendocino_IN" junction.

B. Consumptive Withdrawals

Water withdrawals occur in the Russian River basin for various purposes. Sonoma Water developed estimates for the distributed losses throughout the Russian River watershed. These losses include Sonoma Water's diversions and all other depletions from the watershed, including evapotranspiration by riparian vegetation, aquifer recharge, agricultural diversions, and non-Sonoma Water municipal and industrial (M&I) diversions. Sonoma Water serves as the best source of data on this topic.

For the HEC-ResSim modeling, the simulation relies on some constructed data for the diversions, implemented as repeating annual patterns. The years are classified as wet or dry, with separate annual patterns developed for both conditions. Figure 61 shows the diversions in the watershed. Table 1 shows the list of diversions and their locations.



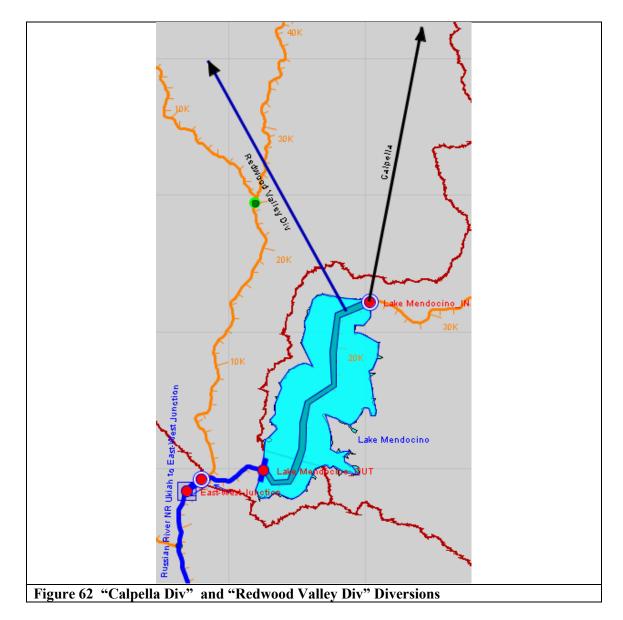


Figure 62 shows the "Calpella Div" diversion from "Lake Mendocino_IN" junction and "Redwood Valley Div" diversion from the diverted outlet at Lake Mendocino.

Figure 63 shows the "Hopland Div" diversion from "Hopland Gage" junction and "Cloverdale Div" diversion from "Cloverdale Gage" junction.

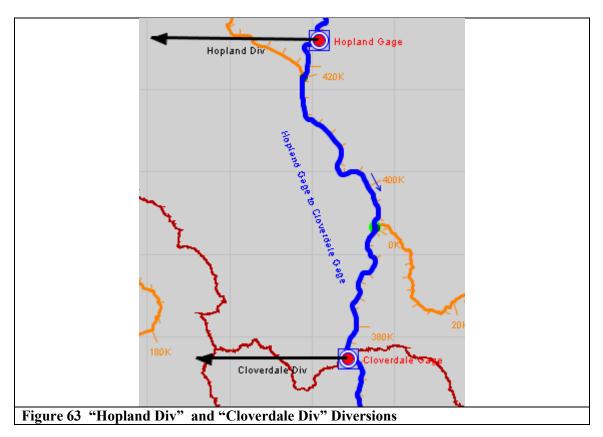


Figure 64 shows the "Healdsburg Div" diversion from "Healdsburg Gage" junction and "Dry Creek Div" diversion from "Dry Creek" junction.

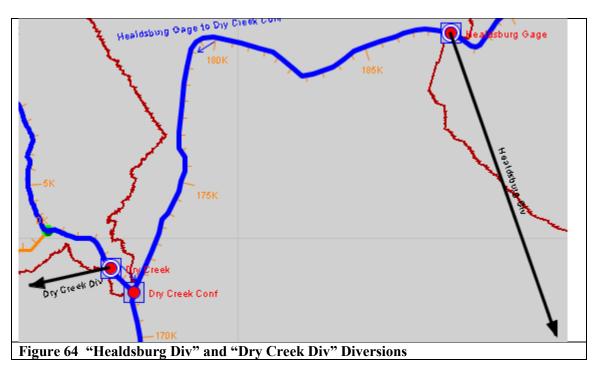
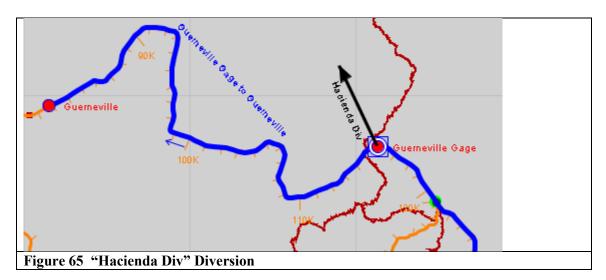


Figure 65 shows the "Hacienda Div" diversion from "Guerneville Gage" junction.



VIII. Baseline Validation Results

Reservoir model validation compares results against historical data to determine whether the model reacts as desired under the same circumstances. Validation results were only evaluated at Lake Mendocino, and were not assessed for Lake Sonoma. Operation of Lake Mendocino is not affected by Lake Sonoma outflows.

The historical observed outflows and pool levels for Coyote Valley Dam represent different regulation practices and diversion flows, so the model results reflecting the Existing Condition are unlikely to match the historical observations. The primary differences from historical operations, especially during the early years of Lake Mendocino, involve:

- 1) The *Baseline* alternative assumes the existence of current Potter Valley Project flows. The current flows diverted from the Eel River are greatly diminished from historical amounts. The *Baseline* results in the FIRO analysis reflect a drier system than what occurred in the observed record.
- 2) The *Baseline* alternative reflects higher agriculture and municipal demands than historically occurred, as well as newer requirements for instream environmental flows. The *Baseline* reservoir storage depletions often exceed historical amounts.
- 3) Reservoir operating practices of the past differ from the *Baseline* simulation rules. Some standard practices have evolved, such as earlier reservoir filling dates in recent years. In other situations, the historical operations differ from the expected plans for unknown reasons. The *Baseline* simulation does not have access to all the information available to the human operators of the past, and does not attempt to represent the judgment calls that occur throughout the historical record.

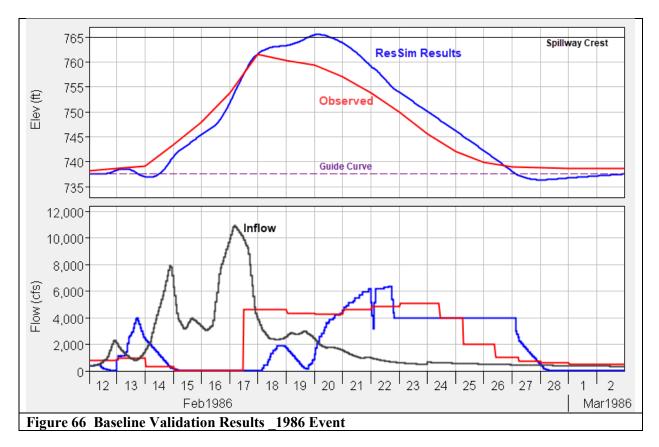
Because the goal of this study was to assess flood risk for FIRO alternatives, it was important to validate flood operation for the largest events in the available Period of Record (1986, 1995, 1997, and 2006).

Figure 66 to Figure 71 show the *Baseline* results validation for 1986, 1995, 1997, and 2006 events at Lake Mendocino, showing short windows from the Period of Record computation. Inflows shown in the figures represent modeled *Baseline* reservoir inflows.

1. 1986 Event

Figure 66 displays the baseline validation results for the 1986 event. When the 1986 event started, the historical operation and modeled reservoir were almost at the same pool elevation. The modeled reservoir gets to the higher flood pool due to different release decisions. Both the historical operation and modeled reservoir try to get back to guide curve as soon as possible. This takes a longer time for the modeled reservoir since it has a higher flood pool.

For the 1986 event, the maximum modeled flood pool elevation is 765.52 feet and the historical operation flood pool elevation is 761.57 feet. This means that the modeled reservoir flood pool elevation is 3.95 feet higher than the historical reservoir flood pool elevation.



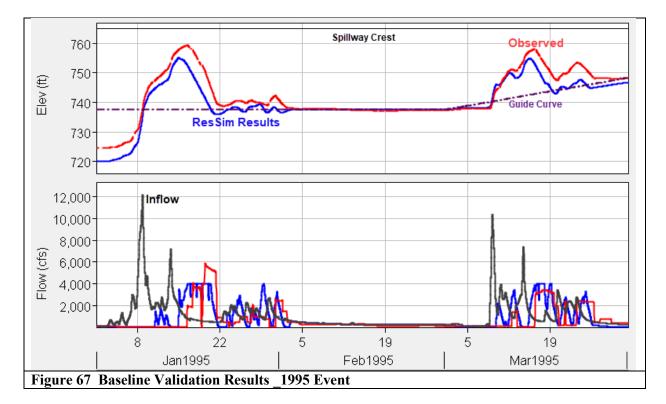
2. 1995 Event

Figure 67 displays the baseline validation results for two 1995 events in January and March. The modeled reservoir level enters the January event lower than the historical level and keeps a lower peak flood pool. The historical operation and modeled reservoir enter the second event in March

1995 at the same pool level and get to almost the same maximum flood pool. However, the modeled reservoir gets back to guide curve more aggressively and stays on the guide curve. This is because the current guide curve was not applied until 2009. The historical operation stays at a pool level around 748 feet, which was the applied guide curve in 1995.

For the January 1995 event, the maximum historical operation flood pool elevation is 759.26 feet, and the maximum modeled reservoir flood pool elevation is 755.06 feet. This means that for the January 1995 event, the historical reservoir flood pool elevation is 4.2 feet higher than the modeled operation flood pool elevation.

For the March 1995 event, the maximum historical operation flood pool elevation is 758.09 feet, and the maximum modeled reservoir flood pool elevation is 754.77 feet. This means that for the March 1995 event, the historical operation flood pool elevation is 3.32 feet higher than the modeled reservoir flood pool elevation.

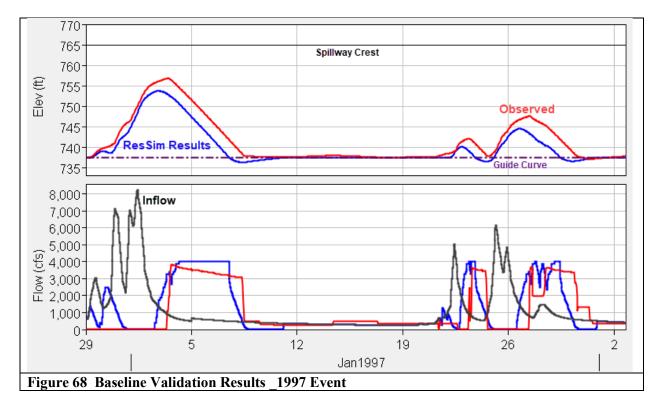


3. 1997 Event

Figure 68 displays the *Baseline* validation results for the January 1997 event. When the 1997 event started, the historical operation and modeled reservoir were at almost the same pool elevations. The historical operation gets to the higher flood pool due to different release decisions at the end of December, perhaps because of downstream flooding concerns. Both the historical operation and modeled reservoir try to get back to guide curve as soon as possible. This takes a longer time for the historical reservoir since it has a higher flood pool.

At the beginning of the January 1997 event, the historical operation flood pool elevation was 756.82 feet and the modeled reservoir flood pool elevation is 753.76 feet. This means for the first peak of the January 1997 event, the historical operation flood pool elevation is 3.06 feet higher than the modeled reservoir flood pool elevation.

During the second peak of the January 1997 event, the historical operation flood pool elevation was 747.62 feet, and the modeled reservoir flood pool elevation is 744.51 feet. This means that for the second peak of the January 1997 event, the historical operation flood pool elevation is 3.11 feet higher than the modeled reservoir flood pool elevation.

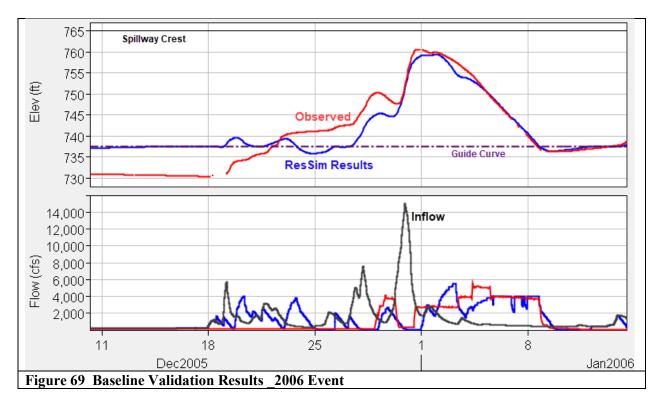


4. 2006 Event

Figure 69 displays the *Baseline* validation results for the 2006 event. The modeled reservoir level enters the prior small events starting on 19 Dec 2005 at an elevation 7 feet higher than the historical level. The guide curve used in the model allows for storage up to 761.8 ft for all simulated years, while the historical operation only allowed storage up to 748 ft before 2007. As a result, the modeled storage in 2005 was higher than the observed, which carried over to December.

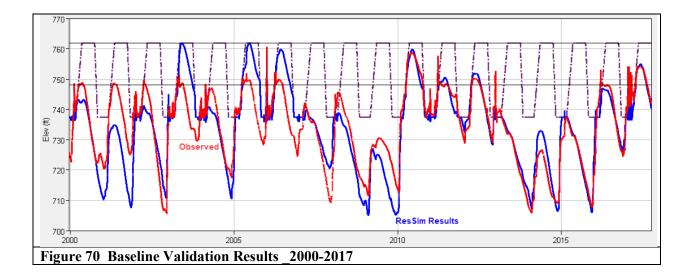
Both the historical operation and modeled reservoir get to the maximum flood pool at almost the same elevation because at the end of December the observed flood release is twice as high as modeled release.

The maximum historical operation flood pool elevation was 760.63 feet, and the modeled reservoir flood pool elevation is 759.42 feet. This means that for the 2006 event, the historical



operation flood pool elevation is 1.21 feet higher than the modeled reservoir flood pool elevation.

Figure 70 displays the *Baseline* validation results for the years 2000 through 2017. The current guide curve with the summer pool at 761.8 feet came into use during 2009. Note that the reservoir typically failed to re-fill the pool in spring due to diminished inflow from the Potter Valley Project. Also note that observed level prior to 2009 reflects operations using a different guide curve with the summer pool at 748 feet, while the simulated reservoir operations always used a guide curve elevation of 761.8 feet.



IX. Representation of Baseline Operation

A typical flood operation and conservation operation simulated at Coyote Valley Dam for the *Baseline* alternative is provided in this section.

A. Coyote Valley Dam

1. Flood operations

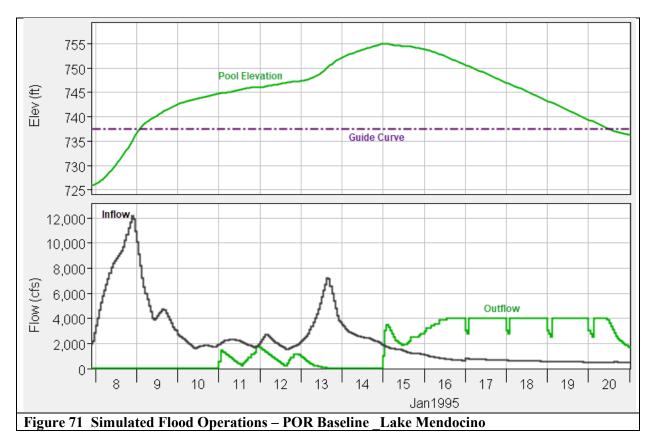
A typical flood operation simulated at Coyote Valley Dam for the *Baseline* alternative is provided in Figure 71. Prior to 9 January, the pool was below the guide curve and the reservoir was releasing only the minimum 25 cfs.

Inflows from the first storm drove the pool above guide curve on 9 January. Early on 9 January, the West Fork gage was falling and the pool remained below 755 feet, so the Coyote Valley Dam release was based on West Fork flows, according to the relationship specified in the *Hopland fn* of WF IF_Block. According to that relationship, outflows remain limited to 25 cfs flow while the West Fork flows exceed 2,150 cfs. The *Hopland fn of WF* IF_Block (*Section IV.2.9*) displays the detail of this relationship. Based on this rule, when the West Fork gage was rising, outflows remained limited to 25 cfs flow while the West Fork flows exceeded 650 cfs.

The reservoir continued to follow the *Hopland fn of WF* IF_Block conditions and released appropriate flows, based on both the West Fork flow values and the rising or falling condition with a pool elevation below 755 feet. The outflow is constrained by the maximum limit of 4000 cfs applied by the *MaxReleaseWCM-FC* rule starting on 16 January.

The pool rose above 755 feet only in the first two time steps of 15 January. The *IROC_BIOP* rule constrained the release to 1025.6 cfs and 3025.6 cfs in these time steps. The pool followed the relationship defined in the 'falling \geq =755' condition of the *Hopland fn of WF* IF_Block at 15 January 1995, 03:00.

The reservoir attempted to limit outflows to 25 cfs according to the rule for rising flows at Ukiah at the beginning of 11, 12, and 13 January, but the DROC requirement limited the release change to a maximum of 100 cfs/hour, taking several hours to reach 25 cfs each time.

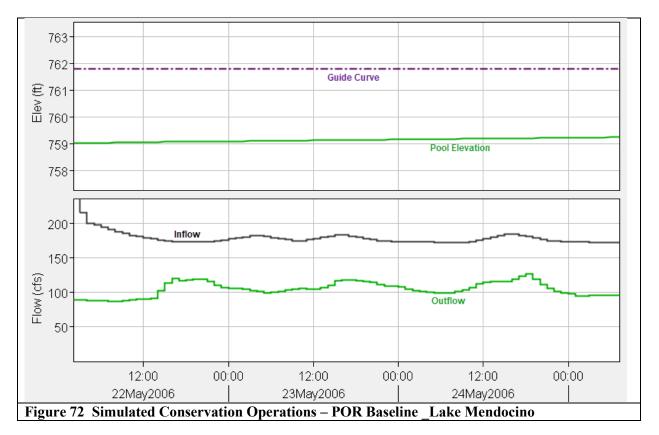


2. Conservation Operation

Conservation releases were generally determined according to the highest of the minimum flow rules. HEC-ResSim iteratively performed linear routing of candidate releases to evaluate which of the downstream minimum locations controlled. The calculations included local flows from downstream tributaries and diversions out of the river. A typical series of release decisions for a period of time when the reservoir was in the conservation pool (i.e., below guide curve) and the watershed had a hydrologic index of "Normal" is displayed in Figure 72.

SWRCB Decision 1610 requires that the Coyote Valley Dam releases ensure 125 cfs throughout the Upper Russian River during the month of May, and the model rules included an additional 5 cfs buffer for East-West junction and a 9 cfs buffer for locations from Hopland through Healdsburg, making the effective minimum 130 for East-West junction and 134 cfs for locations from Hopland through Healdsburg.

Until 22 May 2006, 13:00 the reservoir released around 86 cfs to maintain the desired flow at East-West junction. Starting at the next time step, the Hopland Gage junction controlled the minimum release until 25 May 2006, 02:00. This shift in controlling rules occur due to a change in local flows.



X. Description of State Variables

A. StorageState

The "StorageState" state variable code (script) computes the Lake Mendocino storage index. This script is evaluated by HEC-ResSim each time-step during the model simulation. Output from the script is the index used when setting minimum flows from Lake Mendocino in *WSC I-1610 Q-TUCP* IF_Block logic.

The script checks the date of the time step. At the beginning of June, the script reads in the storages from Lakes Mendocino and Pillsbury and defines the combined storage. The *Slave_CombineStorageid_May31* state variable stores the combined storage value. That value is maintained through the rest of the year (unless other criteria are met in the fall).

```
#####
###### STATE VARIABLE SCRIPT INITIALIZATION SECTION
######
```

from hec.script import Constants from hec.hecmath import TimeSeriesMath, DSS, DSSFile from hec.script import ClientAppWrapper

This script is evaluated by HEC-ResSim each time-step during the model simulation. Output from the script is # the hydrologic index used when setting minimum flows from Lake Mendocino in WSC I-1610 Q-TUCP If logic. # Script checks the date of the time step. At the beginning of June, the script reads in the storages from lake # Mendocino and Pillsbury and defines the combined storage (Slave_CombineStorageid_May31 state variable stores # the combined storage value). That value is maintained through the rest of the year (unless other criteria met

in the fall).

def initStateVariable(currentVariable, network):

tw=network.getRssRun().getCurrentComputeBlockRunTimeWindow()
tws = tw.getTimeWindowString()

currentVariable.localTimeSeriesNew("step") currentVariable.localTimeSeriesNew("curmonth") currentVariable.localTimeSeriesNew("curday") currentVariable.localTimeSeriesNew("curhour") currentVariable.localTimeSeriesNew("combStorMay31") currentVariable.localTimeSeriesNew("mendfractionMay31")

return Constants.TRUE

STATE VARIABLE SCRIPT COMPUTATION SECTION

from hec.heclib.util import HecTime from hec.script import ClientAppWrapper from hec.hecmath import DSS

curmonth=currentRuntimestep.month() curday=currentRuntimestep.getHecTime().day() curhour=currentRuntimestep.getHecTime().hour() step = currentRuntimestep.getStep()

step_TS=currentVariable.localTimeSeriesGet("step")
step_TS.setCurrentValue(currentRuntimestep, step)

curmonth_TS=currentVariable.localTimeSeriesGet("curmonth") curmonth TS.setCurrentValue(currentRuntimestep, curmonth)

curday_TS=currentVariable.localTimeSeriesGet("curday") curday_TS.setCurrentValue(currentRuntimestep, curday)

curhour_TS=currentVariable.localTimeSeriesGet("curhour") curhour TS.setCurrentValue(currentRuntimestep, curhour)

combStorCap = 160370 #Combinded LM and LP storage capacity

#Get StorageState value from previous time step stateid = currentVariable.getPreviousValue(currentRuntimestep) mendStateid = currentVariable.getPreviousValue(currentRuntimestep) combineStorageid_May31SV = network.getStateVariable("Slave_CombineStorageid_May31")

If time step is prior to dry spring then set id to 1
if curmonth<=5:
 stateid = 1
 mendStateid = 0</pre>

if curmonth>=6:

mendStateid = 0 if curmonth == 6 and curday == 1 and curhour==6:

> mendStorTS = network.getTimeSeries("Reservoir","Lake Mendocino", "Pool", "Stor") pillStorTS = network.getTimeSeries("Reservoir","Lake Mendocino", "Pillsburry Storage", "",1) #pillStorTS = currentVariable.localTimeSeriesGet("pillStorTS")

```
mendStorMay31 = mendStorTS.getValue(step-1)
pillStorMay31 = pillStorTS.getValue(step-1)
combStorMay31 = mendStorMay31+pillStorMay31
mendfractionMay31 = combStorMay31/combStorCap
```

combStorMay31_TS=currentVariable.localTimeSeriesGet("combStorMay31") combStorMay31_TS.setCurrentValue(currentRuntimestep, combStorMay31)

mendfractionMay31_TS=currentVariable.localTimeSeriesGet("mendfractionMay31") mendfractionMay31_TS.setCurrentValue(currentRuntimestep, mendfractionMay31)

```
if combStorMay31 >= 150000 or mendfractionMay31 > 0.9:
                            combineStorageid May31 = 1
                   elif combStorMay31 >= 130000 or mendfractionMay31 > 0.8:
                            combineStorageid_May31 = 2
                   else:
                            combineStorageid May31 = 4
                   combineStorageid_May31SV.setValue(currentRuntimestep, combineStorageid_May31)
         else:
                   combineStorageid May31 = combineStorageid May31SV.getPreviousValue(currentRuntimestep)
                   combineStorageid_May31SV.setValue(currentRuntimestep, combineStorageid_May31)
else:
 combineStorageid May31SV.setValue(currentRuntimestep, 1)
if curmonth>=10:
         mendStor = network.getTimeSeries("Reservoir","Lake Mendocino", "Pool",
"Stor").getCurrentValue(currentRuntimestep)
         if mendStor < 30000:
                  mendStateid = 3
         else:
                   mendStateid = 0
if mendStateid == 3:
         stateid = 3
else<sup>.</sup>
         stateid = combineStorageid May31SV.getValue(currentRuntimestep)
currentVariable.setValue(currentRuntimestep, stateid)
######
##### STATE VARIABLE SCRIPT CLEANUP SECTION
#####
```

from hec.script import Constants

```
currentVariable.localTimeSeriesWriteAll()
```

B. Slave_CombineStorageid_May31

"Slave_CombineStorageid_May31" is a slave state variable that stores the combined storage of Lakes Mendocino and Pillsbury and is used in *StorageState* state variable.

XI. Reference

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